Naval Education and Training Command

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Training Manual (TRAMAN)

Shipboard Electronics Material Officer

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Naval Education And Training Program Management Support Activity

SHIPBOARD ELECTRONICS MATERIAL OFFICER

NAVEDTRA 12969

1992 Edition Prepared by
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PREFACE

This text and the associated NRTC were prepared to provide officers of the Navy and Naval Reserve with information about the organizational and administrative responsibilities of the shipboard electronics material officer (SEMO).

The purpose of the text is to condense, update, and supply information of a practical nature to shipboard electronics material officers to help them understand and carry out their duties.. This discussion of organizational and administrative duties includes shipboard organization, training, safety, and security information and procedures.. Typical electronic systems that the SEMO may encounter aboard ship are also included.. The supply operations and procedures related to the SEMO's particular duties are also discussed in this text.

This manual was prepared by the Naval Education and Training Program Management Support Activity, Pensacola, Florida, for the Chief of Naval Education and Training.

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations as we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

CONTENTS

CREDITS

The illustrations listed below are included in this edition of *Shipboard Electronics Material Officer* through the courtesy of the designated sources.. Permission to use these illustrations is gratefully acknowledged.. Permission to reproduce illustrations and other materials in this publication must be obtained from the source.

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CHAPTER 1

ORGANIZATION AND ADMINISTRATION

OBJECTIVES

Describe the material and administrative duties of the EMO.

Describe the electronics division within the shipboard organization.

OUTLINE

Mission, duties, and responsibilities

Organizing the electronics division

Directives and correspondence

We have designed this text for the junior line officer, warrant officer, or limited duty officer who is assigned to shipboard electronics material officer (EMO) duties. Also, it will prove helpful for a senior enlisted petty officer who must fill the role as an EMO, either on a permanent or temporary basis. Our intent is to furnish a practical approach to the maintenance and logistic support of electronic equipment. This instruction will also serve as a ready reference when you carry out your administrative duties. The contents of this text is also appropriate for personnel assigned to combat systems division officer duties on board sea and shore commands.

Based on data gathered as a result of inspections of electronic material aboard ships for the past several years, inspecting officers have concluded that the good material condition of shipboard electronic equipment is more often the result of **administrative** rather than technical ability. The EMO does not need extensive electronics training to administer the electronics division. However, the EMO must have knowledge of the capabilities, limitations, and reliability of the equipment. With this information, the EMO will be able to brief the chain of command as to what to expect from the equipment, and whether it is operating according to design capabilities. It is not part of the EMO's job to repair inoperative equipment or adjust equipment that does not meet performance standards, but he is charged with the responsibility of directing and coordinating equipment maintenance programs. In this publication the terms *shipboard electronics material officer, shipboard electronics officer, electronics readiness officer, electronics officer, electronics coordination officer*, and *electronics maintenance officer* (EMO) are synonymous.

In this chapter, we will present various organizational and administrative responsibilities at a general level. We do not include all areas of organization and administration. In the chapters throughout this text, we will provide amplifying information to support your organizational and administrative responsibilities. A quick check of the table of contents at this point will provide you an overview of the book.

MISSION OF THE ELECTRONICS DIVISION

In simple terms, the mission of the electronics division is to ensure the operational readiness of all assigned electronic equipment. To fulfill this requirement, the electronics division must be organized efficiently to perform preventive and corrective maintenance, train personnel, maintain and submit records and reports, maintain and clean electronics spaces, administer electronics supply, and inventory equipment. A brief description of these requirements is given under the section covering the EMO's duties and responsibilities. They are described in detail in a later chapter.

DUTIES AND RESPONSIBILITIES OF AN EMO

The general and specific duties of the electronics material officer is outlined in the *Standard Organization and Regulations of the U.S. Navy* (SORM), OPNAVINST 3120.32. In addition to providing a list of duties of the EMO, the SORM, fully describes the ship's organization. It also outlines the duties and responsibilities of the various departments and divisions, gives the procedures for accomplishing the various tasks and duties, and lists the ship's regulations. All commands have individual SORMs that are tailored through deletions, substitutions, or additions to OPNAVINST 3120.32 to conform to that particular unit's mission, task, and function. Additionally, each department and each division has an organization manual. The electronics division organization manual is more commonly referred to as the electronics doctrine.

NOTE: These will be amplified and additional duties and responsibilities will be delineated in TYCOM, IUC, and command instructions.

General Duties

> "The EMO will be responsible, under the operations officer, for the readiness of all assigned electronic equipment, the administration of electronics material maintenance, and the repair of all shipboard electronic equipment other than weapons control radar and equipment specifically assigned to another division. In ships having a combat systems department, the EMO's duties will be performed by the Electronics Coordination Officer (ECO)."
>
> (**NOTE**: The electronics coordination officer reports directly to the combat systems officer.)

The specific duties of an EMO are as follows:

- Ensure that electronics personnel are familiar with and follow **electrical/electronic safety procedures**.
- Be responsible for the maintenance and repair of all electronic equipment, excluding weapons control radar and equipment specifically assigned to another division.
- Manage and supervise the electronics Maintenance Material Management Program (3-M).
- Provide for maximum operational readiness of electronic equipment by performing operational tests and established maintenance procedures.
- Provide for correct use, maintenance, and repair of assigned electronic repair equipment.
- Direct equipment modifications required by authorized field changes.
- Establish and maintain a reporting and record system in accordance with current instructions on the material status of all electronic equipment under his/her cognizance, including authorized equipment changes, repairs, and expenditure of repair funds.
- Assist and advise operating personnel, as requested by cognizant officers, in the proper operational procedures and characteristics of electronic equipment, including performance capabilities and limitations.
- Prepare for forwarding through the engineering officer work lists for shipyard availability repairs, and provide detailed specification and information requests for shipyard work. Follow-up with shipyard officials on work status; keep informed of work progress, and carry out inspection of completed work.
- Keep informed of the ship's current general-purpose electronic test equipment (GPETE) allowance and ensure the requisition and procurement of authorized test equipment. Supervise the installation and storage of such equipment in accordance with Test Equipment Storage Guide.
- Maintain a technical library including at least two copies of instruction books for each type of equipment under his/her cognizance, and other related Navy manuals and commercial publications.
- Advise the supply officer on the requisitioning of electronic spare parts and ensure the ready availability of such parts.
- Conduct a training program for assigned personnel.
- Be responsible for the cleanliness and preservation of assigned spaces.
- Be aware of technological developments and advancements in the field of electronic equipment, maintenance, repair techniques, and especially information affecting the ship's installation.

The shipboard duties and responsibilities of the EMO may be divided into two main areas: material and administration. These two areas are not entirely separate and should be viewed as interdependent. They are, however, distinct elements of the EMO's responsibilities.

Material Duties

Material readiness of shipboard electronic equipment and systems is based, in part, upon the installation, support, and maintenance of the equipment and its systems. Material duties of the (EMO) will include direct involvement with all areas that are related to material readiness. Some of the material duties are discussed in the following four paragraphs.

1. Preventive Maintenance: Regularly scheduled maintenance actions performed to prevent equipment malfunction are categorized as preventive. Ideally, preventive maintenance is designed to preclude malfunctioning and sets forth the minimum performance standards for an equipment. Practically, it is recognized as a program for minimizing the amount of corrective maintenance that would otherwise be required. The primary means of administering preventive maintenance is the Planned Maintenance System (PMS) in accordance with OPNAVINST 4790.4.
2. Corrective Maintenance: Maintenance activity performed on equipment after a malfunction has occurred is defined as corrective. Its purpose is to restore equipment that is not operating to its maximum operational capability in accordance with equipment technical manuals and established directives.
3. Equipment Installation: The installation of electronic equipment by the ship's force for special operating commitments, or other reasons, is the responsibility of the EMO. Installation criteria are governed by various instructions and directives, depending upon the equipment involved and the type of installation. Equipment installations accomplished by other than the ship's force may require the EMO to assume test, acceptance, and reporting responsibilities. Accounting for configuration changes in the ship's equipment is under the cognizance of the Naval Sea Systems Command, through the Ship Configuration and Logistics Support Information System (SCLSIS). The reporting of configuration changes are made in accordance with OPNAVINST 4790.4 using the OPNAV Form 4790/CK.
4. Field Changes: Field changes are properly authorized modifications to equipment accomplished by personnel on ships or at maintenance facilities. Field change kits and field change information are disseminated under the Field Change Program administered through the command having cognizance over that specific equipment. The Naval Sea Systems Command (NAVSEA) and the Space and Naval Warfare Systems Command (SPAWARS) are examples of such commands. Field changes are mandatory, and they must be installed correctly and in a timely manner. The EMO is guided by the instructions accompanying each field change kit. The prerequiste to accomplishing any field change is to ensure that the equipment is fully operational.

Administrative Duties

Shipboard training and the maintenance of material are two major factors contributing to battle readiness. Although one cannot be said to be more important than the other, **training is always a prerequisite to maintenance**. Shipboard training contributes to the ship's ability to function as a fighting unit, directly through operational training and indirectly through maintenance training. For the electronics division, the subject of most divisional instruction is electronics maintenance. The training of electronics technicians in operational areas occurs mainly in interdivisional drills conducted during general quarters and refresher training. Weekly operational training can be conducted in conjunction with Overall Combat System Operability Test (OCSOT).

The EMO, as a division officer, is responsible for preparing a divisional training program. To support this program, divisional training objectives are designed to provide personnel with training in their assigned duties, general military matters, advancement, and personal improvement.

To provide uniformity of training and to assure adequate training time, the division training program is an extension of the ship and department training plans. The administration of shipboard training programs is covered in detail in the SORM. The success of the divisional training program is dependent upon proper documentation and scheduling.

Training often includes use of Personnel Qualification Standards (PQS) for watchstation qualifications. A watchstation, as it applies to PQS, refers to those positions normally assigned by a watchbill, usually of four-hour duration, and in the majority of cases, operator oriented. PQS is mandatory.

Further information on PQS may be found in OPNAVINST 3500.34 and in the text entitled, *PQS Management Guide*, NAVEDTRA 43100-1.

Supervision and Assignment of Electronics Technicians

Direct technical supervision of electronics technicians is the job of the leading electronics technician or group supervisor. Supervision by an **officer** entails knowing who is on what job, what progress is being made, and any difficulties that have arisen that could keep the job from being completed on time. The officer should also know the status of repair parts, availability, and location on board or elsewhere. The best way to get this information is through your leading ET. You should have a good working relationship with your technicians, but this works better when you use the chain of command. Do not look over the technician's shoulder in a bothersome manner. Good technicians are worth their weight in gold. Let them do their job. The EMO should tour the electronics spaces at least once a day, as well as prior to special evolutions such as sea detail. Your **presence** should be known on the bridge and CIC in order that you may handle any last minute radar or communication problems. The leading electronics technician will assign technicians to particular jobs. He will have a better idea who is most qualified. Remember, use your senior ET resources to the maximum extent possible. The EMO is ultimately responsible for the administration and maintenance, and he must know who is doing what job. If that is all you know initially, it is a good start to effective electronics maintenance.

Records and Reports

The EMO is responsible for maintaining records and submitting at periodic intervals certain material and operational reports on electronics equipment. Various records relating to the custody, inventory, status, and disposition of electronic equipment are maintained by electronics personnel under the direction of the EMO.

Rules governing the requirements for equipment record keeping may be found in the *Naval Ships' Technical Manual*, NAVSEA S9086-C2-STM-000/Ch-090; the *Electronics Installation and Maintenance Book (EIMB) General Handbook*, NAVSEA SE000-00-EIM-100; the *Ship Configuration and Logistics Support Information System*, NAVSEA S0752-AA-SPN-010/SCLSIS; and the *Ships' Maintenance and Material Management (3-M) Manual*, OPNAVINST 4790.4. The latter two publications deal with programs in which the EMO has a major responsibility for record keeping and reporting. Additionally, the EMO has a responsibility for reporting equipment casualties by message, under the Casualty Reporting System (CASREP) detailed in NWP 10-1-10, Operational Reports.

Maintenance and Cleanliness

The upkeep and cleanliness of a space reflect the effectiveness of supervision and division administration. Cleanliness is essential for proper maintenance. Dust can inhibit the proper ventilation of electronic equipment, causing overheating with resultant circuit breakdown. Dust accumulating between electronic components develops resistance, inherently causing premature failure of those components. In addition, it acts as an abrasive, which can cause parts to wear excessively. Top to bottom space cleanliness will reduce electronic equipment downtime.

Administration of Electronics Supply

Without an adequate supply of spare parts, tools, and test equipment, the maintenance of electronic equipment would be an impossible task.

To achieve a responsive maintenance program, each department is allocated funds based on projected needs for a calendar quarter. The department head then determines, through the division officers, how much money each division will need to function. As part of this projection, the electronics division requires tools, consumables, and equipage items to replace those lost, expended, or surveyed. Like all good plans, this one fails to take into consideration unexpected systems repairs resulting from operations on heavy seas.

These needs should be accounted for in the EMO's input to the annual budget. However, care must be taken to ensure requirements are valid and within budget constraints. The Coordinated Shipboard Allowance List (COSAL) and the Coordinated Shorebase Allowance List (COSBAL) ensure that a supply of spare parts is kept on hand. The EMO should be very familiar with the COSAL. This is the document used by the supply department to replenish those applicable parts and to establish procedures for requisitioning onboard spares.

Keeping the CO Informed

No ship can perform effectively if the commanding officer is not aware of the capability of all its systems at any given moment. If a piece of equipment fails or is not operating to design specifications, the EMO should use the chain of command, to verbally inform the operations officer or combat systems officer (as applicable) of the problem. The equipment status section of the operations/combat systems department daily eight o'clock reports meets this need. It then becomes the operations/combat systems officer's responsibility to relay the information to the commanding officer. Some commanding officers prefer a more direct link to the EMO, and will question the EMO extensively about a particular problem. **Be sure** to inform your operations/combat systems officer if the CO should ask you a direct question concerning equipment status. You must keep your operations/combat systems officer informed of all aspects of electronic equipment status. One way that you can keep completely informed of all electronic equipment status is to type the eight o'clock reports yourself. Either a SNAP 2 or personal computer has proved useful for this purpose.

STANDARD SHIP ORGANIZATION

Because the Navy has standardized shipboard organization, it is much the same on all ships in the Navy, differing only to accommodate specific functions of unique types of ships.

To have good shipboard administration, there must be sound shipboard organization. A shipboard organization, designed to carry out the objectives of the command, is based on a division of activities and on the assignment of responsibilities and authority to individuals within the organization.

The responsibility for organization of the officers and crew of a ship is assigned to the commanding officer by *United States Navy Regulations, 1973*, (with changes) and the SORM, OPNAVINST 3120.32. The executive officer is responsible, under the commanding officer, for the organization of the command as a whole. The heads of departments are assigned the duty of organizing their departments for readiness in battle and assigning individuals to stations and duties within their respective departments. The EMO who will be the division officer for the electronics division will manage his division.

Battle Organization

The requirements for battle form the basis for the organization of combat ships and, as appropriate, for the organization of noncombatant ships. Functional groups, such as those shown in figure 1-1 (Aegis Cruiser Condition I),

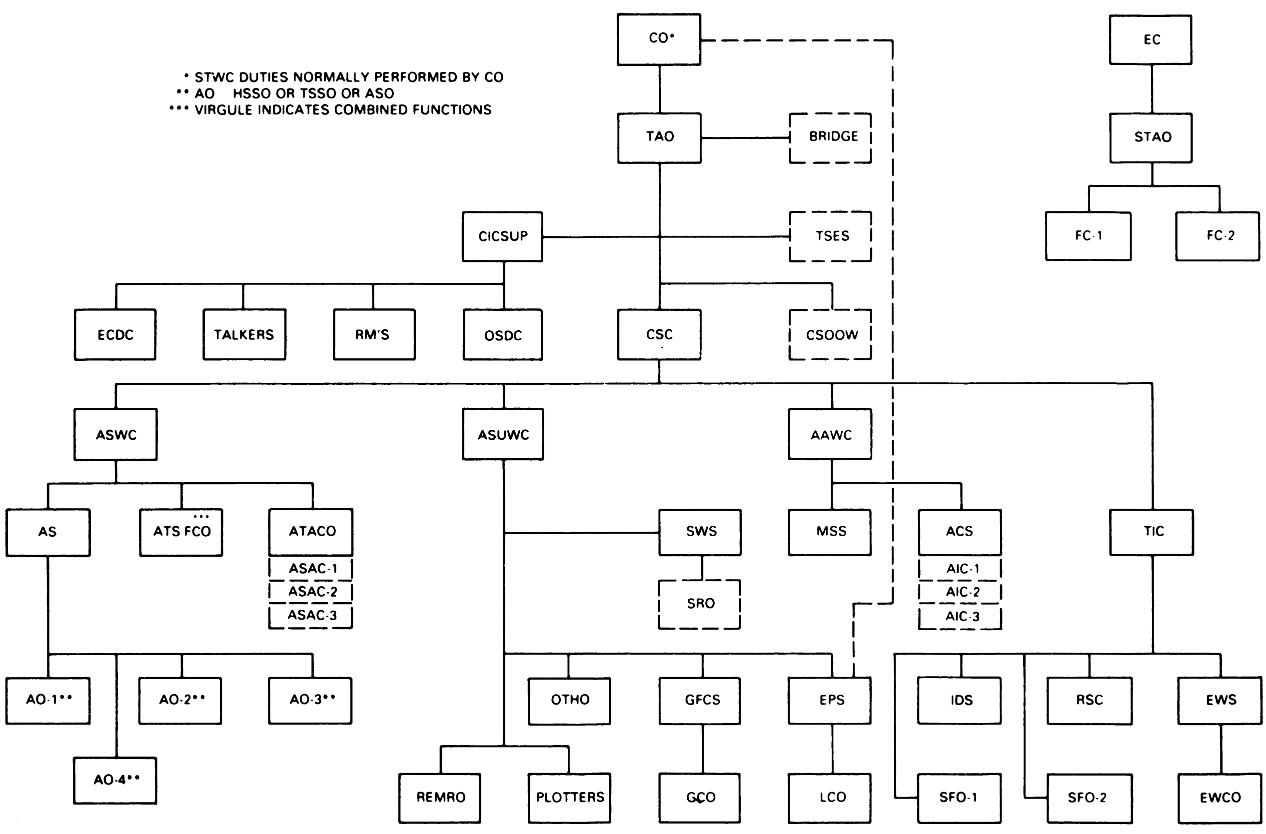

Figure 1-1.—Aegis cruiser condition I battle organization.

are headed by key officers and comprise the battle organization of such ships. The officers man specified stations and control the activities of personnel under their direction. Functional group control contributes flexibility to the battle organization. This increases its effectiveness when executing the plan for battle, or variations thereof, necessitated by the tactical situation. As EMO you will normally be tasked with heading the Electronic Casualty Control Team (Repair 8).

The commanding officer as head of the battle organization exercises command control and is responsible, during action, for engaging the enemy. The commanding officer is assisted in these tasks by the navigator, operations officer, weapons officer (or combat systems officer, as applicable) engineering officer, damage control assistant, air officer (aircraft carriers), electronics material officer, and combat cargo officer (amphibious operations). Each one has cognizance over a major control function of the ship in battle. Your individual battle organization will be dictated by the ship's commanding officer who will solicit inputs from each department head via the executive officer. Changes will be incorporated periodically, and you are very likely to get a memo from your department head requesting information for this revision. List any changes you have in personnel that have transferred or changes you desire to make in your electronic casualty control organization. When embarked, an air group commander is responsible to the commanding officer in matters affecting the air group's readiness.

Additional information concerning shipboard battle organization or damage control battle organization is found in chapter 2 of the SORM.

Shipboard Organization

In many departments, the division of personnel in the shipboard organization closely approximates that in the shipboard battle organization. Figure 1-2 shows an overall shipboard organization to the department level. Table 1-1 shows a cross chart of departments, which will be organized to the various ship types; i.e., weapons will be organized under the weapons department. When the offensive characteristics are not primarily related to ordnance, weapons will be organized under the deck department. On aircraft carriers, there will be both a weapons

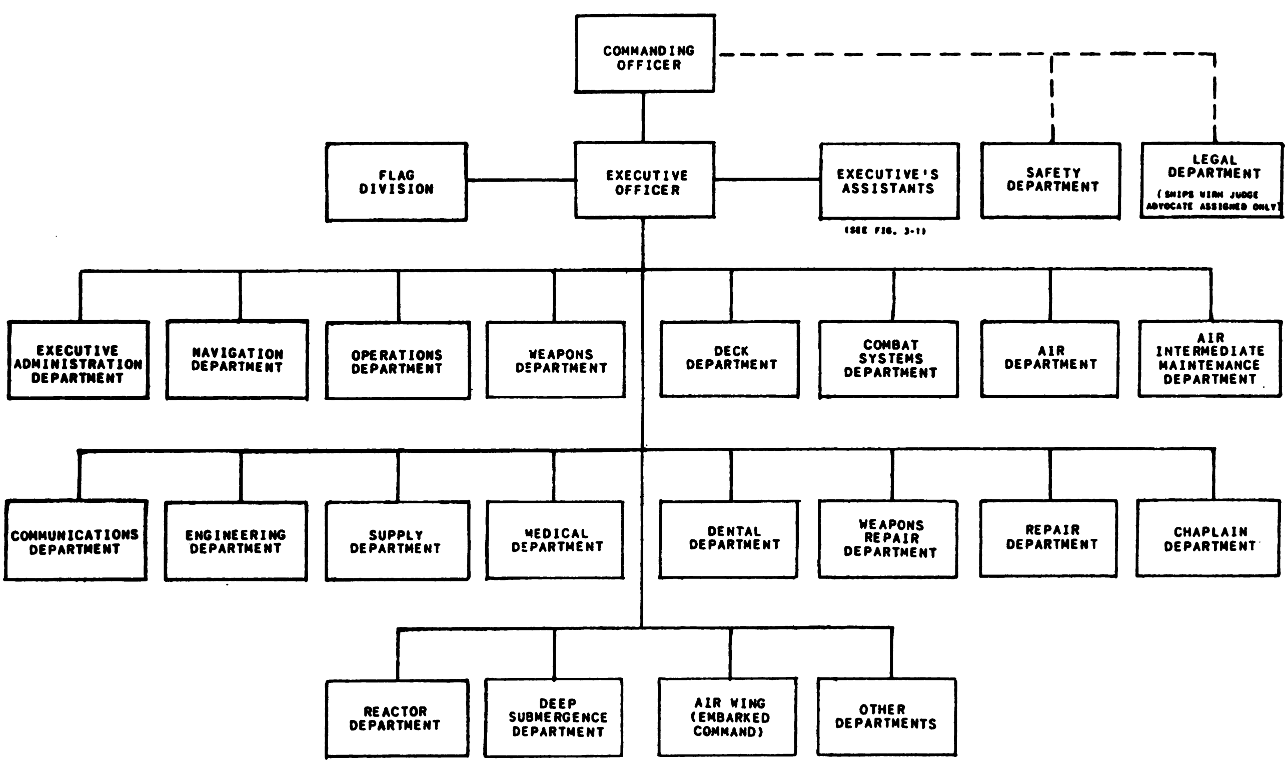

Figure 1-2.—Shipboard organization.

Table 1-1.—Shipboard Departmental Organization Cross-Chart

SHIP TYPE	1 EXECUTIVE/ ADMINISTRATION	2 NAVIGATION	3 OPERATIONS	4 WEAPONS	5 DECK	6 COMBAT SYSTEMS	7 AIR	8 AIMD	9 COMMUNICATIONS	10 ENGINEERING	11 SAFETY	12 SUPPLY 6	13 MEDICAL	14 DENTAL	15 WEAPONS REPAIR	16 REPAIR	17 LEGAL 7	18 CHAPLAIN	19 DEEP SUBMERGENCE
LCC	x	x	x		x				x	x		x	x	x					
LHA/LHD	x	x	x		x	x	x	x	x	x	x	x	x	x					
LKA	x	x	x		x					x		x	x						
LPD	x	x	x		x		x			x		x	x	x					
LPH	x	x	x	x			x	x	x	x	x	x	x	x					
LSD	x	x	x		x					x		x	x	x[2]					
LST	x	x	x		x					x		x	x						
BB	x[8]	x	x	x	x		x[1]		x	x		x	x	x			x	x	
CV/CVN	x[8]	x	x	x	x		x	x	x	x[5]	x	x	x	x			x	x	
CG/CGN	x	x	x	x[3]		x[3]	x[1]		x	x		x	x	x					
DD/DDG	x	x	x	x[3]		x[3]	x[1]			x		x	x						
FF/FFG	x	x	x	x[3]		x[3]	x[1]			x		x	x						
MCM/MSH/MSO	x		x		x					x									
PHM						x				x									
AD	x	x	x		x				x	x	x	x	x	x	x	x	x		
AE	x	x	x		x		x[1]			x		x	x						
AFS	x	x	x		x		x[1]			x		x	x						
AGF	x	x	x		x				x	x		x	x	x					
AO	x	x	x		x					x		x	x						
AOE	x	x	x		x		x[1]			x		x	x						
AOR	x	x	x		x		x[1]			x		x	x						
AR		x	x		x					x	x	x	x	x		x			
ARS	x	x	x		x					x		x							
AS	x		x		x					x	x	x	x	x	x	x	x		
ASR	x	x	x		x					x		x							x[4]
ATF	x	x	x		x					x		x							
ATS	x	x	x		x					x		x							
AVT	x[8]	x	x		x		x		x	x	x	x	x	x					

NOTES:

1. ON LAMPS/VERTREP HELO DETACHMENT SHIPS ONLY.
2. ON CGN 9/LSD 41 CLASSES ONLY.
3. CG 26, CG 47, CGN 25, CGN 36, CGN 38, DD 963, DDG-51, DDG 993, AND FFG 7 CLASS SHIPS ARE REQUIRED TO HAVE A COMBAT SYSTEMS DEPARTMENT VICE A WEAPONS DEPARTMENT.
4. ASR 21 CLASS ONLY.
5. NUCLEAR POWERED CARRIERS WILL ALSO HAVE A REACTOR DEPARTMENT.
6. ON SMALL SHIPS WHEN A LINE OFFICER ASSUMES SUPPLY OFFICER DUTIES, HE/SHE SHALL BECOME A DEPARTMENT HEAD.
7. ON SHIPS WITH A JUDGE ADVOCATE ASSIGNED THERE SHALL BE A LEGAL DEPARTMENT.
8. IN BB/CV/CVN/AVT THERE IS AN ADMINISTRATION DEPARTMENT.

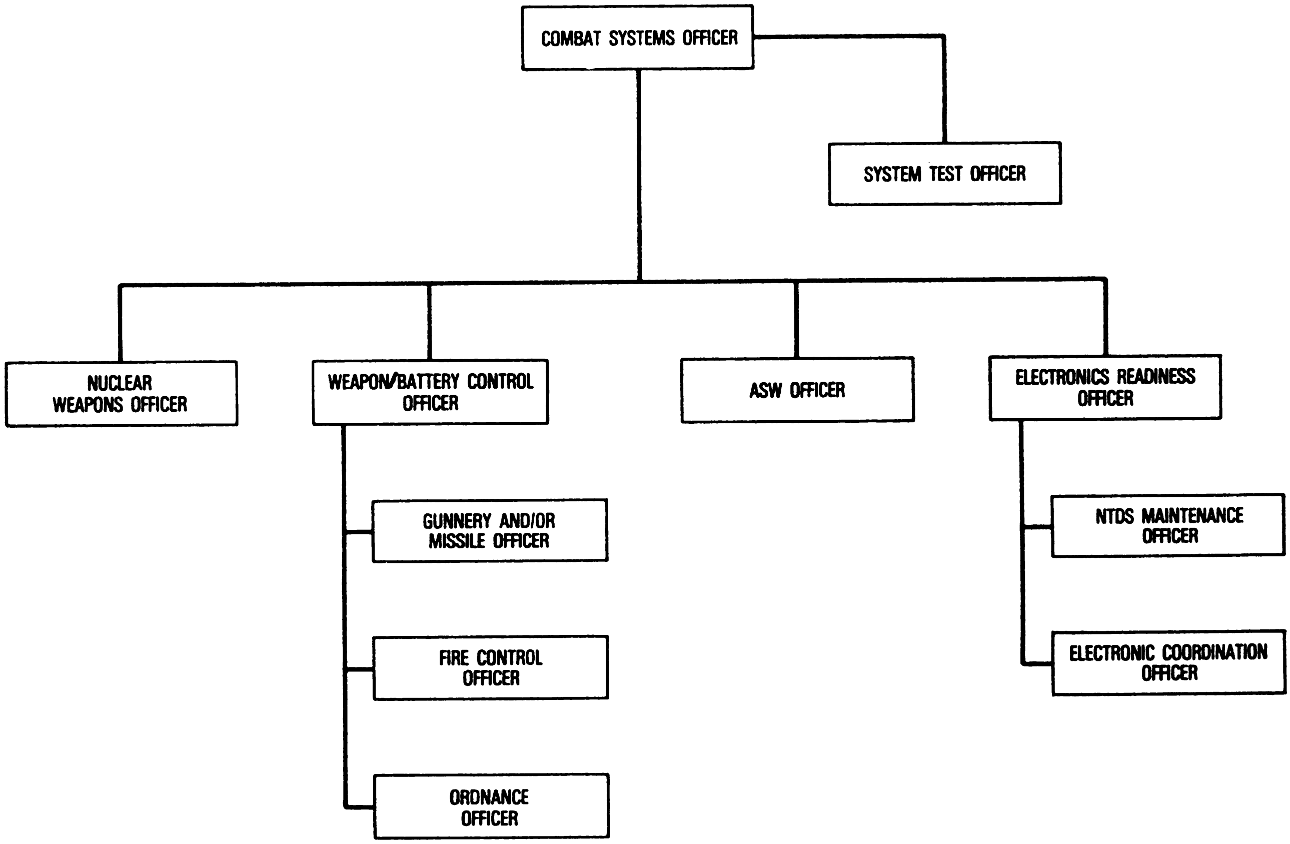

Figure 1-3.—Sample combat systems organization.

department and a deck department. On specifically authorized ships, weapons will be organized under the combat systems department (fig. 1-3) instead of the weapons department. Ordinarily, the EMO is responsible to the operations/combat systems officer under both battle and administrative organizations. However, the requirements of an administrative organizational structure must allow for the accomplishment of certain functions that have no place in battle. In the day-to-day routine, the functions of training and maintenance are emphasized.

The SORM prescribes the administrative organization for all types of ships. The navigation department, operations department, weapons department, engineering department, and the supply department are the five basic departments found on most ships.

Departments are further organized into divisions. At this level they are then used as units under their own officers and petty officers. The SORM lists the standard letter and numeral designations of divisions for all types of ships.

Sometimes it is necessary to establish a division not listed, or functions of two or more divisions are combined in a single division. The type commander then assigns a suitable letter or numeral designation conforming to those designations listed.

ORGANIZING THE ELECTRONICS DIVISION

A division cannot function properly without effective administration. The first step you must take is to set up a good organization. The procedures you should follow when initially organizing a division are as follows:

1. Write down and adequately define all the duties and responsibilities assigned to the division.
2. Group the duties by function so that they may be properly administered.
3. Prepare an organizational chart delineating each area of responsibility and a chain of command.
4. Assign specific personnel to each duty.

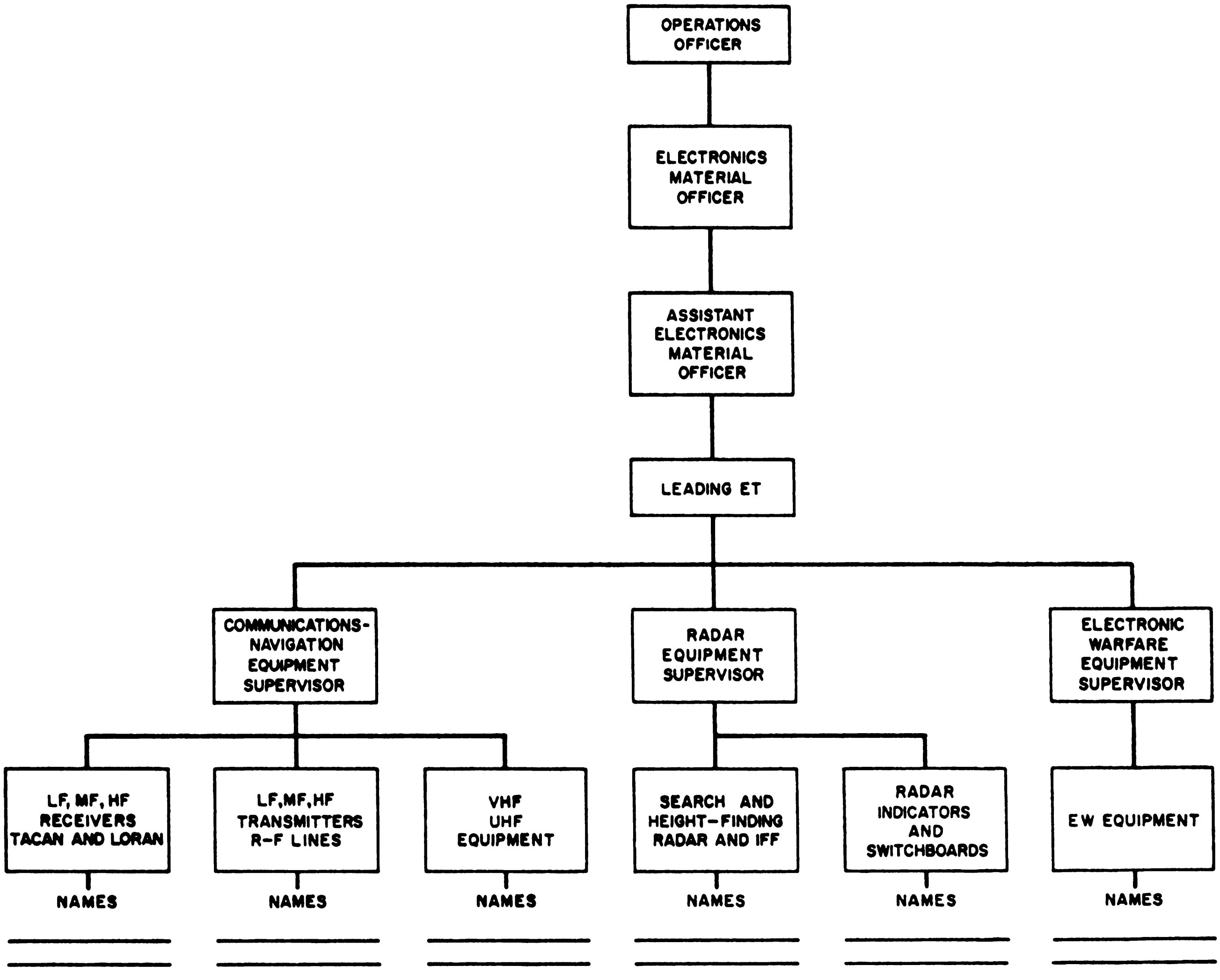

Figure 1-4.—Sample of an electronics repair organization chart.

The proper assignment of available personnel for the upkeep of equipment (and other necessary duties) is most essential. It is particularly critical if the division manning is under its personnel allowance, or if the available technicians are inexperienced. The leading petty officer must be alert to the qualifications of the onboard technicians.

If the division has adequate talent, it will be possible to assign the inexperienced personnel to some of the more experienced crew members. In this case, the leading petty officer should be sure that the experienced personnel are teaching the others and not using them merely as toolbox carriers and supply part chasers.

Although the establishment of an electronics repair organizational chart is primarily the responsibility of the EMO, the leading ET is an important part in the organization plan.

Electronics repair organizational charts are useful in the assignment of responsibilities. It is impossible to standardize an electronics organizational chart because of the many differences that exist in both ship and equipment. However, a fairly simple approach for organizing the division is to use the 3-M organization that exists on the ship, using billet numbers instead of names. Another type of chart, operations configured, is the type presented in figure 1-4.

The names of the ETs (and other rates as applicable to the electronics division) assigned to the various groups of equipment are written under the appropriate blocks. The top name in the list is the ET in charge of that particular group. In the final breakdown of duties, a certain number of equipment units may be assigned to an individual ET. An advantage of such an arrangement is that it places the responsibility for the maintenance of certain equipment with an individual ET.

In smaller vessels the equipment to be maintained and the electronics personnel available are, of course, reduced proportionately.

Each person should also be assigned administrative as well as maintenance responsibilities in keeping with the rating. When practicable, personnel should be rotated among the various types of administrative duties. It is a good practice to rotate each individual assignment on the various bills from special assignments to routine operations or evolutions, such as the Special Sea and Anchor Detail, the Replenishment, the Rescue and Assistance, and the Landing Party.

ELECTRONICS DIVISION ORGANIZATIONAL MANUAL (ELECTRONICS DOCTRINE)

The *Electronics Division Organizational Manual* is made up of the divisional instructions, bills, and general safety information. This manual is intended to set forth the organization, procedures, and policies for the proper management of your maintenance efforts and resources. A properly established electronics division organization manual reflects the actual organization and procedures to be followed on your ship and provides realistic guidance for all personnel in their efforts. As the EMO, you will need to ensure the division organizational manual is updated annually and/or revised as necessary. Ensure new personnel read it soon after they report on board. The organizational manual reduces duplication of effort and prevents loss of information upon personnel transfer. It also establishes performance standards for you and the personnel of the electronics division.

In addition to the *Electronics Division Organizational Manual*, notices and instructions helpful in the administration of shipboard electronics repair organizations are found in Department of the Navy, fleet, force, and type commander directives, instructions, and notices. The Engineering Information Bulletins (EIBs) and the Electronics Installation and Maintenance Books (EIMBs) are also helpful.

The Navy Directives System Consolidated Subject Index (NAVPUBNOTE 5215) and 5215 Notices issued by each command contain lists of these notices and instructions. Some contain information that will be directly applicable to the administration of an electronics repair organization.

ELECTRONICS CASUALTY CONTROL MANUAL

During battle conditions, you will be responsible for assigning personnel to Casualty Control Teams. These teams will normally consist of two people each. They may be ETs, but they can be of any rating preferably with at least a minimum training in basic electronics and electricity (BEE). You will need a special set of instructions to handle the complex task of maintaining electronic equipment. This Casualty Control Manual must be clear and concise so that it can be easily understood. A person with minimum technical knowledge must be able to enter an unfamiliar space, remove shock hazards, perform initial casualty control, and render lifesaving first aid. Copies, which must be a good quality, will be maintained as follows: primary ECC—master; secondary ECC—one copy of master; and each space—one copy of the ECC manual tailored specifically for the space in which it is located.

The items from the TRE checklist (and other areas applicable to your ship) should be included in this manual. Give the following information for each system: a description of the system, a block diagram showing all check points, and the location of all units that comprise the system, and any other information that will facilitate the accomplishment of the task. The following sample TRE checklist (CTLFORM 5041/12) is the minimum requirements for a casualty control manual and contains the following:

TRE CHECKLIST

1. Antenna systems details (block diagram topside, below decks, port/starboard elevations, including cable numbers).
2. Power system details (from source of power to equipment, including cable numbers, fuze size, breaker size, and cutout switches. For all sources of power: 60HZ, 400HZ, GYRO, SYNCHRO, etc).
3. Radar data transmission systems details (path of triggers and video, including cable numbers).
4. IFF data transmission systems details (path of enabling voltages and video, including cable numbers).

5. Transmitter and receiver patching details (including cable numbers).
6. TTY patching details (including cable numbers).
7. Audio patching details (including cable numbers).
8. All means of communications.
9. Repair equipment location (test equipment and tool boxes).
10. Specific location of CO_2/Dry Chemical extinguishers in electronic spaces including back-up.
11. Procedures to obtain routes to all electronic casualty control spaces during General Quarters.
12. Procedures to obtain spare parts during General Quarters.
13. Electronic emergency access routes.
14. Dry Air systems with flow paths including cut-out valves external to space.
15. Cooling water systems with flow paths including cut-out valves external to space.
16. Location of vent switches and controllers for all spaces.
17. Listing of all classified fittings by space (CCOL).
18. First aid equipment location (nearest if not in space).
19. Emergency Destruction equipment location (nearest if not in space).
20. Technical manual location and index.
21. If part of or in an Electronics Casualty Control space, the following list applies:
    a. EW systems details.
    b. Fire control systems details.
    c. Sonar systems details.
    d. Data systems details.

BILLS FOR SPECIAL CONDITIONS

There are other bills in addition to the usual operational bills. Some of these are the Cold Weather Bill, the Hazards of Electromagnetic Radiation to Ordnance (HERO) Bill, and the Emission Control (EMCON) Bill are some of the more common ones. The Cold Weather Bill describes certain routine operations necessary when operating at extreme cold temperatures, such as procedures for deicing exposed equipment and draining wave guides.

Information on the HERO Bill may be found elsewhere in this text.

The EMCON bill is an instrument for controlling the unauthorized radiation of radiating equipment. On some occasions the use of radiating equipment can be more detrimental than valuable. Using electronic warfare (EW) techniques to detect (intercept) our electromagnetic radiations, an enemy force may locate our force long before we are in an advantageous position to engage. Needless to say, such detection could seriously impair the mission of the force. Emission control is used mainly to deny intercept and early warning to an enemy, thus reducing the chance of being detected.

The control of electromagnetic radiations does not fall specifically within the scope of electronics maintenance. However, basic aspects and considerations of EMCON are important to the EMO because of their impact on the planning and accomplishment of maintenance. To accomplish emission control within the force while at sea, the Officer in Tactical Command (OTC) imposes conditions of silence on transmitting equipment by means of an EMCON plan or EMCON annex to the OPORDER/OPPLAN.

Conditions of electronic silence may range from complete silence to unrestricted use of transmitting equipment. Conditions of silence for various portions of the rf spectrum ordinarily apply to all equipment using the affected frequencies.

The EMCON plan may be imposed on particular frequency bands or on types of equipment. Restrictions imposed on one type of emission are accompanied by corresponding restrictions on other equipment using the same part of the frequency spectrum.

Various degrees of frequency silence are defined for naval use. The unqualified term silence indicates that complete frequency emission restrictions are in effect. By referring to NWP 10-1-40, *Electronic Warfare*, the EMO can code/decode the various restrictions that have been placed on the radiations of designated frequency. Under certain conditions it may not hold true, but as a general rule, the detectable range increases as the frequency becomes lower. The higher the frequency, the more closely the electromagnetic wave approaches a line-of-sight transmission. Although surface ship radar waves might not be detected by a surfaced submarine at a distance of 75 miles, the force may be detected by and tracked by high-flying aircraft. Such considerations are the basis for the force commander's decision regarding the EMCON condition employed.

At times, complete silence would work to the detriment of the force. For example, it is obvious that nothing is to be gained by the force

EMITTING EQUIPMENT & LOCATION	FREQUENCY RANGE IN MHz	OPERATING FREQUENCY MHz	INDEX NO. (TABLE E. ATP 1, Vol. II)	PERSONNEL TO NOTIFY (BY BILLET) CONDITION			EQUIPMENT EMISSION STATUS					NOTIFIED	RPT EMCON SET
				I & II	III	IV	RADIAT-ING	STAND-BY	SECURED	AUTH	NOT AUTH		
CIC				CIC OFF	CIC WO	CIC WO							
WEAPONS				WP CONT OFF (JC CIRCUIT)	DIR OFF (JC CIR-CUIT)	WEAPONS OFFICER							
ASW				ASW EVAL (1 JS CIR-CUIT)	SONAR SUPV (29 MC)	SONAR SUPV (29 MC)							
				NAVIGATOR	QMOW	QMOW							
COMM				RADIO SUPV (1 JX)	RADIO SUPV (21 MC)	RADIO SUPV (21 MC)							

SILENCE CONDITION ____________ TIME ORDERED ____________ TIME SET ____________

Figure 1-5.—Sample of an EMCON Bill Format.

maintaining electronic silence when you are in actual contact with the enemy.

After all alternatives have been considered, the force commander will issue an EMCON plan. This must include a statement on EMCON in the communication annex of the OPORDER/OPPLAN. If the operation is one for which specific times for EMCON can be anticipated, the commander may promulgate a separate annex scheduling the degree of silence for electronic equipment.

Figure 1-5 is a sample of an EMCON Bill. On an actual EMCOM Bill, the equipment and frequencies would, of course, be filled in and this document would be classified.

EMERGENCY BILLS

Emergency bills are prepared by the type commander. Such a bill serves as a checkoff list and guide in assigning personnel to emergency stations and in training them to cope with emergencies. The general emergency bill covers the Collision Bill and the Abandon Ship Bill. It should also include contingencies, such as the means by which explosions or extensive fires would be dealt with. Other ship's emergency bills are the Man Overboard Bill and the Nuclear, Biological, and Chemical Defense Bills. It is usually not necessary to prepare special division emergency bills, since all emergencies aboard ship are adequately covered in the ship's emergency bills. An important exception, however, is the Emergency Action Plan/Emergency Destruction Bill. It should list all of the classified publications and equipment that must be destroyed before abandoning ship. Their location, the methods of destruction, and the priority of destruction is also listed. The assignment of personnel (by billet or rate) responsible for such destruction must be included. Your operations or combat systems officer, depending on the organization, will require you from time to time to provide an input to the the updating process. This will maintain the manual in a current state. Again, he will send you a memo when this is required.

WATCH, QUARTER, AND STATION BILL

The Watch, Quarter, and Station (WQS) Bill is a summary of personnel assignments to stations or duties specified in each of the ship, department, or division bills. The WQS Bill is the one document that division personnel may use to find all of their assignments. For this reason, the WQS Bill should be prominently posted in one of the electronics spaces, usually in the ET shop. In addition, personnel should be notified immediately whenever changes are made.

The forms used for WQS Bills can vary with the type of ship. Type commanders usually prescribe the WQS format for ships under their administrative control. Leading petty officers should know the capabilities and limitations of assigned personnel. Therefore, they should be able to offer invaluable assistance in maintaining the WQS Bill. In addition to having a knowledge of the capabilities of the assigned personnel, the preparation of the WQS Bill entails an application of the basic principles of leadership. Before a person is assigned a watchstation, he/she must complete all qualifications/PQS for the watchstation.

ELECTRONICS PERSONNEL MANAGEMENT (NAVY MANNING PLAN [NMP] RULE)

As the EMO, you must ensure that the administration of your electronics organization supports the mission of electronics maintenance. Of prime importance to you is the manning of the organization. One of the management tools you will be using is the Enlisted Distribution and Verification Report (EPMAC-EDVR-1080), often referred to as the EDVR, or the "ten-eighty report."

The need for priority manning is necessitated by personnel shortages that exist in many categories. Available personnel are distributed equitably, sharing the shortages that exist, except in special cases. These cases are the result of the need to man certain activities that are considered especially essential to the nation's defense. Priority manning may be on a continuous basis or may last only for a specified period of time. All priority manning assignments are reviewed annually to see if the requirements still exist. These priorities are defined in NMPCINST 1080.1.

BASIC MANNING DOCUMENTS

As the EMO and division officer, you will be responsible for the effective management of personnel assigned to you. You will need correct information about those personnel, and an understanding of your organization's manning requirements for the electronics organization to fulfill its assigned mission.

Three basic documents are used to determine how your division will be managed: the Ship Manpower Document (SMD), the Manpower Authorization (MPA), and finally, the Enlisted Distribution and Verification Report (EDVR). A brief description of these documents and sample excerpts from the SMD, MPA, and EDVR are provided in this section.

The main purpose of the following information is to focus on the EDVR as the main document for your use in personnel management. To fully understand and effectively use the EDVR, you must be knowledgeable in both the SMD and the MPA for your ship.

SHIP MANPOWER DOCUMENT

The SMD is developed and promulgated by the Chief of Naval Operations (CNO). It is based on the organizational manning necessary for a ship to perform mission requirements specified in the Required Operational Capabilities (ROC) and Projected Operational Environment (POE) statements.

The organization and billet assignments shown in the SMD are based on work studies and detailed manpower analysis. While the assignments of billets in the SMD is based on detailed analysis and is considered to achieve optimum use of manpower, the actual assignment of personnel within the unit continues to be a command prerogative. This document shows the ideal level of manning and does not take budget or manpower policies into consideration.

The SMD is divided into seven (7) sections. They are as follows:

Section I	Officer Billet Summary
Section II	Manpower Summary
Section III	Manpower Requirements
Section IV	Battle Bill
Section V	Functional Workload
Section VI	(Part 1) Summary of Officer Manpower Requirements
	(Part 2) Summary of Enlisted Manpower Requirements (fig. 1-6)
	(Part 2A) Summary of Enlisted Manpower Requirement by department
Section VII	Summary of Organizational Manpower Requirements

SECTION VI (PART 02)
SUMMARY OF ENLISTED MANPOWER REQUIREMENTS

OPNAVINST 5321.435
29 JUN 1981

FOR
USS NEVERSAIL (DD 123)

RATING	PRI NEC	SEC NEC	E-9 MCPO	E-8 SCPO	E-7 CPO	E-6 PO1	E-5 PO2	E-4 PO3	DISG STKR	1-3	1-2	1-1	TOTAL
DK						1			1				2
RATING TOTAL						1			1				2
DS	1615	9535			1								1
DS	1623							1					1
DS	1672						3						3
DS	1682					1		1					2
RATING TOTAL					1	1	3	2					7
EM					1		1	1					3
EM	4626					1		1					2
RATING TOTAL					1	1	1	2					5
EN					1		1	4	2				8
EN	4291					1		1					2
EN	4398					1	1						2
RATING TOTAL					1	2	2	5	2				12
ET		9535		1									1
ET	1426	1454					1						1
ET	1431	1425					1						1
ET	1436	1422						1					1
ET	1438	1453					1						1
ET	1453	1454						1					1

PAGE VI - 3

Figure 1-6.—Sample page from a ship manpower document.

Figure 1-6 is a page extracted from a ship manpower document (SMD).

As the EMO, you must utilize Section III and IV; Section III should reflect all of your required NECs; and Sections IV contains the watchstation numbers that are used on the WQSB.

The SMD for your ship should be located in the ship's office.

For additional information relating to the SMD program, refer to OPNAV 1000.16 and OPNAVINST 5300.19.

MANPOWER AUTHORIZATION (MPA)

The SMD serves as the basis for the Manpower Authorization (MPA) (OPNAV 1000/2). The Billets Authorized (BA) column on the MPA indicate the billets that are authorized by the Chief of Naval Operations (CNO) after considering current budgetary constraints, priorities, and manpower policies. The quantity assigned to each billet authorized on the MPA must normally be the same as the corresponding billet in the SMD. SMD billet requirements, which are not included in the Billet Authorization (BA) column on the MPA, are entered on the MPA as Mobilization Billets, which will be filled by Selected Reservists.

As the EMO, you must check the MPA to ensure that all of the navy enlisted classifications (NECs) listed in the MPA are current and correct. It is also important to make sure that the NECs no longer required are deleted. This can be accomplished by initiating a Short Form Change Request to the MPA. Additionally, an OPNAV Form 4790/CK must be submitted to make this a permanent change. (CK forms will be covered later in this manual.)

Article 903 of OPNAV 1000.16 contains all of the information and procedures necessary for your command to initiate a Short Form Change Request (Military Only). This type of change request will primarily be used to change NECs listed in the MPA when requirements exist.

Figure 1-7 is a page extracted from a Manpower Authorization Document.

OPNAV 1000/2 (REV. 9/82)
FROM: CHIEF OF NAVAL OPERATIONS
TO: [illegible]

MANPOWER AUTHORIZATION

DATE: 04/03/83 PAGE: 6

Activity Code	Activity Name	Homeport Geographic Location	Transaction Number	Transaction Date
[illegible]-0962-[illegible]	DD	VIRGINIA, NORFOLK	EC0007	02/01/83

Billet Position Sequence Code	Billet/Position Title	Rate	NEC	27	SI	BA	FY85	FY84	FY83	FY86	FY87	FY88	SR	M+1	M+2	M+3	M+6	M+12	45
07700	NBTA	[illegible]	9700	965	0	2	2	2	2	2	2	2		2	2	2	2	2	N
08000	COMBAT SYSTEMS DEPARTMENT																		
08100	CD DIVISION																		
08200	NBTA	DSC	1615 9835	955	0	1	1	1	1	1	1	1		1	1	1	1	1	N
08300	NBTA	DS1	1682	955	0	1	1	1	1	1	1	1		1	1	1	1	1	N
08400	NBTA	DS2	1672	955	0	3	3	3	3	3	3	3		3	3	3	3	3	N
08550	NBTA	DS3	1682	955	0	1	1	1	1	1	1	1		1	1	1	1	1	N
08600	NBTA	DS3	1628	955	0	1	1	1	1	1	1	1		1	1	1	1	1	C
09000	CF DIVISION																		
09100	NBTA	ETCS	9505	955	0	1	1	1	1	1	1	1		1	1	1	1	1	N
09200	NBTA	ET1	1572 1504	955	0	1	1	1	1	1	1	1		1	1	1	1	1	N
09300	NBTA	ET1	1516 1501	955	0	1	1	1	1	1	1	1		1	1	1	1	1	N
09400	NBTA	ET2	1438 1456	955	0	1	1	1	1	1	1	1		1	1	1	1	1	N
09450	NBTA	ET2	1516	955	0	1	1	1	1	1	1	1		1	1	1	1	1	N
09500	NBTA	ET2	1481 1425	955	0	1	1	1	1	1	1	1		1	1	1	1	1	N

Figure 1-7.—Sample page from the manpower authorization document.

ENLISTED DISTRIBUTION AND VERIFICATION REPORT (EDVR)

We have already briefly mentioned the Bureau of Naval Personnel (PERS) Enlisted Distribution and Verification Report (EDVR), but since this is a report you will see and use often, more so than the MPA or SMD, we will describe it in more detail at this time. As an EMO, you will be working closely with the NEC manning and personnel losses and gains. The EDVR is distributed monthly by the Enlisted Personnel Management Center (EPMAC) as a statement of an activity's personnel account.

The purpose of the EDVR is to provide:

- A distribution community summary of the current and future manning status of the activity,
- A common reference point in any discussion of manning status between the manning or detailing control authorities and the activity,
- A statement of account for verification by the activity, and
- A permanent historical record in PERS of an activity's personnel account for statistical uses and overall Navy manning.

The EDVR printout is divided into 11 sections, which are described as follows:

Section 1. Prospective Gains (PG). This section lists all members who have currently been ordered to report to your activity within the next 9 months. It is further categorized into expired, current, and future gains.

Section 2. Prospective Losses. This section contains a listing of all members who should have been detached or are expected to be detached from the activity within the next 10 months. Career and noncareer EAOS (end of active obligated service) losses are listed as well as expected losses due to Projected Rotation Date (PRD).

Section 3. Personnel On Board for Temporary Duty or Assigned in a Deserter Status, followed by an alphabetic listing of all members assigned to the activity regardless of duty status. (Commonly referred to as the "alpha roster.") Note, deserters do not count for manning because they have been administratively dropped from Navy Strength Accounts.

Section 4. Total Personnel On Board in Distribution (RATE) Community Sequence. This section is a listing of all members in the activity's personnel account, regardless of their loss, gain, or duty status. When a member also appears in one of the three preceding sections, the section in which the member is listed is displayed in item AA of the EDVR. This section contains all of the significant data needed by the division officer. An example of this section of the EDVR is shown in figure 1-8.

Section 5. Personnel Status Summary. A numerical summary of the activity's personnel account showing authorized billets, the Navy manning plan (NMP), and members on board the activity.

Section 6. CNO Billets Authorized Revision Number XXXXX dated yr/mo/da. The information contained in this section is identical to the Summary of Organizational Billets appearing in the activity's Manpower Authorization (MPA) OPNAV Form 1000/2, and reflects the latest manpower authorization as established by the CNO.

Section 7. NEC Billet/Personnel Inventory (except MCA "X" accounts). This section is a listing of NECs for which the activity has authorized billets and/or members who hold these billets.

Section 8. NEC Inventory Section. This section lists the names of the activity's personnel who hold NECs, and lists up to five NECs per individual.

Section 9. Officer/Enlisted Diary. Shows all transactions for the previous month.

ENL DIST VERIFICATION REPORT-EDVR LJ 83-01-31-0121 L JG 20574 PAGE NO. 25 EPMAC-EDVR-1080

00 123 NEVERSAIL 12345 JO 82 11 01 830366 83 01 26 2 FNO SINCLANTFLT 5080

NAME (E)	SOCIAL SECURITY NUMBER (F)	ACTUAL RATE (H)	ASSGN RATE (J)	DIST NEC'S (K)	NEC'S (L)	M–P	Q–R	S	T	U	W–X	Y	Z	AA	BB	CC
SECTION 4			*	* * *	* TOTAL	PERSONNEL	ON	BOARD *	*	* * *						SECTION 4
ENNIS CHARLE	555-11-0001	EN2	EN2	1294	1294	CA DO	7401 11	850616		8401	8212 821230	100				GN-AC
HUBBARD FRAN	555-11-0002	EN3	EN2	0000	00000000	CA D10	7905 11	830529		8305	7911 791123	100			SEC2	J
ENGEL HUGH T	555-11-0003	EN3	EN2	0000	00000000	CA DO	8011 11	841127		8411	8301 830110	100				GN-AC
SESSOMS HARO	555-11-0004		EN3			DI	7909	830927		8309	8001 800108	100			SEC2	
MORTAZAVI MA	555-11-0005	FN	EN3		0760	D	7909	830905		8309	8109 810903	100			SEC2	
LANGLEY WILL	555-11-0006		EN3				8008 02	830821	12	8408	8103 810310	100			SEC2	
HUTTON RUFUS	555-11-0007		EN3			D	7905	840510		8405	8206 820622	100				
LESSMAN JOHN	555-11-0008		EN3			DI	7911	831107		8311	8005 800506	100				
SOKOLOWSKI H	555-11-0009	ENFN	EN3			V	8008	840818		8408	8101 810123	100				
WHELAN GEORG	555-11-0010	ENFN	EN3	0000	00000000	CA DO	8107 02	840729		8407	8112 811222	PL	8303	10143	SEC2	J
CATTENHEAD W	555-11-0011	ENFA	ENFN			T	8203 02	850302		8503	8207 820710	100				
MUSTIN BRIAN	555-11-0012	ENFA	ENFN	0000	5804	CA V DO	8105 11	850521		8505	8202 830122	100				GN-AC
QUIRINO ALFON	555-11-0013	ENFA	ENFN	0000	00000000	CA V DO	8203 12	850228		8502	8209 820913	100				GN-AC
WALKER RALPH	111-11-0001		ETCS			E	6403	851214		8504	8202 820206	100				
LEWIS ROBERT	111-11-0002	ET1	ET1	14261454	14541426	CA D10	7303 11	840227		860408	8301 830114	100				GN-AC
OTTER CALVIN	111-11-0003	ET2	ET1	14541423	14541423	T	7703	830327		8303	7903 801231	100			SEC2	
YOUNG GARRET	111-11-0004		ET1	1516	15121441	SD	6809	841001		8504	8201 820130	100				
COYNE CURTIS	111-11-0005		ET2	14731425	14701426	D	7901	83012824		8307	8004 800416	100			SEC2	
KAUFFMAN ROY	111-11-0006		ET2	14381470	14381470	DI	7903	83032124		8311	8008 800801	100			SEC2	
SLOANE KENNE	111-11-0007	ET2	ET2	15041473	1458	CA K DO	7810 11	81047		8812	8309	PG	8309	83562	SEC1 30811	
WEST GEORGE	111-11-0008		ET2	14531438	14381453	KD	7810	841010		8410	8206 820703	100				
SECTION 4			*	* * *	* TOTAL	PERSONNEL	ON	BOARD *	*	* * *		EM	-ET			SECTION 4

Figure 1-8.—Example of EDVR format.

Section 10. Duty Preference Listing. It has four parts:

(1) PRD or EAOS 10 months from current date
(2) Duty preference verification listing
(3) Personnel reaching ADSD plus 18 months
(4) Personnel who have duty preferences on file

Section 11. Security. Contains security clearance data for afloat commands. This section of the EDVR controlled by the Department of the Navy Adjudication Facility (DONCAF) and may be used to grant access.

Format and procedures for validation of the EDVR are found in PERSINST 1080.1.

The EDVR is a very useful report, which should be used for its main purpose—manpower management. However, the information contained in the various sections have many administrative uses.

To maintain currency in personnel assignment, a configuration validity system, the Ship Configuration and Logistics Support Information System (SCLSIS) should be used extensively. This system replaced the SECAS system. In addition to the EDVR, PERS detailers use the SCLSI as a basis for assigning electronics personnel to ships by Navy Enlisted Classification Codes (NEC). This procedure is used to maintain consistency in system training and systems installed.

The EMO should check the current Enlisted Distribution and Verification Report (EPMAC-EDVR-1080) held by the ship's office (obtain copies of the applicable sections, if possible). This will enable you to determine whether the ETs on board are NEC-qualified to maintain the types of electronics equipment installed. Also check the individual service record of each ET for NECs not listed on the EDVR. Be sure your EDVR is up to date and you have NECs listed to cover the electronic equipment on board, especially NEW INSTALLATIONS resulting from a shipyard overhaul. Your personnel office will assist you with the paperwork required to add additional NECs to your EDVR. You should keep a copy of the current EDVR in your division officer notebook.

Once the proper NECs are identified, technicians should be cross-trained on all equipment on board ship whenever possible. This practice broadens their knowledge and perspective. It will ensure that there will be several individuals available with a good working knowledge of each piece of equipment. This will also provide flexibility for equipment maintenance when a critical situation or requirement occurs.

OFFICER DISTRIBUTION CONTROL REPORT (ODCR)

You, as EMO, will be concerned with the information about your own billet and other officers who may be assigned to your division. The Officer Distrubution Control Report (ODCR) is a valuable source of personnel information about you, your billet, other assigned officers, and your relief, when assigned.

The following three sources, the *Manual of Navy Total Force Manpower Policies and Procedures*, OPNAVINST 1000.16; *Officer Distribution Control Report*, NMPCINST 1301.2; and the *Manual of Navy Officer Manpower and Personnel Classifications* (Volumes I and II), NAVPERS 15839 will provide the basic personnel knowledge you will need as EMO.

NAVY MANPOWER/MANNING REFERENCES

The following references provide the required information to both interpret and apply the data displays contained in the different manpower/manning documents.

- *Manual of Navy Total Force Manpower Policies and Procedures*, OPNAVINST 1000.16

- *Ship Manpower Document (SMD) Program*, OPNAVINST 5310.18

- *Enlisted Distribution and Verification Report (EDVR); Format and Procedures for Validation of*, NMPCINST 1080.1

- *Enlisted Transfer Manual*, NAVPERS 15909

- *Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards*, (Sections I and II), NAVPERS 18068

- *Officer Distribution Control Report, NAVPERS 1301/5; Format and Procedures for Validation of*, PERINST 1301.2

- *Manual of Navy Officer Manpower and Personnel Classifications*, (Volumes I and II), NAVPERS 15839

Figure 1-9 shows an example of an Officer Distribution Control Report.

DIRECTIVES

Directives are instructions or notices used by a command at any echelon to prescribe policies, organization, procedures, or methods, which serve as guides for controlling the decisions and actions of subordinates. *The Department of the Navy Directives Issuance System*, SECNAVINST 5215.1, established the directive system for the Navy and sets forth a simple and uniform plan for issuing, filing, and maintaining directives under the system. Directives are assigned identifying numbers according to their subjects as listed in *Department of the Navy Standard Subject Identification Codes*, SECNAVINST 5210.11. The Consolidated Subject Index (CSI), NAVPUBNOTE 5215 is issued twice each year. It will help you identify correct naval instructions.

TERMINOLOGY

The following definitions of policies, procedures, orders, instructions, and regulations are

ACTIVITY NAME	ACTIVITY CODE	MARP	ACTIVITY SPONSOR	TRANSACTION NUMBER	DATE OF REPORT	RUN DATE	PAGE	1 OF 10	AMC
NETPMSA PENSACOLA	2135 0305 00	4041	UNKOHN	MECONV900208	900509	05/09/90	11344	B	JH
UIC 68322								AODC C9	

BILLET SEQUENCE CODE / OFFICER'S NAME	BILLET TITLE	SOCIAL SECURITY NUMBER	BP / AC	BILLET DESIG / DESIG	CAT	NOBC / DATE OF RANK	BILLET SUB SPECIALITY / EST LOSS CODE DATE	CURR ALLOW / DATE ASSIGNED BILLET	M+1 / EST DATE DETACH	LAST FITREP RECEIVED FROM DATE / DATE REPORTED OR EDA	TO DATE / PROJ ROT DATE	UIC TRF FROM TO: ACC	DSSD	ACTIVITY WHERE ASSIGNED	SEC CODE / SEC DATE	SUB SPECIALITY 1 / 2	ACD SSCD / NCD	ASI	ASED SSE / NSCD
00100	CO SHR ACT SEL		AB	1000	0	9422	90370	001	001	8811RD	8907		31912	NETPMSA PNCLA	TT8605	50950	600408	H	60070
WRIGHT LEO P.		XXX-XX-XXXX	3	M1320	0	8109	F0690	8710	9006	871027	9006	100	871027	30 0 203	5 8707	9033R			
00100	CO SHR ACT SEL		AB	1000	0	9422	90370			8807RD	8907		62917	NAVCRUITAREA I	TS8701	0000P			
HORNE DICK S.		XXX-XX-XXXX		F1100	0	8709			9005	9006	9206	1		0J	5 8707				
00120	XO SHR ACTY		AB	1000	H	9436	90375	001	001	8808RD	8908			20	SS6510	50950			
ASHER FRED G.		XXX-XX-XXXX		M1110	H	8009		8808		880829	9108	100	880829		2 8707	8054R			
00120	XO SHR ACTY		AB	1000	H	9436	90375			8812RD	8908		21297	CVN 72 LINCOLN	TS8106		710416	D	71051
BAKER TOM F.		XXXX-XX-XXX	1	M1310	H	8510			9007	9009	9309	1		30 0 206	4 8707				
00130	PWO/STAFF CIVIL ENGINEER		B	5100	L	4250		001	001	8812RD	8903				SS7510	90144			
LONG WILL H.		XXX-XX-XXXX		M7531	M	9003		8812		881209	9205	100	881209	30	2 8707				
00140	COMPTROLLER		AB	1000	I	1050	00315	001	001	8809RD	8908				TS6803	6031F	660801	G	66090
JAMES BILL. L.		XXX-XX-XXXX	1	M1310	H	8107	V0890	8909		890912	9008	100	890912	20 0 124	4 8707				
CHAPLAIN PROGRAM DEVELOPMENT OFFICE																			
01100	SUPV CHAPLAIN		B	4100	0	3740		001	001										
01120	CHAPLAIN		B	4100	I	3701		001	001	8809RD	8908				SQ7312	1450P			
BROWN JASON L.		XXX-XX-XXXX		M4100	H	8508		9002		900226	9104	100	900226	10	2 8707	0000P			
01120	CHAPLAIN		B	4100	I	3701				8807RD	8907				SQ6809	1440S			
SANDY KIRK L.		XXX-XX-XXXX		M4100	G	8906		9002		900226	9107	100	900226	40	2 8707	M03 155/122			
ADMIN/BASE OPS DEPARTMENT																			
02010	ADMIN/BASE OPS DEPT HEAD		AB	1000	J	2615		001	001	8902RQ	9001		62980	NETPMSA PNCLA	TT8711				
DYKES JIM A.		XXX-XX-XXXX		F1100	J	8503		8708	9007	870814	9008	100	870814	30	4 8707				
02010	ADMIN/BASE OPS DEPT HEAD		AB	1000	J	2615				8908RG	9001		31912	NETPMSA PNCLA	T48609	L02 5/30 151/054			
~~HANCE LYLE J.~~		~~XXX-XX-XXXX~~		~~M1110~~	~~J~~	~~8706~~		~~8908~~	~~9008~~	~~890814~~	~~9005~~	~~100~~	~~890814~~	~~00~~	~~4 8009~~				
02020	LES OFF SHRACT		B	7490	0	2775		001	001	8908RG	8909				S47509				
HENRY ROBT C.		XXX-XX-XXXX		F6492	L	8908		9002		890925	9109	100	890925	00	1 8909				
ADVANCEMENT IN RATING DEPARTMENT																			
03020	PERS RSCH/ADV DEPT HEAD		AB	1000	H	3950		001	001	8809RD	8908				T97807				
SMITH JAMES R.		XXX-XX-XXXX		F1100	H	8610		8909		890912	9110	100	890912	20	5 8707				

PROJECTED ROTATION DATE IS TENTATIVE - SUBJECT TO CHANGE - PLANNING AID ONLY

NO OF COPIES

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Figure 1-9.—Example of an ODCR.

necessary for an adequate understanding of the purpose of directives.

A military POLICY prescribes the course of action to be followed in a given situation. Policies are best effected through written means, for they are used in determining the action required in recurring situations. Policies established at the top echelon are broad and general; whereas those established at lower echelons must be specific, conforming to the policies established by higher command.

A military PROCEDURE is a series of coordinated set of steps for the performance of functions.

A military ORDER is a formal oral or written command, issued by a superior officer to a subordinate. This issuance of order establishes a rule or regulation or delegates authority for the performance of a function.

A military REGULATION is a rule which sets forth standards concerning the conduct of individuals.

Navy DIRECTIVES contain information concerning the methods for the accomplishment of a mission and specifying the manner and conditions of performance in the execution of projects and programs. Also, DIRECTIVES require action or sets forth information essential to effective adminisrtration.

Navy INSTRUCTIONS are directives that have a long term reference value and continue in effect until canceled by the originator. Instructions may contain information of a continuing nature or information that requires continuing action.

Navy NOTICES are directives that are applicable for a brief period of time (usually 6 months or less) and provide for automatic cancellation on a prescribed date or under a certain condition. Notices may require action that can be completed upon receipt. Notices may also contain announcements and items of current interest.

DIRECTIVE FORMAT

Directives may be of the letter type or publication type. A publication type of directive differs from a letter type in that it normally has covers and contains a title page, a letter of promulgation, a record of changes page, a table of contents, and an alphabetical index of contents. The Ship's Organization and Regulations Manual is a directive in publication form.

Certain shipboard directives, however, are excluded from the directives system. The directives excluded are the captain's night order book, the ship's plan of the day, the engineer officer's night order book, the OOD's standing order book, and the OOD's memoranda.

PROMULGATION AND DISSEMINATION

The commanding officer promulgates the ship's directives system by the issuance of two instructions. The first prescribes the directives to be issued in the system, the responsibilities of originators of the directives, and the directives' control points, and their functions. Also, the instructions for departmental and divisional use of the system, and the standards for reproducing the ship's directives. The other promulgates the distribution lists for the ship's directives.

The ship's directives system provides for the wide dissemination of the policies of the commanding officer, the executive officer, and the heads of departments. It also supplies subordinate officers with a medium for the issuance of amplifying and supplementary instructions placing the policies in effect. The system ensures the policies and procedures used in the administration and operation of the ship keep with the plans and policies of the Navy Department and of the fleet and type commanders. This system permits integration of the ship's directives with those from higher authority.

CORRESPONDENCE

Initiating and handling correspondence is part of the administrative duties of an EMO. Refer to the *Department of the Navy Correspondence Manual*, SECNAVINST 5216.5, for formats, policies, procedures, and other useful information. The Division Officer's Guide provides information on a wide range of correspondence subjects:

References

Basic rules

Naval correspondence

Standard naval letters

Memoranda

Naval speedletters

Naval messages

Other naval correspondence

TACTICAL PUBLICATIONS

An indispensable source of information, procurement, and guidance is the naval warfare publications NWP series. The Tactical Warfare Publications Guide NWP 0 lists and briefly describes the tactical warfare publications. Information on naval communications can be found in *Fleet Communications Publication* NTP 4, *Telecommunications User's Manual* NTP 3, and *Operational Reports* NWP 10-1-10.

SUPPLY PUBLICATIONS

Detailed supply message procedures may be found in NAVSUP Publication 485, *Afloat Supply Procedures*. A more practical publication that every EMO should have is the *MILSTRIP/MILSTRAP Desk Guide*, NAVSUP PUB 409, 0503-LP-001-0460. It contains much of the routine information contained in NAVSUP Pub 485.

SUMMARY

In this chapter, we have discussed the mission of the electronics division and your role as EMO. Not only are you the leader of your technicians, but also you are a vital link in the chain of command. Additionally you are the person who must provide the necessary coordination with other divisions when required. You must be able to view the ship as a whole, perceiving all the electronic equipment within the ship, and being able to mentally place the various equipments within the systems to which they belong.

No two electronics divisions will ever be organized exactly the same, but in this chapter we have presented suggestions and examples for you to use as a basis for structuring your own. The references we have mentioned will be invaluable as day-to-day sources of information.

In the next chapter we will discuss many of the required records, reports, and publications that you as the EMO will be required to complete. This chapter will assist you in familiarizing yourself with the use, format, and contents of those documents.

REFERENCES

Combat Systems Electronics Administration, Course A-4B-0019, Student Guide, Fleet Training Center, Norfolk, Va.

Military Requirements for Petty Officer First Class, NAVEDTRA 10046, Naval Education and Training Program Development Center, Pensacola, Fla., 1984.

Military Requirements for Senior and Master Chief Petty Officer, NAVEDTRA 10048, Naval Education and Training Program Development Center, Pensacola, Fla., 1985.

Standard Organization and Regulations of the U.S. Navy, OPNAVINST 3120.32(B), Office of the Chief of Naval Operations, Washington, D.C., 1973 (with updates).

NAVSURFLANT Maintenance Manual, COMNAVSURFLANTINST 9000.1C, Commander, Naval Surface Force Atlantic, Norfolk, Va., 1989.

CHAPTER 2

RECORDS, REPORTS, AND PUBLICATIONS

OVERVIEW

Describe the records, reports, and publications with which the EMO will be associated.

OUTLINE

Administration

Publications

Records

3-M

Controlled Equipage

SCLSIS

Casualty Reporting

Supply

Underway Reports

Efficient administration requires exact and current knowledge of all matters under the cognizance of the administrator-electronics material officer (EMO). In your position as the EMO, you should have knowledge of the current operating status of all electronic equipment and systems for which you have maintenance responsibility. Efficient administration also requires you to supervise the maintaining of proper records, and forwarding of various reports to higher administrative levels. The reports are required for Navy officials to carry out their responsibilities for shipboard electronic installations. You are also responsible for ensuring the proper use of publications that present information on electronics maintenance matters.

Many publications and records have been, or will be, discussed in other chapters pertinent to their subject matter. Some of the information may be repeated in this chapter because of its importance to the EMO. In this and other chapters, only the basic publication number is given for printed matter (manuals, directives, and forms). Once assigned to a ship or shore station, you should review your technical publications to ensure you have current information. If not, you must obtain the latest edition and its changes, if applicable. Use of incorrect or out-of-date information can be dangerous. Refer to the *Department of the Navy Directives/Issuance System Consolidated Subject Index*, NAVPUBNOTE 5215.1, for a listing of current instructions. In addition, each command has a 5215 Notice which you will need to consult; for example, TYCOM, IUC, and your own command.

RECORDS

Because of the complex details of electronics, it can be hardly envisioned that an individual would try to place it to memory. On board ship, your faculties must be directed to anticipating problems as well. Writing it down may be the best advice that can be given. To assist electronics personnel in keeping up-to-date information on equipment under their cognizance, NAVSEA and NAVELEX have established certain required records.

It is the responsibility of the EMO to ensure that required records are maintained by electronics personnel. Regulations governing the requirements of records and instructions and their use are contained in the following references:

- *Naval Ships' Technical Manual*, Chapters 400 and 090
- *Electronics Installation and Maintenance Book, General*, (EIMB Series), NAVSEA 0967-LP-000-0100
- *Ships' Maintenance and Material Management (3-M) Manual*, OPNAVINST 4790.4 (Series)
- Type commanders' instructions on required records

THE SHIPS' MAINTENANCE AND MATERIAL MANAGEMENT SYSTEMS (3-M)

The primary objective of the ships' 3-M Systems is to provide for managing maintenance and maintenance support in a manner that will ensure maximum equipment operational readiness. The 3-M Systems is applicable to all ships, submarines, service craft, small boats (with the exception of those operated by civilian crews), and nonaviation fleet test and support equipment. Some strategic weapons systems, however, use the Preventative Maintenance Management Plan (PMMP) rather than the 3-M Systems.

The 3-M Systems consists of two parts:

1. Planned Maintenance System (PMS)
2. Maintenance Data System (MDS)

PMS provides each ship with a simple and standard means for planning, scheduling, controlling, and performing planned maintenance on all equipment.

MDS is the means by which maintenance personnel report corrective maintenance actions on specific categories of equipment. The PMMP system is used for corrective maintenance reporting on strategic weapons systems.

As EMO, you should be aware of the various reports and forms that must be completed. The following is a brief description of the reports and forms used to report matters relating to PMS and MDS. Detailed instructions are available in OPNAVINST 4790.4.

PMS Feedback Report

The PMS Feedback Report (PMS FBR) (OPNAV 4790/7B) is a form used by fleet personnel to notify the NAVSEACEN or the TYCOM, as applicable, on matters relating to PMS. The report is a five-part form composed of an original and four copies. Instructions for preparation and submission of the form are in the 3-M manual and on the back of the form. These forms are available through the Navy supply system.

MDS Reporting

The MDS requires the reporting of maintenance actions to achieve desired objectives. Two such objectives are the deferment or completion of a maintenance action. The following forms are used to report information into the MDS.

SHIP'S MAINTENANCE ACTION FORM, OPNAV 4790/2K. This form is used by maintenance personnel to report the following:

- Deferred maintenance actions
- Completed maintenance actions, which do not result in a configuration change (including those previously deferred.)

This form also allows the entry of screening and planning information for management and control of intermediate maintenance activity (IMA) workloads.

SUPPLEMENTAL FORM, OPNAV 4790/2L. This form is used by maintenance personnel to provide amplifying information relating to a maintenance action reported on an OPNAV Form 4790/2K (e.g., drawings, listings, and the like, for use by repair activities).

MAINTENANCE PLANNING AND ESTIMATING FORM, OPNAV 4790/2P. This form is used with an OPNAV 4790/2K when deferring maintenance to an IMA under Intermediate Maintenance Activity Maintenance Management Subsystem (IMMS). It is designed to allow screening and planning to be done in detail. This planning will include information pertinent to the Lead Work Center, Assist Work Center(s), material requirements, technical documentation, cost estimates, and man-hours required to complete the maintenance action. Planning and estimating (P&E), a section of the IMA, completes this form.

AUTOMATED SHIP'S MAINTENANCE ACTION FORM, OPNAV 4790/2Q. This form, which is filled in by computer, contains the same information as the OPNAV 4790/2K. Additional handscribed information may be entered by maintenance personnel. This form may be used as an automated work request and may also be used in preparation for INSURV.

AUTOMATED WORK REQUEST, OPNAV 4790/2R. This form combines the information from the OPNAV 4790/2K and 4790/2P. It is available in four copies. It has been designed for machine and hand-printed entries. This form may be used as follows:

- As an automated work request
- As an ADP-produced work control document for internal IMA use
- When using an item from the master job catalog (MJC)
- When preparing for INSURV

SHIP'S CONFIGURATION CHANGE FORM, OPNAV 4790/CK. This form is used to report any maintenance action that results in a configuration change, such as:

1. Partially or fully accomplished alterations.
2. Completed or partially completed maintenance actions that result in a configuration change. The 4790/CK form is also used to correct erroneous or deficient data in the configuration files. Detailed procedures for use of OPNAV 4790/CK are found in chapter 9 of the 3-M manual.

The EMO should also become familiar with the Departmental Master PMS Manual and the Work Center PMS Manual outlined in OPNAVINST 4790.4.

Current Ship's Maintenance Project (CSMP)

The purpose of the CSMP is to provide shipboard maintenance managers with a consolidated listing of deferred corrective maintenance to manage and control its accomplishment. All such deferred maintenance should be recorded in the CSMP. The complete shipboard CSMP consists of the following:

The "automated CSMP," which is the computer-produced listing of deferred maintenance and alterations that have been identified through the submission of OPNAV 4790 forms to MDS.

The suspense file of OPNAV 4790 documents for maintenance items that have been submitted but (1) have not yet been reflected in the CSMP reports, or (2) have not appeared in the MDS Transaction and Error Identification Report as having been accepted by the 3-M program.

The Work Center Work List/Job Sequence Number (WCWL/JSN) Log which is the work center list of all material discrepancies to be either corrected by ship's force or an outside activity.

The CSMP is the basic management tool used on board ship. The work center supervisor is responsible for ensuring the CSMP accurately describes the material condition of the work center.

The CSMP is to be physically located in the work center. The work center work list is to be kept current and reviewed at least weekly by the division officer.

SHIP CONFIGURATION AND LOGISTICS SUPPORT INFORMATION SYSTEM (SCLSIS)

SCLSIS replaced an older configuration system known as SECAS. You may have had one of the NAVSEA SECAS validation teams on board in the past. During their visit, they verified all of your equipment on board using nameplate data and attached validation stickers to your equipment. Your equipment may still have some of the SECAS validation stickers attached. Your ship may be maintaining a yellow SECAS folder with pen and ink corrections at the time of this printing.

The ability to determine the configuration (onboard systems and equipment) of your ship is essential to maintaining proper shipboard support. To effectively manage your onboard electronic systems, configuration data must be accurate and timely. Historically, Navy managers have developed independent information systems for gathering and processing ship configuration data appropriate to their individual needs. While such systems were adequate for specific requirements, each required maintenance and organizational support. This resulted in inconsistent results and interface problems because of language or equipment identification incompatibilities. As a result of a search to resolve this problem, a central Navy system was developed to accurately monitor shipboard configuration data, SCLSIS.

SCLSIS is applicable to all ships of the active and reserve fleets with the exception of fleet ballistic missile submarines (SSBNs) and nuclear propulsion systems. Figure 2-1 shows the data flow for non-SCLSIS ships.

SECNAVINST 4130.2 assigns responsibility to the Naval Sea Systems Command (NAVSEA) for maintenance and control of ship's configuration data. This includes related platforms, systems, and equipments. Furthermore, it requires that a single activity be designated as the ship class control authority for configuration data input, and changes to the Weapons Systems File/Ship Configuration and Logistic Support Information Database. The SCLSI Database, which is maintained by Configuration Data Manager (CDM), contains ship configuration and associated logistics support information. It does not contain parts level or parts inventory information. The *Weapons System File* contains the parts level, parts inventory portions, and related secondary ship component level configuration data files. SCLSI is the master configuration file for all Navy

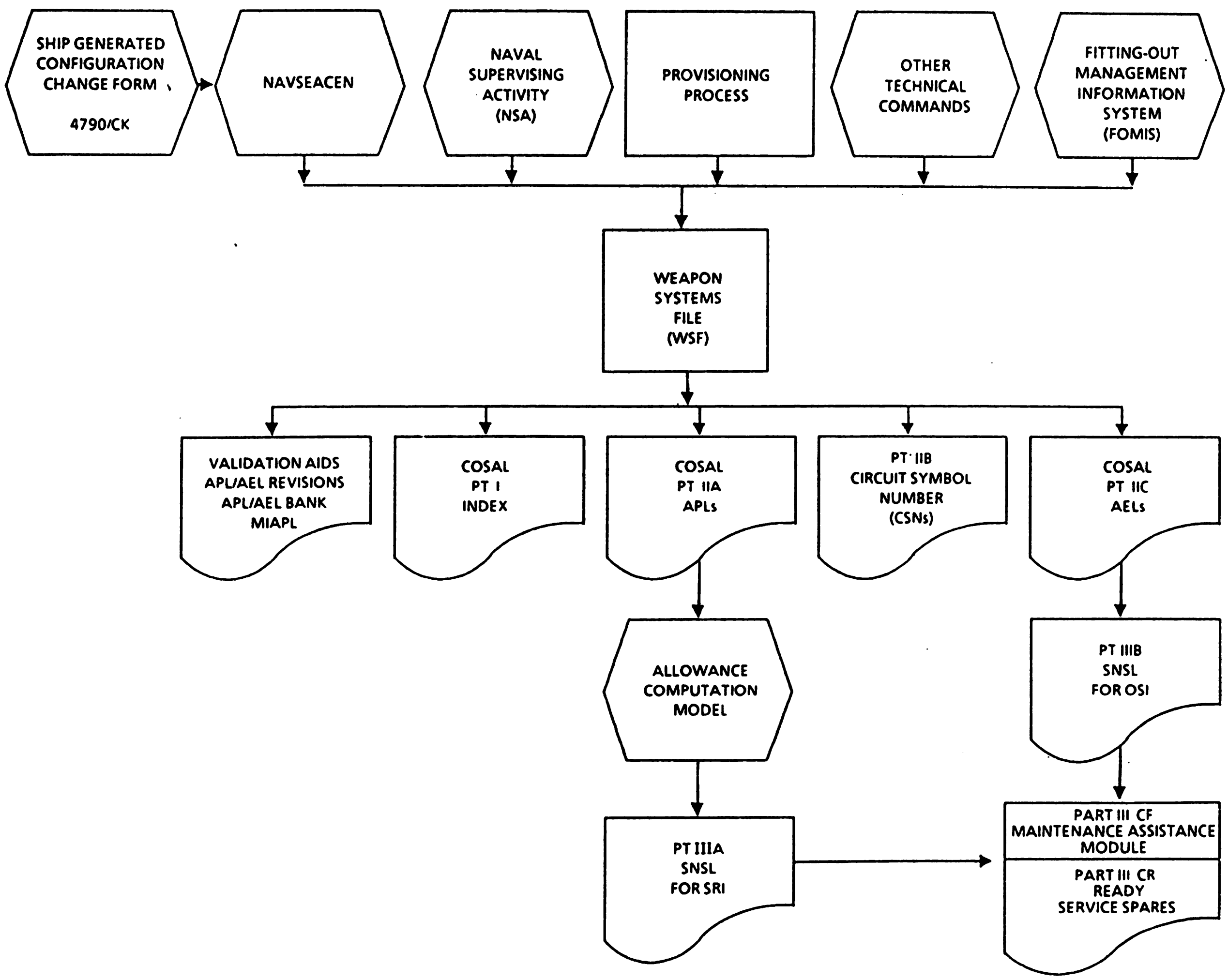


Figure 2-1.—Data flow for non-SCLSIS ships.

ships. It covers the life cycle of a ship from the time of construction to the present.

Figure 2-2 shows the data flow for automated SNAP II Ships—from the ship to the TYCOM using 3-M reporting procedures. The data are then forwarded to the Central Data Exchange (CDE) at the Naval Sea Logistics Center (NAVSEA-LOGCEN). Here the data are consolidated with that of configuration and logistics and routed to the cognizant Configuration Data Manager (CDM).

The CDM is the single activity responsible for the accuracy and maintenance of the configuration data for a ship class. All data entries into the Weapon System File/SCLSI database are made directly by the CDM. When information is submitted for inclusion to the database, the CDM performs the necessary research and then updates the SCLSI database.

SPCC then processes the CDM-directed transactions, calculates allowance changes, and extracts related supply support information as appropriate. All SCLSI database updates whether initiated by the ship or CDM, results in an output from the SCLSI database to be sent to the ship. SPCC also passes supply support changes back to the ship. These changes include new and revised APLs and National Item Identification (NIIN) changes. Response to Coordinated Shipboard Allowance List (COSAL) Feedback Reports are passed from SPCC to the ship in the same process. This source data file provides information to the

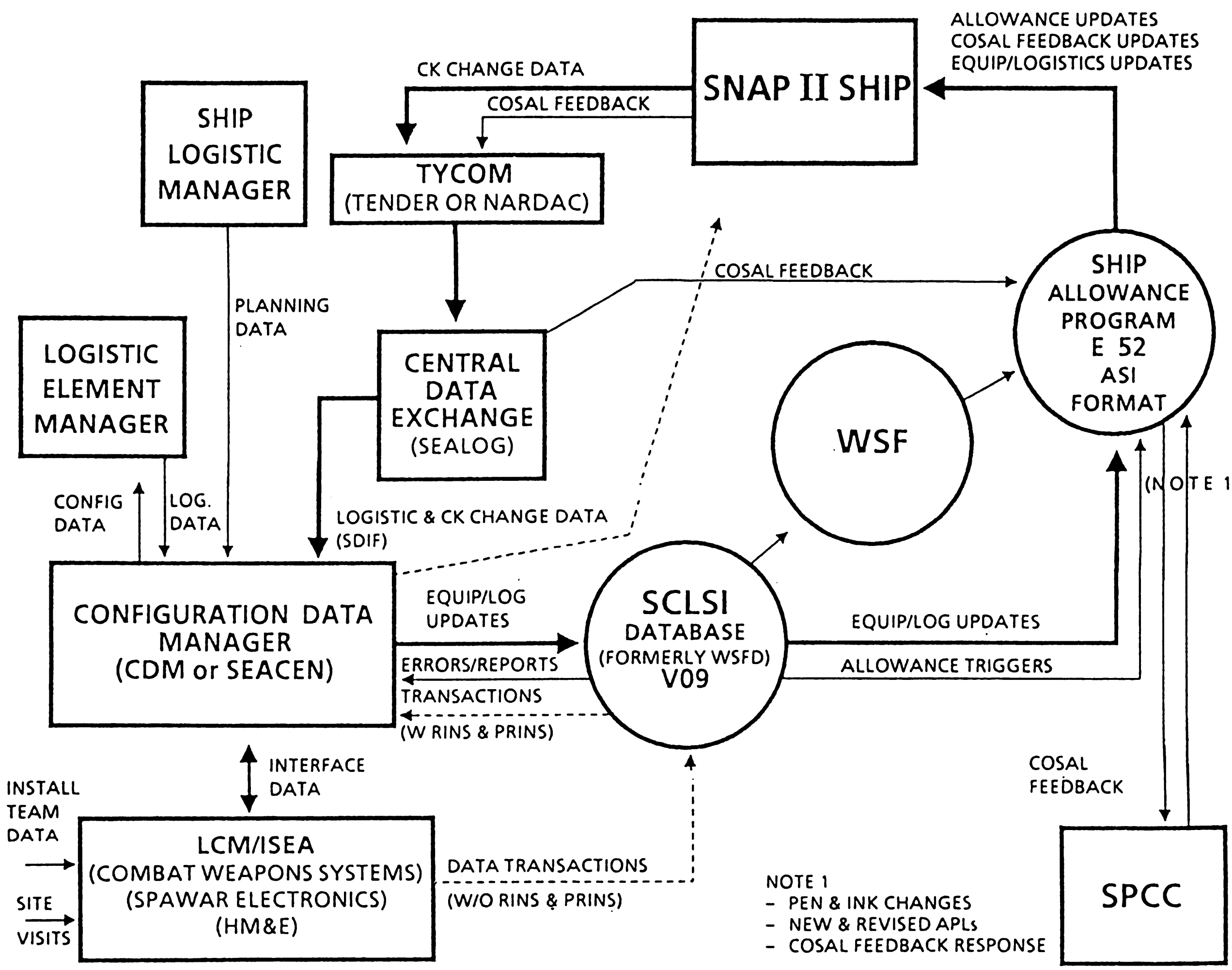


Figure 2-2.—Data flow for automated SNAP II ships.

Shipboard Nontactical ADP Program (SNAP) databases and data to other fleet and shore activities requiring authoritative configuration and logistics information. Refer to figure 2-3 which shows SCLSIS data flow for non-SNAP configured ships.

SCOPE OF SCLSIS

The Scope of SCLSIS is intended to include all configuration-worthy items necessary for the operation, maintenance, modernization, and support of shipboard equipment.

An item is "configuration worthy" if:

1. It requires any one of the following elements of logistics support: supply support, test equipment requirements, technical manuals and repair standards, Planned Maintenance System coverage, or drawings.
2. Configuration information (e. g., nameplate data, technical characteristics data, component drawing) is required to support any level of maintenance (organizational, intermediate, or depot), and modernization (planning and execution).
3. It is needed to fully describe the functional hierarchy of the ship.

Four levels of configurations are defined within NAVSEA Technical Specification 9090-700 series that governs SCLSIS.

1. **Ship Level Configuration.** The Planning Yard maintains ship level configuration information with general arrangement drawings and various ship level records, such as weight and stability analysis.
2. **System Level Configuration.** The Planning Yard maintains system level configuration information with system selected record drawings and configuration control drawings.
3. **Component Level Configuration.** Along with ship and system level configuration data,

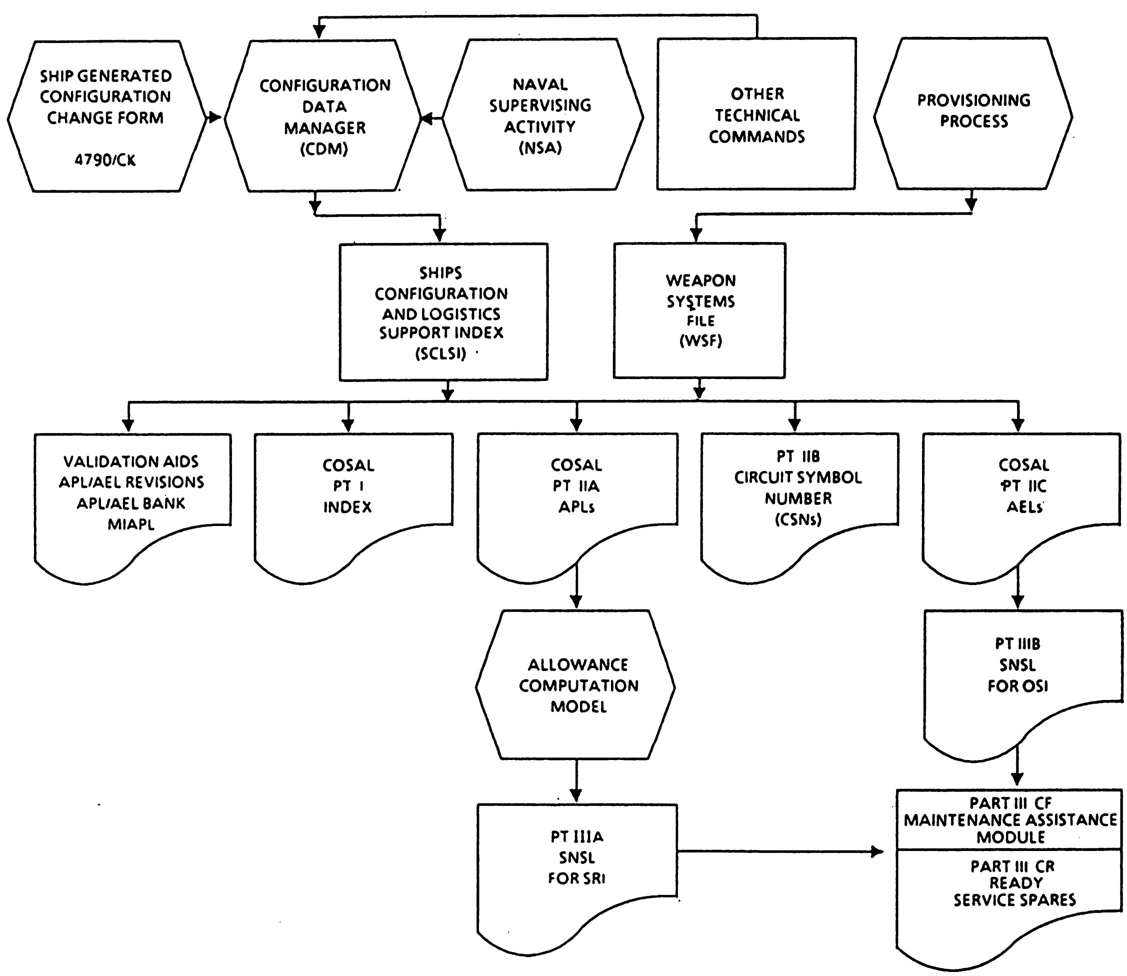


Figure 2-3.—Data flow for non-SNAP configured ships.

component level configuration data is maintained in the SCLSI database.

4. **Parts Level Configuration**. Parts level configuration data is maintained in the equipment file of the WSF and is controlled by the life cycle manager (LCM) and SPCC.

VALIDATIONS AND AUDITS

A team of validation inspectors will visit your ship periodically to verify nameplate data of the equipment you have on board. You may ask, why? As your ship continues service in the Navy, new equipment will be added during the operational cycle or at the time of shipyard overhaul. This new equipment must be supported with repair parts and personnel with technical training on that specific equipment. SCLSIS maintains an up-to-date database of the equipment you have on board allowing managers to accomplish these functions.

Validations and Audits are grouped in several basic categories, which may involve different levels of effort and specific timing requirements for execution. The basic validations and audit categories include:

1. **Baseline Validation**. The purpose of the Baseline Validation is to establish the ship Class Standard Database (CSDB) for ship's configuration and logistics information. The Baseline Validation is applied to the first ships of a class implemented under SCLSIS to produce the initial CSDB. Baseline Validation includes a ship check of the configuration of equipment, alteration status, applicable revisions, and logistics support research. At a minimum, the Baseline Validation will encompass validation of configuration and alteration status, for critical equipment. Next in priority would be the verification of critical equipment logistics support information. The minimum requirement for noncritical equipment is that validation will be accomplished whenever there is an indication of inaccurate data in the ship's file.

2. **Audits**. Audit teams will sample validation to statistically ascertain the quality level of configuration and logistics data in the SCLSI database.

3. **Correction Validation**. A validation of items reflected in an audit, including follow-on clarification audits to identify further validation candidates needed to restore data quality level.

4. **Installation Validation**. A verification of configuration and logistics data being reported for new configuration item installations.

For more detailed information on SCLSIS, refer to NAVSEA Technical Specification 9090-700 and the *COSAL Use and Maintenance Manual*, SPCCINST 4441.170.

CONTROLLED EQUIPAGE

Controlled equipage is the term used to designate selected items of equipage that require increased management control because they are either costly, easily pilfered, or essential to ship's mission. Controlled equipage includes such material as tape recorders, first-aid boxes, life preservers, and some test equipment. A complete listing can be found in *Afloat Supply Procedures*, NAVSUP Publication 485. As EMO, you must ensure that all equipment in the electronics area is managed properly, even though it is not listed as controlled equipage.

A custody signature of the responsible department head is mandatory on Controlled Equipage Custody Record (NAVSUP FORM 306) for articles of controlled equipage listed in Controlled Equipage Item List (CEIL). In addition to the equipage listed on the CEIL, the type commander or the commanding officer may determine that additional equipage items require a custody signature.

A copy of the Controlled Equipage Custody Record must be furnished to the department head at the time the original custody card is signed. The duplicate copy becomes the department head's record of controlled equipage requiring custody signature. As controlled equipage is received or expended, appropriate entries are made on all equipage records. The supply officer and custodial department head are jointly responsible for ensuring the original and duplicate custody cards are in agreement.

Inventories of Controlled Equipage

Items of controlled equipage, including custody-signature-required items, must be inventoried annually between 15 February and 15 March. Deficiencies must be reported by the supply department to type commanders in Budget/Operating Target (OPTAR) reports. Inventories are also required when the ship is commissioned, deactivated, or reactivated. Upon relief of the head of department, an inventory must be taken jointly by the relieved and reporting department heads. If there is a change of command, an inventory can be directed by the relieving commanding officer.

The department head is furnished a file of duplicates of the Controlled Equipage Custody Record (NAVSUP 306). This provides a logical basis for conducting the inventory of controlled equipage. Each article must be sighted and inspected for serviceability by the inventorying officer. Articles identified by serial numbers must be checked by those numbers when inventories are taken. Any shortages or items found to be unserviceable during the inventory must be reported according to survey procedure found in NAVSUP P-485.

Upon completion of the equipage inventory, the department head must submit a letter to the commanding officer and a copy to the supply officer. When possible, the letter should be a joint report from the relieved and relieving department head. The signature of both officers are required on the report.

The report must include the following information:

1. Controlled equipage inventory has been completed.
2. Surveys applicable to shortages and unserviceable items have been submitted (or the reasons why they have not been submitted).
3. Issue requests applicable to shortages and unserviceable items requiring replenishment have been submitted to the supply officer (or the reasons why they have not been submitted).
4. List of excess controlled equipage items, including justification or authority for any excess items desired to be retained.

MEMO RECEIPT FOR CONTROLLED EQUIPAGE OPS 12
(Appl Dept Card No.)

Receipt is acknowledged for the following item of controlled equipage in the quantity indicated:

BINOCULARS, prismatic, 7 X 50, w/filters, case, and straps

Date	Serial	Quantity	Signature and Rank/Grade
3/15/70	42450	1 EA	R. E. Underwood, ENS
3/15/70	703	1 EA	Richard Bacon, QM3
4/6/70	5467	1 EA	J. McClure, BM2

(Columns cont'd on reverse)

Figure 2-4.—Sample memorandum receipt on 3″ × 5″ card.

Accountability of Equipage

As EMO, you will normally be directly responsible to the operations department head for the control and inventory of "signature required" electronic controlled equipage. This is accomplished by the use of a memorandum receipt. An example of a memorandum receipt is shown in figure 2-4.

Column entries on the card are made in pen. The person requesting use of the controlled equipage should fill in the Date, Serial, Quantity, and Signature Columns. This information should be checked for legibility and accuracy by the person issuing the equipment. Upon return of the controlled equipage, the applicable entry on the memo receipt will be lined out by pen in the presence of the person returning the equipage, and the deleted entry will be initialed by the person holding the memo receipt.

REPORTS

To increase the effectiveness of recurring reports and to avoid duplication, a program known as the Reports Control Program has been put into effect. The major objectives of this program are (1) to develop the most effective new reports and reporting procedures; (2) to improve existing reports and related procedures in the light of current needs; (3) to ensure economy in paperwork, man-hours, and other costs by analyzing and simplifying reports and reporting procedures; and (4) to eliminate and prevent unnecessary or duplicate reporting.

The Reports Control Program is installed at the various naval and marine commands. The sites are in selected major field activities and under direct responsibility of the Chief of Naval Operations (OP 09B83). Required reports are detailed in reports required of the operating forces by Washington Navy Headquarters Commands, OPNAVNOTE 5214. Also Fleet, TYCOM, IUC, and local commands issue 5214 notices.

Some reports that are the responsibility of the EMO are discussed in the following paragraphs.

SURVEY REPORT

A survey is a procedure required by U.S. Navy regulations when naval property must be condemned as a result of damage, obsolescence, or deterioration, or acknowledged as nonexistent as a result of loss, theft, or total destruction.

The survey is prepared in accordance with NAVSUP P-485.

TROUBLE REPORTS

Normally the electronics maintenance assignments are made by the EMO and LPO based on the priorities of locally generated equipment reports. (Refer to figure 2-5.) Each time an equipment problem is detected, a separate trouble report is filled out indicating such things as equipment affected, nature of trouble, time of failure, and the like. After the report is filled out,

Sample
Trouble Report

System/Sub-System ______________________________

Equipment ______________ Serial #/Position ______________

Circle One
Major Casualty (Tech Called)/ Minor Casualty (Hold for WC SUP)

Description of Problem: ______________________________

____

____

____

____

Submitted by: ______________ Date/Time ______________

Date/Time Accepted: ______________ Supervisor: ______________
(Signature)

Technician Assigned: ______________ Date/Time ______________

Action Taken: ______________________________

____

____

____

____

____

Date/Time Resolved ______________ EDL Entry Made: YES NO

WC SUP Reviewed ______________ Date/Time ______________
(Signature)

JCN Assigned YES/NO Number ________

Note: Turn in to Group Supervisor upon completion.

Figure 2-5.—Equipment trouble report.

or in urgent situations that require immediate action, the failure is brought to the attention of the EMO or LPO to ensure correct assignment of maintenance priorities and proper supervision. When the trouble has been corrected, the maintenance supervisor will sign the appropriate block in the original trouble report. The trouble reports is then used to make appropriate 3-M reports. Ensure you get every trouble report, remember the old adage: "If The EMO Doesn't Know About It, It Ain't Broke!"

CASUALTY REPORTING

The Casualty Report (CASREP) is a form of external trouble reporting. It has been designed to support the Chief of Naval Operations (CNO) and fleet commanders in the management of assigned forces. The effective use and support of Navy forces require an up-to-date, accurate operational status for each unit. An important part of operational status is casualty information. The CASREP system contains four types of reports: Initial, Update, Correct, and Cancel. These reports are described in general in the following paragraphs. CASREPS are not a substitute for, but are in addition to and complement for 3-M data. For more complete information on preparation and submission of those reports, see Operational Reports NWP-10-1-10 and the outstanding Operational orders.

Initial Casualty Report (INITIAL)

An INITIAL casualty report identifies, to an appropriate level of detail, the status of the casualty and parts and/or assistance requirements. This information is essential to allow operational and staff authorities to apply resources and assign proper priority.

Update Casualty Report (UPDATE)

An UPDATE casualty report contains information similar to that submitted in the INITIAL report and/or submits changes to previously submitted information.

Casualty Correction Report (CASCOR)

A unit submits a Correction Casualty Report (CASCOR) when equipment that has been the subject of casualty reporting is repaired and back in operational condition.

Cancellation Casualty Report (CASCAN)

A unit submits a Cancellation Casualty Report (CASCAN) when equipment that has been the subject of casualty reporting is scheduled to be repaired during an overhaul or other scheduled availability. Outstanding casualties that will not be repaired during such availability shall not be canceled and shall be subject to normal follow-up casualty reporting procedures.

Anticipated Not Operationally Ready (Supply) (ANORS)

NAVSUP P-485 describes the use of ANORS requisitions (casualty anticipated because of lack of material). For example, the ship's AN/SPS-10 Magnetron is beginning to arc, and there is no spare on board. The AN/SPS-10 remains operational; however, since failure of the magnetron is anticipated, an ANORS requisition would be made.

GETTING UNDERWAY REPORTS

On most ships the EMO is responsible for turning in an equipment status report prior to getting underway. This report may be due anytime between 24 and 72 hours prior to getting underway, depending on the requirements of the TYCOM. It usually includes major equipment status, estimated time of repair (ETR), power out/MDS readings from the radars, and power out/receiver sensitivity readings from communications equipment. This report is usually a locally generated form and may vary between commands (see fig. 2-6).

EIGHT O'CLOCK REPORTS

The eight o'clock reports are written equipment status reports given to the commanding officer by the executive officer at eight o'clock (2000). (In port they are reported to the CDO by duty department representatives). As EMO, you will normally be responsible for making electronic equipment status reports to the operations department head or executive officer between 1900 and 1930. These reports are verbal and include major equipment status and estimated time of repair (ETR). You must have up-to-date information and be able to answer any questions that may arise. For example: What parts do we

16 May 1990

USS ________________________________

UNDERWAY EQUIPMENT STATUS

Equipment	Technician		Condition	48	24	Status
AN/URT-23 #1	ET3	McAdams	UP	OK	OK	PMS W1, M1
AN/URT-23 #2		"	UP	OK	OK	PMS W1, M1
AN/URT-23 #3		"	UP	OK	OK	PMS W1, M1
AN/URT-23 #4		"	UP	OK	OK	PMS W1, M1
AN/WSC-3 #1	ET3	Barkwell	UP	OK	OK	PMS W1, M1
AN/WSC-3 #2		"	UP	OK	OK	PMS W1, M1
AN/WSC-3 #3		"	UP	OK	OK	PMS W1, M1
AN/WSC-3 #4		"	UP	OK	OK	PMS W1, M1
AN/SPS-10		"	UP	OK	OK	PMS W1, M1
LN/66	ET3	Humber	DOWN		Local Oscillator on order. Ship date 14 May from NORVA. ETD 17 May	

(signature) ________________________ Leading ET

(signature) ________________________ EMO

(signature) ________________________ Operations Officer

Underway Check Lists Instructions

1. Work Center Supervisors fill in names of assigned technicians.

2. Assigned technicians initial 48 hour/24 hour column to signify the following:

   a. 48 hour - Major parameters within PMS standards/necessary alignments completed.

   b. 24 hour - Remote tests/operational tests completed. Operator control.

3. Record PMS checks completed where applicable.

4. Completed lists will be turned in to Group Supervisor for review and filing.

Figure 2-6.—Equipment status report.

need for repair? Are they on board? Has a requisition been made to supply? Will a CASREP be necessary? Ensure you have an answer to these questions. In accordance with Material Deficiency Management, OPNAVINST 4790, the EMO may control the status of equipment. The Equipment Status Log (ESL) is the main component of this tool. See OPNAVINST 4790.2 and your ship's instruction.

DEFECTIVE MATERIAL REPORTING

Reporting of defective materials obtained through the supply system is covered in NAVSUPINST 4440.120. It is important to note that in many instances SPCC does not receive a report of defective material such as improper fit, poorly packaged, of cheaper quality than previous issue, or incorrect replacement. The EMO is encouraged to ensure that SPCC is notified directly of defective material in the supply system and should provide other reports that may close the loop.

ADDITIONAL REPORTS

Type commanders and other authorities may require reports in addition to the ones already mentioned. Instructions concerning such reports may be promulgated via letter, message, or other official means. As EMO, you will be routed all official correspondence regarding electronics. To keep abreast of current instructions, develop a correspondence file that can be referenced not only by you, but also by your relief.

PUBLICATIONS

Various publications, some of which are discussed below, are available for guidance in maintenance work, or for reference and study. Some are as vital to intelligent maintenance as is test equipment.

In general, publications are available from the forms and publications supply distribution point, Naval Publications and Forms Center (NPFC), Philadelphia, Pennsylvania. Several important points that should be considered before requisitioning such material: the equipment installed, the mission of the ship or activity, the purpose of the distribution policy for the individual publication, and the available stowage space.

Because it is essential that reference material be as current and accurate as possible, publications changes and corrections must be entered as they are issued. For example, if the current issue of the EIB corrects information in an earlier issue, the earlier issue should be changed at once. If no page is furnished for recording completed changes, some method for this must be devised. One method is to annotate the margin of the new material to indicate the source publication that initiated the change.

Specific individuals should be assigned responsibility for making all changes in designated publications. As EMO, spot checking entries has proved to be an excellent management tool for eliminating the possibility of having incorrect repair information.

Current issues of NAVSEA *Deckplate*, the EIB, and the EIMB should be examined for information on the availability of handbooks, final technical manuals, revisions, supplements, and changes pertaining to the equipment on board.

INSTALLATION AND MAINTENANCE PUBLICATIONS

The Naval Sea Systems Command is endeavoring to eliminate the large number of maintenance and installation publications now in use.

Naval Ships' Technical Manual

The Naval Ships' Technical Manual is one of the most complete authoritative references available on NAVSEA equipment. Chapter 400 of the manual is titled, "Electronics" and is required reading for electronics personnel. This chapter is available as a separate pamphlet, and two copies per ship are usually required—one for the shop and one for the electronics technical library. Chapter 400 lists other publications containing information of value to electronics personnel.

The purpose of Chapter 400 is to provide major policies and instructions pertaining to electronics maintenance and electronics material under NAVSEA and NAVELEX cognizance.

Other chapters of the Naval Ships' Technical Manual that will be of interest to the electronics personnel are listed below.

Chapter 90	Inspections, Tests, Records, and Reports
Chapter 300	Electric Plant General
Chapter 491	Electrical Measuring and Tests Instruments
Chapter 532	Liquid Cooling Systems for Electronics Equipment
Chapter 634	Deck Coverings

Electronics Installation and Maintenance Book

The *Electronics Installation and Maintenance Book* (EIMB), NAVSEA 0967-LP-000-0000, consists of a series of authoritative publications that provide fleet and field activities with information on the installation and maintenance of electronic equipment under the technical control of NAVSEA and NAVELEX. Information for the EIMB has been taken from such sources as the Electronics Information Bulletin (EIB), NAVSEA *Deckplate*, and NAVSEA Notices and Instructions. The EIMB supplements the equipment technical manuals and related publications. The intent of this series is to reduce time-consuming research.

The EIMB is organized into 13 different handbooks. These handbooks are being updated and upon completion of revision will all be assigned the SE Series number (TMINS). The stock numbers will remain the same. In the front of each EIMB is a box score that reflects the latest EIMB and change information contained in that volume.

GENERAL INFORMATION HANDBOOKS. In addition to the EIMBs discussed in the previous paragraph, the EMO should be aware of the general information handbook series. These handbooks are discussed in the following paragraphs.

1. *General EIMB Handbook*, NAVSEA 0967-LP-000-0100. The purpose of this handbook is to provide policies and instructions pertinent to the proper use of the EIMB. The handbook is published for the guidance of all personnel in the naval establishment responsible for or engaged in the installation, maintenance, and repair of electronic equipment.

The information contained in the handbook has been carefully selected and arranged so that it is easily identified and retrieved.

The handbook consists of the following:

Section 1 - Introduction

Section 2 - Administration

Section 3 - Safety and Accident Prevention

Section 4 - Publications and their Handling

Section 5 - EIB/EIMB Indexes

When properly used, the General handbook is a quick source of information for installation and maintenance personnel. Valuable data pertaining to administration, supply, publications, and safety matters is arranged in quick reference index. Previously only after considerable research in more than one EIMB handbook could a technician have found the desired information. In addition, the EIMB Subject Index (Index C), located in Section 5 of the handbook, provides another handy reference for identifying the specific EIMB handbook(s). These references will have all of the information on a particular subject.

2. *Installation Standards EIMB Handbook*, NAVSEA 0967-LP-000-0110. This handbook promulgates approved shipboard installation standards, techniques, and practices for NAVSEA electronic equipment. The information contained in this handbook has been extracted from numerous publications, instructions, and pamphlets obtained from military and commercial sources. It represents the best current knowledge in the electronic installation and maintenance field. The handbook has been arranged so that material is presented as nearly as possible in the chronological order of installation events, starting with receipt of equipment from the source of supply, to standard installation practices preliminary to placing the equipment into service. Periodic revisions and additions are made to ensure that the handbook always reflects the current techniques and new developments. This handbook is intended primarily for installation personnel.

3. *Electronic Circuits EIMB Handbook*, NAVSEA 0967-LP-000-0120. This handbook provides electronic circuitry theory and descriptions for basic vacuum tube and semiconductor circuits. The contents of the handbook have been carefully selected and prepared to serve the requirements of naval personnel in the electronics field. The handbook, as sectionalized, permits the addition of new circuits to keep the handbook abreast of current electronic developments. This format permits the addition of new electron-tube, semiconductor, and allied circuits, as well as the revision of existing circuits. Each circuit description includes information on the circuit application, its important characteristics, an analysis of circuit theory and operation, and failure analysis based upon output signal indications. This handbook is intended primarily for shipboard electronic training personnel and as electronic reference material.

4. *Test Methods and Practices EIMB Handbook*, NAVSEA 0967-LP-000-0130. This handbook provides Electronics Technicians with reference information on the fundamentals of test methods and basic measurements, step-by-step procedures for testing typical electronic equipments and circuits, and functional descriptions of the theory of operation of the test equipment used and circuits tested.

5. *Reference Data EIMB Handbook*, NAVSEA SE000-00-EIM-140. This handbook

contains an encyclopedic arrangement of useful and informative references of pertinent definitions, abbreviations, formulas, and other general data related to electronic installations and maintenance. This handbook of reference data is intended for use by all Navy electronics personnel.

6. *EMI Reduction EIMB Handbook*, NAVSEA SE000-00-EIM-150. This handbook contains NAVSHIPS-approved techniques and procedures for the elimination or reduction of electromagnetic interference (EMI) created by own-forces electromagnetic radiating devices. This handbook is intended for Electronics Technicians involved in the installation and maintenance of electronic and electrical systems and equipment.

7. *General Maintenance EIMB Handbook*, NAVSEA SE000-00-EIM-160. This handbook contains routine maintenance concepts, techniques, and procedures common to all electronic and electrical equipment. Preventive maintenance programs, equipment-level and system-level maintenance philosophies, and maintenance of subsystems and repair parts are discussed. This handbook is intended for use by all technicians involved in the maintenance of electronic and electrical equipment.

EQUIPMENT-ORIENTED HANDBOOKS

Six equipment-oriented handbooks comprise the EIMB series. Each of these handbooks contain general servicing information for the basic equipment category (for example, radar), general servicing information for specific equipments (for example, AN/SPS-10D), the Field Change Identification Guide (FCIG), which provides field change information for all equipments of the basic equipment category, and circuit functional descriptions common to the equipment of the basic equipment category. The six equipment-oriented handbooks are:

Communications EIMB	NAVSEA SE000-00-EIM-010
Radar EIMB	NAVSEA SE000-00-EIM-020
Sonar EIMB	NAVSEA SE000-00-EIM-030
Test Equipment EIMB	NAVSEA SE000-00-EIM-040
Radiac EIMB	NAVSEA SE000-000-EIM-050
Countermeasures EIMB	NAVSEA SE000-00-EIM-060

Managing Publications. All ships are provided an initial allowance of publications, instructions, and notices. You will need to consult NAVSUP P-2000 to order additional publications or replace those that become out-dated or destroyed. If the supply of manuals is extremely limited, special justification may be required.

Requirements for technical manuals are included as a part of the contract for equipment, as a result the number of manuals vary with each contract. Consequently the quantity of manuals is always limited, and for this reason distribution is normally limited to recipients of the equipment and to those activities required to service it.

Technical manuals occasionally contain errors. To permit correction of these, revisions, changes, and Advance Change Notices (ACN) are provided. When available, they are listed in the EIB. The technical background of corrections may also be published in the EIB. All changes and ACNs, including updates due to installed field changes, must be made in the manuals, regardless of the time and effort required. If the corrections are not made, many man-hours may be lost; for example, technicians attempting to repair an equipment using an incorrect schematic.

The EMO should encourage personnel to send in Technical Manual Deficiency Evaluation Reports (TMDERs). All technical manual errors should be reported. The *Guide for User Maintenance of NAVSEA Technical Manuals*, NAVSEA SOO5-AA-GYD-030/TMMP, provides information concerning identifying, ordering, deficiency reporting, and updating technical manuals.

The ship's index of technical publications (ITP) provides a complete listing of onboard technical publications based on SCLSIS.

Miscellaneous Publications

In the following paragraphs, we will brief you on various miscellaneous publications that you will find beneficial.

SHIPBOARD ANTENNA SYSTEMS. The shipboard antenna systems books serve as a source of information for the installation and maintenance of shipboard antennas. Information contained in these manuals supplements, but does not supersede existing specifications. There are five manuals that comprise this series.

- *Shipboard Antenna Systems*, Vol. 1, *Communications Antenna Fundamentals*, NAVSEA 0967-LP-177-3010

- *Shipboard Antenna Systems*, Vol. 2, *Installation Details, Communications Antenna Systems*, NAVSEA 0967-LP-177-3020

- *Shipboard Antenna Systems*, Vol. 3, *Antenna Couplers, Communications Antenna Systems*, NAVSEA 0967-LP-177-3030

- *Shipboard Antenna Systems*, Vol. 4, *Testing and Maintenance, Communications Antenna Systems*, NAVSEA 0967-LP-177-3040

- *Shipboard Antenna Systems*, Vol. 5, *Antenna Data Sheets*, NAVSEA 0967-LP-177-3050

EMISSIONS AND BANDWIDTH HANDBOOK, NAVSHIPS 0967-LP-308-0010. This handbook is concerned with the emissions and bandwidths of radio signals used for communication in the U.S. Navy. It discusses and describes communications signals, and various other emissions (both natural and manmade), frequency allocation and assignment, electromagnetic interference, and methods of specific techniques used to suppress electromagnetic interference. This publication is written for Electronics Technicians, and is highly recommended.

SINGLE SIDEBAND COMMUNICATIONS, NAVSHIPS 0967-LP-307-7010. This handbook identifies and clarifies the areas where operators have had difficulty in developing an understanding of SSB. It is recommended reading for all technicians and operators associated with SSB equipment.

PRINCIPLES OF MODEMS, NAVSHIPS 0977-LP-291-6010. This document explains, in basic nontechnical language, the various methods by which modulation and demodulation of signal-carrying electric currents are accomplished. Also some of the characteristics of the methods that determine their applicability to various system designs. A glossary of terms commonly used in conjunction with modulator-demodulator (MODEM) application is included. The bibliography will assist those who desire a more thorough technical treatment of the subject.

PRINCIPLES OF TELEGRAPHY (TELETYPEWRITER), NAVSHIPS 0967-LP-255-0010. This handbook is devoted to the principles and practices of telegraphy as applied to the teletypewriter. It is recommended reading for Navy Electronics Technicians and operators associated with telegraphy.

MINIATURE/MICROMINIATURE (2M) ELECTRONIC REPAIR PROGRAM, NAVSEA TEOOO-AA-HBK-010/2M. The primary purpose of these documents is to establish uniform procedures and techniques for repairing high-reliability electronic assemblies. This ensures the continuance of the original quality and reliability of the electronic component. It also affords a basis for developing the skills of new personnel and controlling the end results of their repair actions. Personnel must be properly trained and certified to effect high quality reliable repairs to state-of-the-art electronic printed circuits and modules. The Naval Sea Systems Command has developed a program under guidelines established by the Chief of Naval Operations and at the direction of the Chief of Naval Material. This program is called the NAVSEA Miniature/ Microminiature (2M) Electronic Repair Program (NAVSEAINST 4790.17). It provides for proper training in the art of miniature and microminiature repair. The authorization and provisioning of proper tools and equipment are enclosed along with a personnel and activity certification program conducted by fleet and type commanders.

MICROELECTRONIC DEVICE DATA HANDBOOK, MILHDBK-175. This handbook provides general information on microelectronic devices and their application. It provides valuable information and guidance to personnel concerned with the design, development, and production of equipment and systems employing microcircuits. Emphasis is placed upon considerations affecting reliability of systems employing microelectronic devices.

MILITARY COMMUNICATION SYSTEM TECHNICAL STANDARDS, MIL-STD-188 (numerous subjects). This technical publication provides a listing of technical design standards for military communication systems. The standards are intended for research and development of new equipment as well as in preparation of operating standards and engineering installation standards for communication systems. The objective of this standard is to eliminate interface and incompatibility problems from other communications systems.

SHIPBOARD BONDING, GROUNDING, AND OTHER TECHNIQUES FOR ELECTROMAGNETIC COMPATIBILITY AND SAFETY, MIL-STD-1310 (NAVY). The requirements of this standard apply to all new shipboard installations and to that part of existing installations that is being modified. It is not the intent of this standard to update existing installations that are programmed for modification or to change work accomplished according to previous requirements. The procedures and methods specified in this standard shall be used only whenever it is required to (1) bond, ground, insulate or use nonmetallic materials to provide electromagnetic compatibility; (2) provide personnel safety from electrical shock hazards; (3) safeguard electrical transmissions of classified information; and (4) to provide a dc reference ground.

INSTALLATION CRITERIA FOR SHIPBOARD SECURE ELECTRICAL INFORMATION PROCESSING SYSTEMS, MIL-STD-1680 (SHIPS). This standard sets forth the design and installation criteria applicable to shipboard secure electrical information processing systems. This includes detailed hardware and equipment requirements, applicable inspection, reporting procedures and documentation. It is of utmost importance that installation and maintenance managers of these processing systems be well versed in the contents of this standard. This is the standard used for telecommunications electromagnetic performance and emission standard (TEMPEST).

CATALOGS, LISTS, INDEXES, AND DIRECTORIES. These are discussed in the following paragraphs.

1. **Equipment Identification Code (EIC) Master Index**. This index is divided into two sections. Section 1 is a listing of EIC numbers in numerical sequence and identifies the equipment nomenclature assigned to each EIC number. Section 2 is the complement of Section 1. It lists nomenclature in alphabetical-numerical sequence and identifies the EIC numbers assigned to equipment. The EIC Master Index is published by the Maintenance Support Office, Mechanicsburg, Pennsylvania, and a copy should be located in the electronics maintenance office.

2. **Directory of Electronic Equipment, NAVSHIPS 0967-LP-420-000**. The purpose of this directory (by equipment type; for example, radar and communications) is to provide descriptive and illustrative data for electronic equipment procured by the Department of the Navy. These directories are dated, but good information may be found in them.

3. **Electrical/Electronic Test Equipment Index for Support Requirements of Shipboard Electronic, Electrical, IC, Weapons and Reactor Systems, NAVSEA STOOO-AA-IDX-010**. This index has been prepared as a guide to assist maintenance personnel in identifying portable electrical/electronic test equipment (PEETE) required for support of prime electronic, electrical, IC, weapons, and reactor instrumentation systems. It may also be used as an aid to establish priorities for the calibration of PEETE. It should be used in conjunction with the Ship's Portable Electrical/Electronic Test Equipment Requirements List (SPETERL). Data in this index is subject to revision periodically as new equipment/systems become available, and new requirements are generated. Hence, incongruities may exist between data in this index and the SPETERL, depending upon issue date of the latter. Under present procedures, these incongruities will be eliminated automatically in subsequent issues of the SPETERL. This index does NOT in any way supersede or modify the SPETERL, nor does it authorize procurement of, or requisition of, items not listed in the SPETERL.

4. **Portable Test Equipment Stowage Guide, NAVSEA 0969-LP-019-5000**. This publication has been prepared as a guide to assist ship installation and design activities in determining adequate storage facilities for electronic test equipment. The nomenclature, name, functional description, dimensions, weight, and volume of each piece of general-purpose test equipment are listed. Also, included is information on the various types of storage systems that are available.

NOTE: AN does not mean Army/Navy. It identifies the JETDS system.

5. **Electronic Test Equipment, MIL-HDBK-172.** This publication consists of two volumes: Volume 1, UNCLASSIFIED; Volume 2, CONFIDENTIAL. It presents data and information on the technical, physical, and operational characteristics as well as logistics information of electronic test equipment used in the Department of Defense. It is intended primarily for use by standardization, design development, and procurement activities of the Department of Defense. It is also used for technical planning and coordinating logistics personnel involved in supply and maintenance of military technical equipment operations.

6. **United States Radar Equipment (U), MIL-HDBK-162.** This handbook is divided into two volumes: one classified and one unclassified. The handbooks contain technical and functional descriptions, logistical information, installation considerations, and reference data on radar equipment used in the Department of Defense. Ground,

airborne, and shipboard radar equipment is included. The book provides, in concise and convenient form, factual data to familiarize maintenance and engineering military personnel, as well as government contractors, with technical and physical characteristics of radar equipment. It is designed to supplement departmental manuals and directives and is intended for use to the greatest extent possible, in the standardization of the design, development, procurement, and application of military radar equipment.

7. **Electronic Test Equipment Application Guide, NAVSEA 0969-LP-019-7000**. The primary purpose of this publication is to supply manufacturers of major electronic equipment with technical information concerning electronic test equipment currently used in the Navy. It is a guide for the selection and application of test equipment, which is to be used in conjunction with prime equipment. It includes descriptions of the primary function of individual equipment, electrical and mechanical characteristics, mounting methods, accessories supplied, and shipping data.

8. **Index, Electronic Equipment and Systems Installation Control Drawings**. The Installation Control Drawing Index consists of three volumes. Volume 1, NAVSEA 0967-LP-034-4010, consists of a listing of control drawings arranged both alphanumerically by nomenclature and numerically by drawing number. Volume 2, NAVSEA 0967-LP-034-4020, provides a cross-reference between old drawing numbers to new drawing numbers. Volume 3, NAVSEA 0967-LP-034-4030, consists of a listing of mono-detail drawings arranged both alphanumerically by nomenclature and numerically by drawing number. Table 2-1 is an alphabetical listing of useful references that are applicable fleetwide. You should also have a thorough knowledge of amplifying instructions published by fleet or force commanders for your particular unit.

REFERENCES

COSAL Use and Maintenance Manual, SPCCINST 4441.170A, Ship's Parts Control Center, Mechanicsburg, Pa., 1989.

Electronics Technician 1 & C, NAVEDTRA 10192-F, Naval Education and Training Program Management Support Activity, Pensacola, Fla., 1987.

Metrology Measure Format 350, Measure ADP Processing Facility, Naval Weapons Station, (Code 373), Concord, Ca., 1987.

Operational Reports, NWP 10-1-10, Office of the Chief of Naval Operations, Washington, D.C., 1988.

Ship Configuration and Logistics Support Information System, NAVSEA Technical Specification 9090-700A, S0752-AA-SPN-010/SCLSIS, Naval Sea Systems Command, Washington, D. C., 1988.

Ships' Maintenance and Material Management (3-M) Manual, OPNAVINST 4790.4B, Office of the Chief of Naval Operations, Washington, D.C., 1987.

Afloat Supply Procedures, NAVSUP Publication 485, Rev 2., Naval Supply Systems Command, Washington D.C., 1989.

Table 2-1.—Listing of Useful References (NOTE: This list is in addition to those already discussed in this chapter. This list is not all inclusive and additional references may be required).

Afloat Shopping Guide, Section 1-7	NAVSUPPUB 4400
Afloat Supply Procedures	NAVSUPPUB 485
AN/SPS-40 Series Radar Liquid Cooling System	NAVSEA 0948-LP-115-5010
AN/SPS-49 Series Liquid Cooling System	NAVSEA 0967-LP-584-8010
Basic Liquid Cooling Systems for Shipboard Electronics, Technicians Handbook	NAVSEA 0948-LP-115-8010

Table 2-1.—Listing of Useful References (NOTE: This list is in addition to those already discussed in this chapter. This list is not all inclusive and additional references may be required)—Continued.

Bibliogrpahy for Advancement Study	NAVEDTRA 12052
CANTRAC Catalog of Navy Training Courses	NAVEDTRA 10500
CARGO Consolidated Afloat Requisitioning Guide Oversees (Fleet Load List)	NAVSUPPUB 4998
Central Dry Air Systems Surface Ships	NAVSEA 595/D-AV-SSM-010
COSAL Use and Maintenance Manual	SPCCINST 4441.170A
COSAL Coordinated Shipboard Allowance List (Ship Tailored, HM&E, ORD, ELEX)	SPCC Mechanicsburg, Pa.
DECKPLATE - The NAVSEA Publication (bi-monthly) highlighting current technical news	NAVSEA 0900-LP-000-2207
Department of the Navy Information Security Program Regulation	OPNAVINST 5510.1(H)
Navy Standard Technical Manual Identification Numbering System (TMINS)	
Disposal of Navy and Marine Corps Records	SECNAVINST P5212.5
DOD Index of Specification of Standards PT. I (Alphabet), Pt. II (Numeric)	None Assigned
Driver (Traffic Safety for the Military Driver)	NAVSAFECEN
EIB Electronics Information Bulletin (bi-weekly)	NAVSEA SO111-XX-EIB-XXX
EIMB Electronics Installation and Maintenance Book (13 Vols.)	NAVSEA 0967-LP-000-OXXX
Portable Electrical/Electronic Test Equipment Index for Support Requirements of Shipboard Electronics, Electrical, IC, Weapons, and Reactor Systems	NAVSEA ST000-AA-IDX-010
Electromagnetic Radiation Hazards: Volume I, Hazards to Personnel, Fuel and Other Flammable Material Volume II, Part 1, Hazards to Ordnance Volume II, Part 2, Hazards to Classified Ordnance Systems	NAVSEA OP 3565
Electronics Test Equipment Application Guide	NAVSEA 0960-LP-019-7000
Electronics Test Equipment Calibration Program Indoctrination Handbook NAVMAT P-9491	0518-LP-394-5000
Enlisted Distribution and Verification Report (EDVR)	NAVMILPERSCOMINST 1080.1
Equipment Identification Code (EIC) Master Index	MSO 4790.E2579

Table 2-1.—Listing of Useful References (NOTE: This list is in addition to those already discussed in this chapter. This list is not all inclusive and additional references may be required)—Continued.

FATHOM (Surface Ship and Submarine Safety Review)	NAVSAFECEN
FSC Groups and Classes Part I Numeric Index to Classes, Part 2	DOD H2-1 DOD H2-2
GPETE	MIL-STD-1364-H
GSA Supply Catalog	Dated mo/yr
Guide for User Maintenance of NAVSEA Technical Manuals	NAVSEA S0005-AA-GYD-030/TMMP
PQS Management Guide	NAVEDTRA 43100-1(C)
Installation Criteria for Shipboard Secure Electrical Information Processing Systems	MIL-STD-1680( )
Introduction to Federal Supply Catalogs and Related Publications	NAVSUP 4000
LIFELINE (The Navy Safety Journal)	NAVSAFECEN
LINK (Enlisted Personnel Distribution Bulletin)	NAVPERS
List of Training Manuals and Correspondence Courses	NAVEDTRA 12061
Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards (NEC)	NAVPERS 18068(E)
Manufacturer Designating Symbols	NAVSEA 0967-LP-190-4010
Master Cross Reference List Part 1 Part 2	MCRL-1 MCRL-2
Metrology Automated System for Uniform Recall and Reporting (MEASURE)	OPNAV 43P6A
MIAPL-Master Index of Allowance Parts List	SPCC
Metrology Requirements List (METRL)	NAVELEX 0969-LP-2010 NA 17-35MTL-1
METRL (FCA) Field Calibration Activity Program	NAVELEX 0960-133-2020 NA 17-35MTL-2
Minature/Microminiature (2M) Electronic Repair Program; responsibilities and procedures for	NAVSEAINST 4790.17
Repair Handbood	NAVSEA TE000-AA-HBK-010/2M
Workmanship Standards	NAVSEA TE000-AA-HBK-020/2M
Naval Warfare Mission Areas and Required Operational Capability/Projected Operational Evnironment (ROC/POE) Statements	OPNAVINST 3501.2H

Table 2-1.—Listing of Useful References (NOTE: This list is in addition to those already discussed in this chapter. This list is not all inclusive and additional references may be required)—Continued.

NAVSHIPS' Technical Manual	Selected Chapters
Management Data List	Basic Navy NSUP Misc
Navy Stock List of Publications and Forms	NPFC 2002
Navy Field Calibration Activities	NAVELEX 0967-LP-457-1010
Operational Reports	NWP 10-1-10
Portable Test Equipment Stowage Guide	STOOO-AB-GYD-010
Required Reports	5214 Notices
Security Classification and Cognizant Activity of Electronic Equipment	MIL-HDBK-140(D)
SEMO Correspondence Course	NAVEDTRA 10478-B
Ships' Maintenance and Material Management (3M) Manual	OPNAVINST 4790.4B
Shipboard Bonding, Grounding, and Other Techniques for Electromagnetic Compatibility and Safety	MIL-STD-1310(E)
Ship Configuration and Logistics Support Information System	S0752-AA-SPN-010-SCLSIS
SPETERL Ship Portable Electrical/Electronic Test Equipment Requirements List (Ship Tailored Allowance List)	NAVSEC Code 06C13
Standard General-Purpose Electronic Test Equipment (GPETE)	MIL-STD-1364(H)
Standard Organization and Regulations of the U.S. Navy	OPNAVINST 3120.32(B)
Standard Subject Identification Codes	SECNAVINST 5210.11(D)
Uniform Material Movement and Issue Priority System	OPNAVINST 4614.1(F)
United States Navy Uniform Regulations	NAVPERS 15665G

CHAPTER 3

ADVANCEMENT AND TRAINING

OBJECTIVES	OUTLINE
Describe the requirements for advancement, the organization of training aboard ship, including schedules and records	Advancement Shipboard training organization Schedules and records
Describe the availability for technical training and quota procurement.	Types of Navy training Catalog of Navy Training Courses
Explain the PQS program	Personnel Qualification Standards
Explain the different self-study training programs.	Self-study programs

ADVANCEMENT

Each individual should understand that before advancement can be considered, he must study certain manuals and complete specific courses as listed in the Advancement Handbook. Additionally, the individual must complete both the military and personnel advancement requirements (PARS) for advancement. Finally, the command recommendation must be given, and a Navywide competitive examination must be passed (except for E8 and E9). If required the completion of a formal school may be part of the advancement path. Completion of previously mentioned requirements does not necessarily mean immediate advancement. A vacancy in the next higher paygrade must exist so that quotas may be established by the Bureau of Navy Personnel. Reference material required and recommended for study for each of the rates may be found in the *Advancement Handbook for Petty Officers*, NAVEDTRA 71250.

ADVANCEMENT HANDBOOK FOR PETTY OFFICERS

The *Advancement Handbook for Petty Officers* (fig. 3-1) is tailored for each rating and contains the personnel advancement requirement (PAR) record. This publication is updated annually.

The Advancement Handbook contains three parts:

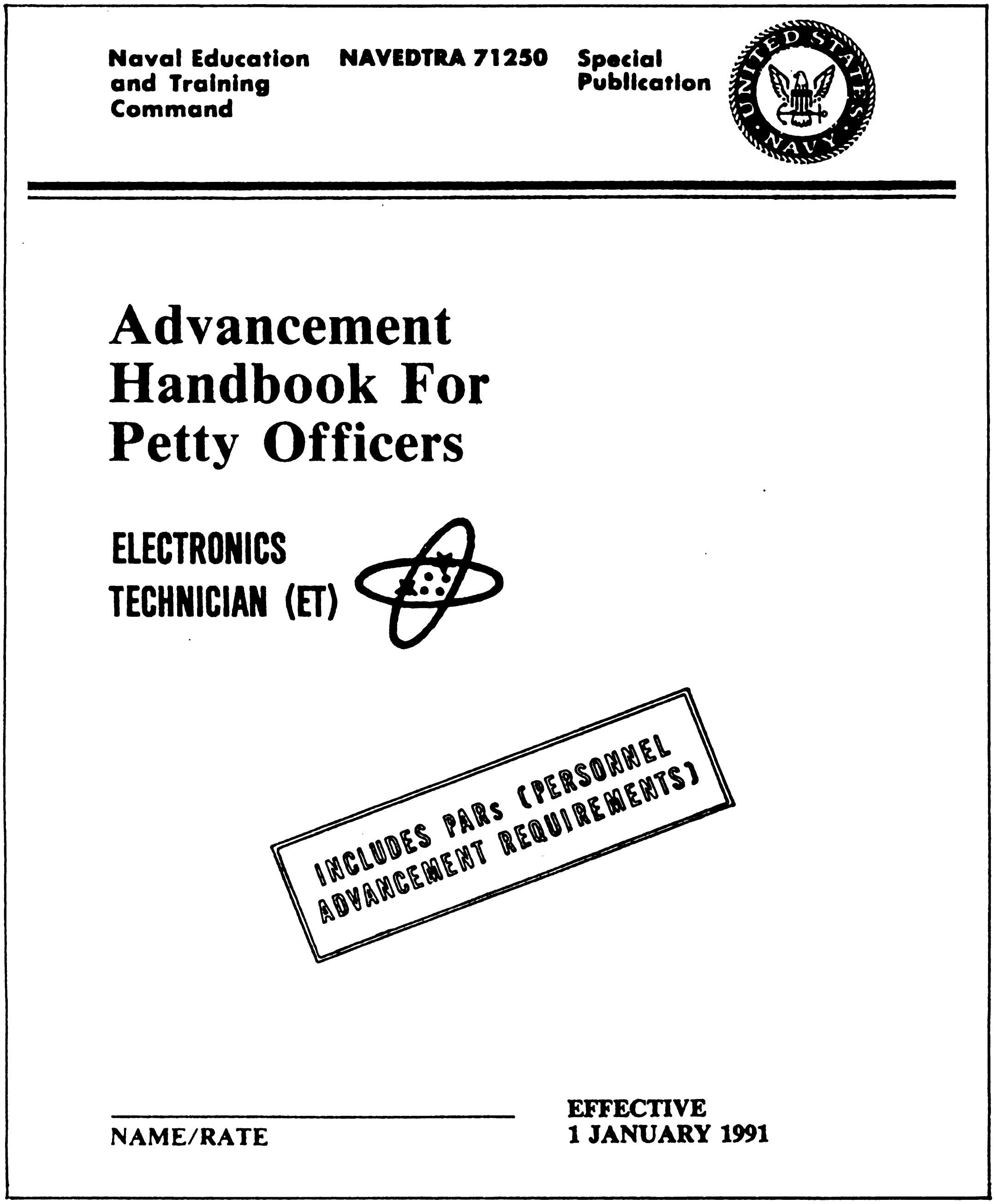
Part A. Navy Advancement System. This section contains an explanation of the Navy advancement system. It provides valuable information about advancement paths, eligibility requirements for advancement, advancement exams, exam scoring, and professional development.

Part B. Naval Standards/Bibliography. This section contains the naval standards (NAVSTDS) and their supporting bibliography for those STDS. This section provides helpful information for an individual preparing for the required military/leadership exam. This examination is based on the NAVSTDS. Enlisted members must pass the military/leadership exam as part of their eligibility requirements for advancement.

Part C. Occupational Standards. This section presents the occupational standards (OCCSTDs) and supporting bibliography for each rate within the rating. OCCSTDs state the Navy's minimum requirement for enlisted occupational skills. The OCCSTDs and bibliography are basic to the enlisted members study for the Navywide Advancement Examination. An individual is responsible for the requirements of the candidate's paygrade as well as all requirements for subordinate paygrades.

ENLISTED ADVANCEMENT EXAMINATIONS

Navywide advancement examinations are conducted on a semiannual basis for paygrades E-4 through E-6, and on an annual basis for paygrade E-7.



Naval Education and Training Command

NAVEDTRA 71250

Special Publication

Advancement Handbook For Petty Officers

ELECTRONICS TECHNICIAN (ET)

INCLUDES PARs (PERSONNEL ADVANCEMENT REQUIREMENTS)

NAME/RATE

EFFECTIVE
1 JANUARY 1991

Figure 3-1.–Advancement Handbook for Petty Officers (sample cover).

These examinations are developed by the Navy Education and Training Program Management Support Activity, Pensacola, Florida.

Military Leadership Examinations for each paygrade E-4 through E-7 are standardized Navywide and are administered locally. Once an individual has passed this examination, it will not be necessary for him to retake it.

The *Manual of Enlisted Manpower and Personnel Classifications and Occupational Standards,* NAVPERS 18068, is the basis for determining qualifications for advancement.

TRAINING

To have a well-trained crew, you must have a formal training program. The extent of the training mission of the Navy depends upon future qualitative and quantitative requirements. Planning for training involves comparing current onboard skills with current and future requirements. Additionally, it also involves providing the education and training needed to compensate for prospective losses in each of the many specialties.

The immediate objective of training is to enhance knowledge and practical abilities so personnel can better perform their duties. Continuing personnel shortages, rapid turnover of personnel, and the heavy demands placed on the time of shipboard personnel are recognized obstacles that must be overcome in establishing and managing a successful shipboard training program. Shipboard training and material maintenance are two of the major factors that contribute to battle readiness. Although both are equally important, training is a prerequisite to proper maintenance. Without a vigorous and continuing shipboard training program, sustained combat readiness is impossible.

To carry out the Navy's mission, modern naval warships and aircraft are equipped with elaborate devices for detecting, monitoring, engaging, and destroying the enemy. To reach their designed effectiveness, these systems must be manned and maintained by highly trained personnel. *The ultimate purpose of naval training is to educate and train naval personnel to ensure efficient employment of modern naval material and procedures.*

The basis of all training is the development of the individual. The individual is trained to fill a billet, prepared for advancement and for broader responsibilities. Group training, or training of a ship's complement, can only be accomplished with a successful individual training program as a base.

Safety MUST occupy the bottom rung of a training ladder. It is a prerequisite for both safety of life and equipment. Before troubleshooting inoperative or damaged electronic equipment, technicians are trained to use tools safely and properly. They must know about the dangerous voltages involved and follow strict procedures when troubleshooting and repairing electronic equipment. Without an extensive awareness of safety, there would be many noncombatant casualties during battle.

SHIPBOARD TRAINING ORGANIZATION

Basic policies for the administration and conduct of shipboard training are set forth in U.S. Navy Regulations, and in the *Standard Organization and Regulations of the U.S. Navy (SORM)*, OPNAVINST 3120.32, chapter 8. However, training methods will vary from ship to ship, depending on the ship's size, design, personnel allowance, and operational requirements. Each ship's training time must be carefully balanced with that of maintenance. Once a balance is established, programs for training and maintenance should be carefully planned, executed, and controlled.

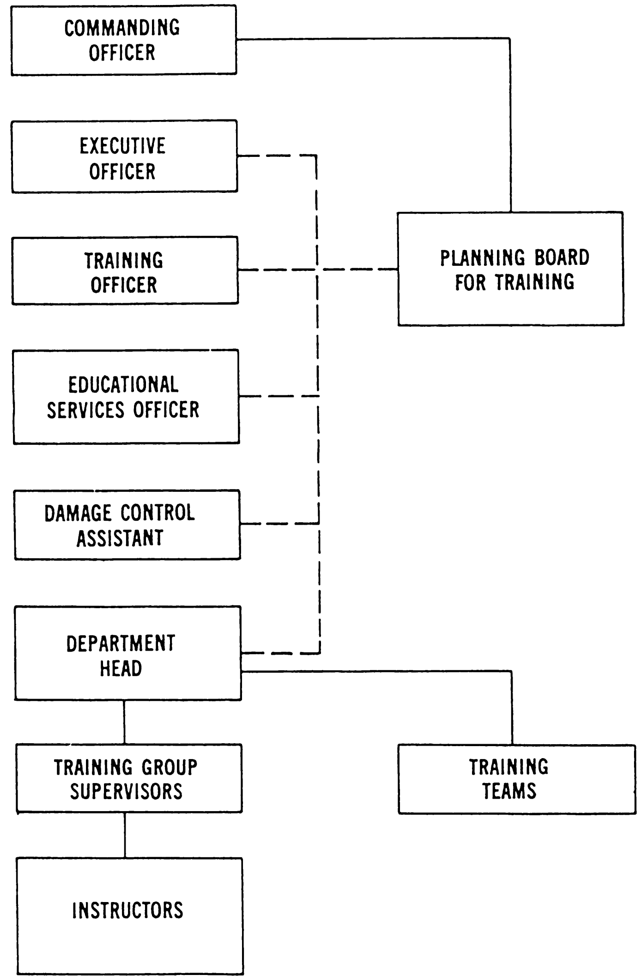


Figure 3-2.–Shipboard training organization.

Figure 3-2 shows a typical shipboard training organization. On small ships the executive officer may assume the functions of the training officer. The division officer or the senior petty officer may perform the duties of the training group supervisor. The EMO, as division officer, will conduct training that will include subject matter pertinent to enlisted personnel of the electronics division, and briefings for senior personnel. Training should be conducted using the training group concept. A training group is defined as any group of individuals requiring similar training; for example, a division of ETs, the SERT Team, OODs, etc.

PLANNING BOARD FOR TRAINING

The Planning Board for Training is responsible to the commanding officer for developing a unit's training

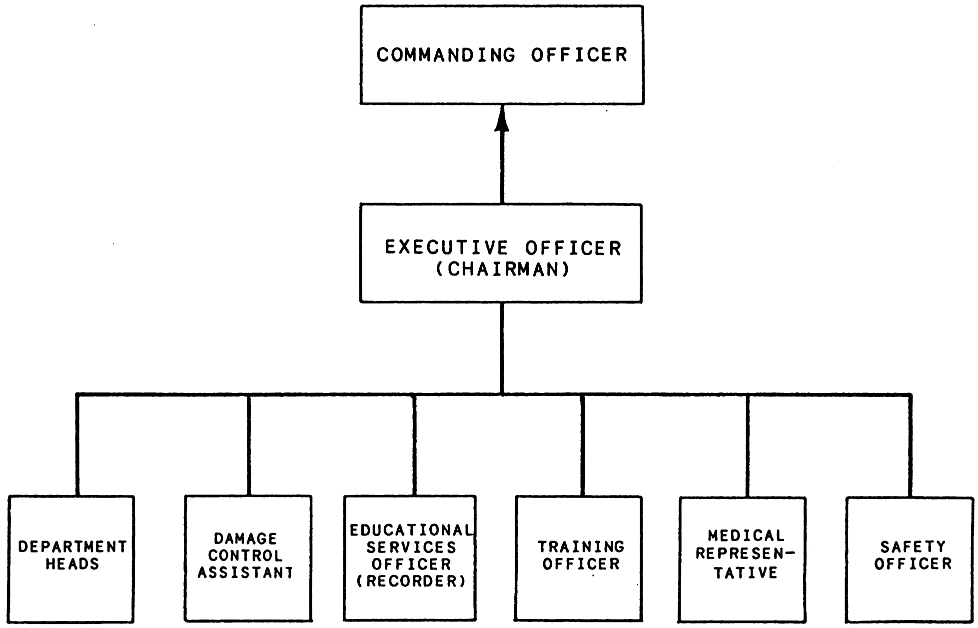


Figure 3-3.–Planning board for training.

program with the goal of producing well-trained and qualified personnel. The planning board is comprised of the personnel shown in figure 3-3. The planning board's duties are outlined in the SORM. The board will convene at least monthly and as directed by the chairperson. The personal knowledge of the members, the reports of the educational officer, and the various control devices used, will all indicate points at which action should be taken to improve coordination.

Quality training will improve morale and motivation of the technicians as well as their skills and knowledge. You should constantly reevaluate the training program to ensure that it is maintained at the highest possible level. Even when the original program is designed with utmost care, a number of variables can cause a need for change.

The following factors should be examined periodically for their possible effect on the training program:

1. A change in the nature or schedule of operations
2. The installation of new or improved equipment
3. A change in the technical knowledge or skills required for the performance of duty
4. A change in personnel
5. A change in regulations or procedures under which the ship is operating
6. The completion of any phase of the training program
7. An unforeseen obstacle to coordination or completion of the training program
8. Changes in availability of fleet and shore-based training facilities

You can see from this list of factors that the planning board's responsibility does not end with issuing the training schedule. Every exercise or training program must be formally reviewed by the planning board. Division officers and petty officers should review daily the effectiveness of the training program to ensure that current information is available to the board members.

TRAINING SCHEDULES AND RECORDS

Scheduling of shipboard training requires the careful attention of the training officer, department heads, and division officers. Schedules serve to minimize conflict in ship's activities and to ensure the time allotted to training is used to its best advantage. The best justification for a record of training is to provide continuity in the training program by indicating what training has been accomplished and what remains to be done. Records should be kept to an absolute minimum consistent with those needs. When possible, the same forms used to schedule training should be used to record completed training. The training plans and records are as follows:

- Long-Range Training Plan
- Short-Range Training Plan

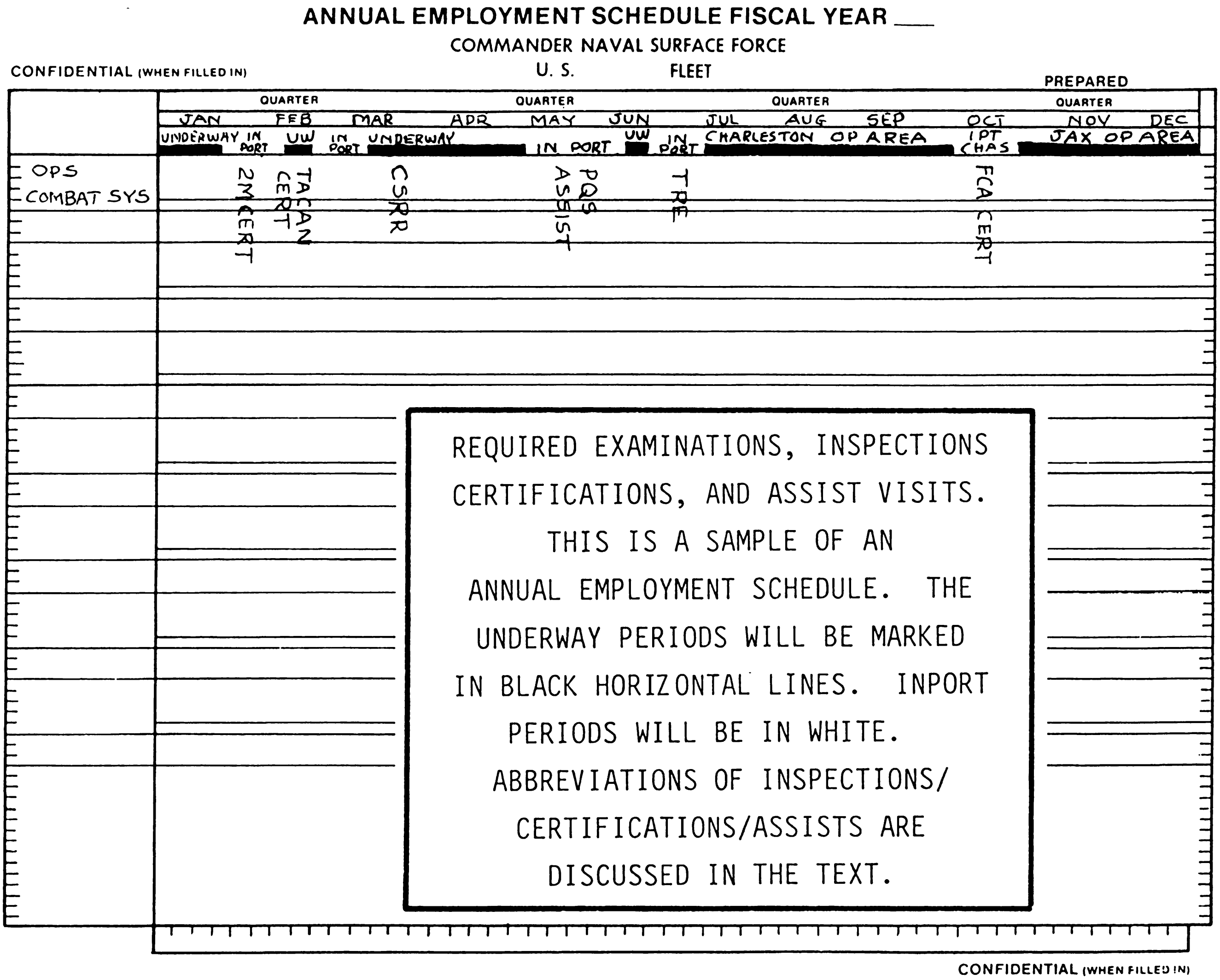


Figure 3-4.–Sample Annual Employment Schedule.

- Training Accomplishment Records

When the planning board establishes the ship's training schedules, requirements set forth by the type commander are the primary consideration. Ship exercises often require the services of other ships and aircraft or of qualified observers from another command. Naturally, whenever external assistance is required, more emphasis must be placed on planning, coordinating, and scheduling.

THE LONG-RANGE TRAINING PLAN

The training officer will normally prepare the long-range training schedules based on requirements delineated by the planning board. The EMO is responsible for providing inputs to the department head for approval by the planning board.

The long-range training plan is the most important training outline aboard ship. When properly used, it is the basic instrument for making and recording the plans for all training and for keeping ship's personnel informed of projected training goals and operating schedules. In general, this schedule should contain enough information to guarantee that the overall coordination and planning of the shipboard training effort will be effective. It provides the framework for the preparation of the short-range training plan. For clarity and ease of comprehension, the long-range plan should be kept free of minor details that might obscure its broad range objectives. The Long-Range Training Plan consists of the following:

- Annual Employment Schedule (fig. 3-4). This is provided by the TYCOM.

COMBAT SYSTEMS DEPARTMENT

REQUUIRED EXAMINATIONS, INSPECTIONS, CERTIFICATIONS, ASSIST VISITS

DESCRIPTION	DATE DUE	DATE SCHEDULED
TACAN CERT	JULY 91	10-14 JUN 91
2M CERT	AUG 91	30 JULY 91
FIELD CALIBRATION ACTIVITY (FCA) CERT	SEPT 91	26 AUG 91
PQS ASSIST	OCT 91	23 SEP 91
COMBAT SYSTEMS ASSESSMENT (CSA)	NOV 91	1 NOV 91
TRAINING READINESS EVAL. (TRE)	DEC 91	3 DEC 91
COMBAT SYSTEMS READINESS REVIEW (CSRR)	JAN 92	11 DEC 91
DEPARTURE MATERIAL STATUS REVIEW (DMSR)	FEB 92	6 JAN 92

Figure 3-5.–Sample Exam/Cert/Inspection/Assist List.

- The Required Examinations, Inspections, Certifications and Assist Visits Lists (fig. 3-5) is completed by each department based on their requirements.
- The TYCOM required exercises is documented on a TYCOM Required Exercise List (fig. 3-6). This is again on the department level and is based on requirements set forth in FXP-4.

COMBAT SYSTEMS DEPARTMENT
TYCOM REQUIRED EXERCISES

EXERCISE NUMBER AND TITLE	PERIODICITY	DATE(S) CONDUCTED
NCO-1-SF PREPARATIONS FOR ELECTRONIC SYSTEMS SPACES UNDERWAY/BATTLE (ESS)		
NCO-2-SF ASSISTANCE TO REMOTE SPACES		
NCO-3-SF INVESTIGATION & REPORTING		
NCO-4-SF REPORT OF ELECTRONIC CASUALTIES		
NCO-5-SF EQUIPMENT CASUALTY REPAIR DURING LOSS OF LIGHTING		
NCO-6-SF USE OF INSTALLED SPARE FUSES		
NCO-7-SF USE OF EMERGENCY POWER IN ELECTRONIC SYSTEMS SPACES		
NCO-8-SF SOUND POWERED PHONE CASUALTY ELECTRONIC SYSTEMS SPACES		
NCO-9-SF SECONDARY ELECTRONIC CASUALTY CONTROL (ECC/ESS)		
NCO-10-SF ELECTRONIC COOLING/CHILL WATER CASUALTY		
NCO-11-SF COMBATTING CLASS "C" FIRES IN ESS		
NCO-12-SF EQUIPMENT CASUALTY REPAIR		
NCO-13-SF USE OF ECC FOLDER		
NCO-14-SF DRAWING EMERGENCY ELECTRONICS SPARE PARTS		
NCO-15-SF USE OF ALTERNATE POWER IN ESS		
NCO-16-SF PERFORMANCE OF ECC		
NCO-17-SF CLEANING PROCEDURES FOR HAZMAT IN ESS		

Figure 3-6.–Sample TYCOM Required Exercises List.

COMBAT SYSTEMS DEPARTMENT

OFF SHIPS SCHOOLS AND NEC REQUIREMENTS

SCHOOL/NEC REQUIRED	NO. REQ.	WHO ATTENDED	EAOS/PRD
AN/SPS 49 ET-1510		ETC HARRISON	
FCA ET 1588	1	ETCM HECK	960811 950919
SAS ET 1486	1	ET2 REICH	970212 960107
KW7 ET 1438	1	ET1 BARKWELL	980107 970305
NAVMACS ET 1473	1		981207 971019

Figure 3-7.–Sample Required Schools/NEC List.

- An Off Ship School and NEC Requirements Form (fig. 3-7). Both the qualification and the person's name who holds those qualifications are listed. This is also maintained at the department level. This form is developed using the Master Training Plan (MTP) and the Enlisted Distribution Verification Report (EDVR).

- The Training Group Lecture Topic List (fig. 3-8) list lectures and seminars applicable to a training group. This will include, as a minimum, the fundamentals and systems topics from applicable PQS.

Initially, this schedule is prepared at the beginning of a ship's overhaul period, and covers the entire training

TRAINING GROUP LECTURE TOPICS
FOR COMBAT SYSTEMS/OPERATIONS ELECTRONICS

ET-1 CSOSS
ET-2 SERT (SHIPBOARD ELECTRONIC READINESS TEAM)
ET-3 CASREP PROCEDURES
ET-4 REPAIR 8 (ECC)
ET-5 SUPPLY PROCEDURES
ET-6 CLASSIFIED MATERIAL

ET-22 TAG OUT LOG
ET-23 CPR

ET-44 ELECTRICAL SAFETY
ET-45 TEST EQUIPMENT
ET-46 WORKING ALOFT
ET-47 ELECTRONIC COOLING/DRY AIR
ET-48 TEMPEST
ET-49 EMI (ELECT
ET-50 FIELD CHANGE/INSTALLATION

ET-75 2M INSPECTION PROCEDURES
ET-76 OCCUPATIONAL STANDARDS

Figure 3-8.–Sample Training Group Lecture Topic List.

cycle (period between regularly scheduled overhauls). Upon receipt of the quarterly operating schedules from the fleet or type commander, the training schedule is revised to reflect all significant changes in the previously planned employment of the ship. The Long-Range Training Plan, when updated, provides the unit with a dynamic management tool.

THE SHORT-RANGE TRAINING PLAN

The Short-Range Training Plan is the mechanism for planning and scheduling training. Effective scheduling requires careful attention by the chain of command to minimize conflicts and to maximize opportunities. The Short-Range Training Plan shall include the following:

- Quarterly Training Plan
- Monthly Training Plan
- Weekly Training Schedule

Quarterly Training Plan

During the planning board for training conducted the month preceding the upcoming quarter, the training

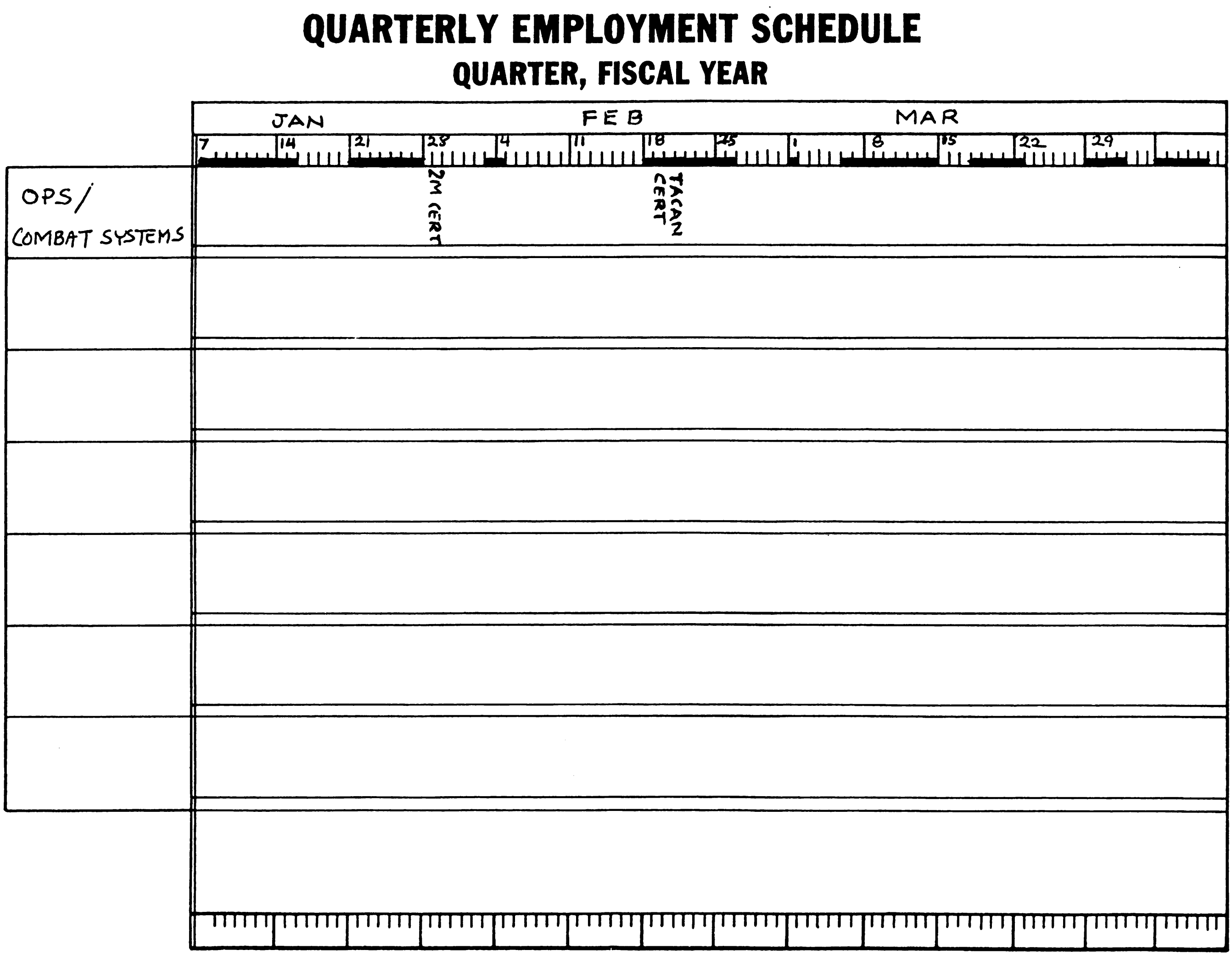


Figure 3-9.–Quarterly Employment Schedule.

officer will distribute copies of the Quarterly Employment Schedule (fig. 3-9) to the board members. Using this schedule as a guide, the Planning Board for Training will develop broad unit training plans for the upcoming quarter. The purpose of this Quarterly Training Plan (fig. 3-10) is to indicate to the training groups the ship's plans. This should make everyone aware of group training conflicts. Once the Planning Board for Training has developed the unit Quarterly Training Plan, department heads shall add any additional broad department plans. At this point, a copy is provided to each training group within the department. Training, planning, and scheduling for periods shorter than a quarter will be scheduled by the department.

Monthly Training Plan

Using the Quarterly Training Plan as a guide, each training group shall submit a proposed Monthly Training Plan (fig. 3-11) to the cognizant department head not later than the last week preceding the upcoming month. This plan shall indicate what training is to be conducted on specific days and who the instructor will be. The department head will review and approve each monthly training plan. He will also maintain files of all the departments' Monthly Training Plans and use the compiled package as a primary tool for scheduling training at the Planning Board for Training.

QUARTERLY TRAINING PLAN (OPERATIONS CONFIGURED)

2ND QUARTER, FISCAL YEAR 1986

	JANUARY 6	13	20	27	FEBRUARY 3	10	17	24	MARCH 3	10	17	24	31
FIRST AID LECTURES	1ST-DIV 2ND-DIV	B-DIV R-DIV	A-DIV E-DIV	M-DIV S1-DIV	S2-DIV S3-DIV	OE-DIV	OI-DIV OC-DIV	G-DIV 4TH-DIV	1ST-DIV 2ND-DIV	B-DIV R-DIV	A-DIV E-DIV	M-DIV S1-DIV	S2-DIV S3-DIV
ALL HANDS LECTURES (CCTV)		CAPTAINS CALL		COMBINED FEDERAL CAMPAIGN			SAFETY STANDDOWN/ "TRIAL BY FIRE"			ELECTRICAL SAFETY			
GENERAL MILITARY TRAINING (CCTV)	BLOOD DONORSHIP PROGRAM	CAREER COUNSELING				CHARACTER EDUCATION			CODE OF CONDUCT	DEPENDENTS ASSISTANCE			
SHIPWIDE EVOLUTIONS	UNDERWAY FLEETEX		OC OLYMPICS (COS-2)	PERSONNEL INSPECTION	SHI		SAFETY STAND-DOWN				MTT VISIT (UWAY)		
ENGINEERING DEPARTMENT PLANS				A/E/R DIVISION PREPS FOR SHI					MM/BT/EM ORAL BOARDS (PRIOR TO MTT WEEK OF 3/17)		CASUALTY CONTROL DRILLS POS EVOLUTIONS		
OPERATIONS DEPARTMENT						2M CERT							

Figure 3-10.–Quarterly Training Plan.

MONTHLY TRAINING PLAN

MONTH OF MARCH 1992 TRAINING GROUP OE01

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THRUSDAY	FRIDAY	SATURDAY
						1
2	3	4 ET-2 SERT	5	6 ET-3 CASREP PROC	7	8
9	10	11 ET-4 REPAIR 8 PROC	12	13 E-5 SUPPLY PROCEDURES	14	15
16	17	18 ET-6 CLASSIFIED MATERIAL	19	20 ET-22 TAG OUT LOG	21	22
23 30	24 31	25 ET-23 CPR	26	27 ET-44 ELECTRICAL SAFETY	28	29

SUBMITTED BY: W. W. Wilcox, LT, USN
DIVISION OFFICER

APPROVED BY: J. P. Jones, LCDR, USN

Figure 3-11.–Sample Monthly Training Plan.

WEEKLY TRAINING SCHEDULE

WEEK OF: MARCH DEPARTMENT OPS/COMBAT SYSTEMS

SUNDAY 3/9	MONDAY 3/10	TUESDAY 3/11	WEDNESDAY 3/12	THRUSDAY 3/13	FRIDAY 3/14	SATURDAY 3/15
		0730 PERSONAL PORTABLE ELECTRONIC EQUIPMENT	0730 TAG OUT LOG PROCEDURES	0815 FIRST AID LECTURE 4 DIV MESS DECKS HMI DILL		
	1230 DIV TRNG AN SPS-49 COOLING ALARMS				1230 DIV TRNG	

PROMULGATED BY: ____________

Figure 3-12.–Sample Weekly Training Schedule.

Weekly Training Plan

Each week after the Planning Board for Training, the department head shall provide each training group within the department a copy of a single department Weekly Training Schedule (fig. 3-12). The single schedule shall include all training applicable to the department. No changes to this weekly schedule should be made without approval of the cognizant department head. This schedule shall indicate the time and location training will be conducted.

TRAINING RECORDS

Training records must be kept to an absolute minimum and need only be maintained to show what training has been completed and what remains to be accomplished. The true measurement of training effectiveness is performance, and the basic objective of maintaining records is to assist in accomplishing this in the simplest way possible. All training may be recorded on a General Record (Type II) form (fig. 3-13). This record form will also serve as an attendance sheet. Each training group supervisor shall maintain records for personnel assigned to his group. Training records shall be retained for an individual for as long as he is assigned to the unit. PQS documentation will be maintained in accordance with the *PQS Manager's Guide,* NAVEDTRA 43100-1.

All training plans, schedule, and records may be either typed, handwritten, or maintained on ADP/WP systems (e.g., shipboard nontactical automatic data processing program [SNAP]). The retention period for training plans and records may be specified by individual commands or type commanders as appropriate. At a minimum, training plans should be retained long enough to assist with planning for the training cycle.

TYPES OF NAVY TRAINING

In the following paragraphs, we will address the types of Navy training offered in the various schools

GENERAL RECORD (Type II)
OPNAV FORM 1500-31 (10-60)
S/N 0107-LF-701-0000

PERIOD COVERED: FROM 3/10 TO

TITLE
CS-2 OR OE DIVISION RECORD

COLUMN CAPTIONS

	ET-2 CERT	ET-3 CASREP PROC	ET-4 REPAIR & PROC	ET-5 SUPPLY PROC	ET-6 CLASSIFIED MATERIAL	ET-22 TAG OUT LOG			
ETCS A. A. ALFA	X	X	INST	X		X			
ET B. B. BRAVO	X	X	X	X		X			
ET2 C. C. CHARLIE	X	X	X	X	X	X			
ET2 D. D. DELTA	X	X	X	X	X	X			
ET2 E. E. ECHO	X	X	X	X	X	X			
ET2 G. G. GOLF	X	X	X	X	X	X			
ET2 H. H. HOTEL	X	X	X	X	X	X			
ET3 I. I. INDIA	LV	LV	LV	LV	X	X			
ET3 J. J. JULLIET	X	X	X	X	NA	X			
ET3 K. K. KILO	X	X	X	X	NA	X			
ET3 L. L. LIMA	X	X	X	X	NA	X			

Figure 3-13.–Sample training record.

throughout the Navy, and the means of obtaining information about the school or quotas for the instruction.

NAVY TECHNICAL/FLEET TRAINING

In carrying out training responsibilities, the EMO must stay informed of the quotas and entrance requirements for naval schools that offer training in electronics. Some of the training avenues are described in the following paragraphs.

Service Schools

Navy schools fall into three basic types:

1. Enlisted service schools, Class A and C, and other specific-purpose schools
2. Fleet schools located at fleet shore-based training activities
3. Commanders and Mobile Technical Units (MOTUs) courses
4. Cryptographic maintenance schools

CLASS A SCHOOLS.–Class A schools provide basic technical knowledge and skills required to prepare personnel for the lower petty officer rates.

CLASS C SCHOOLS.–Class C schools train enlisted personnel in a skill that is usually related to a specific equipment or a special knowledge requirement.

TYPE COMMANDER'S SHORT COURSES.–Type commanders conduct short courses of instruction on various electronic equipments. Training is given on a specific piece of equipment by a specialist in that field. The actual electronic equipment is usually used as a training device, thereby providing *hands-on* training. The courses are normally short in length and the knowledge gained far outweighs the loss of the individual's time from his duties on the ship. The courses offered, their subject matter, and the frequency with which they are scheduled, are governed by the requirements of the fleet. The information concerning these courses is promulgated locally, and ships of a specific type command (TYCOM) usually make themself aware of such schedules. If a course does not exist for a particular equipment, the need should be made known and a special course should be requested through the TYCOM. Very often, when in port, you can develop personal contact via phone with the TYCOM training personnel and the training staff at the school. This extra effort as you will discover, will be well worthwhile. Staff training personnel can make you aware of unexpected training openings. This can prove especially beneficial at local installations where travel funds are not required. Normally, the local readiness support group (RSG) is responsible for scheduling this type of training using such assets as systems commands and contractors to provide the training.

FTU AND MOTU SCHOOLS.–Fleet Training Units (FTUs) and Mobile Technical Units (MOTUs) offer courses at various Navy training activities that are of an equipment operation or team training nature. These courses may also be used to provide strikers and petty officers with basic information in equipment operation. The EMO should review the courses offered and advise the department head when ships operations are most compatible for personnel attendance.

Instruction conducted by MOTUs can be either in a formal classroom or on the job. There is no formal catalog for these schools, but the type of instruction available can be determined from regular MOTU bulletins or by liaison with the local MOTU. As EMO, you should make direct contact with MOTU personnel to identify training availability so your personnel can take advantage of MOTU-conducted training sessions. The MOTUs are tasked with providing OJT on any equipment for which they have the capability. Do not wait until equipment breaks because of inadequate maintenance to request MOTU OJT. Take advantage of this specialized training offered by the MOTUs; their primary mission is to service the fleet.

Also, the combat systems mobile training team (CSMTT) offers a variety of team training, which can be arranged by liaison with the TYCOM.

CRYPTOGRAPHIC MAINTENANCE SCHOOLS.–The complexity and nature of modern cryptographic equipment places the maintenance technician in a critical position of responsibility for the secure operation and maintenance of cryptographic equipment used for naval communications.

Previously trained and qualified technicians must be retrained and/or requalified by an approved examination if either of the following applies:

1. They no longer meet the requirements for installing and maintaining a particular equipment because they have not had training in, nor experience with, the equipment in the preceding 36 months.
2. NSA/CSS has determined that retraining is required because major changes have been made to the equipment. Technicians trained to perform only limited maintenance are excluded from this requirement. Technicians previously trained to

COMSEC MAINTENANCE TRAINING AND EXPERIENCE RECORD (See reverse side for instructions)						
1. NAME (Last - First - Middle Initial)					2. SERVICE NUMBER/SSN	
					CERTIFICATION	
Equipment Short Title a	Qualified (Yes/No) b	Method c	Date (YYMMDD) d	REMARKS (Include School or Organization) e	signature of certifying officer	organization of certifying officer
TSEC/KWR-37	yes	a	91-10-02	COMBAT SYSTEMS TECHNICAL SCHOOLS COMMAND, MARE ISLAND, VALLEJO, CAL. 94592 GRADE RECEIVED: 89.3	[illegible] USN DIRECTOR	CSTSC MARE ISLAND

DD FORM 82 APR 1435 PREVIOUS EDITION IS OBSOLETE

Figure 3-14.–COMSEC Maintenance Training and Experience Record Form, DD-1435.

perform full maintenance, but who are no longer qualified, will retain the certification to perform limited maintenance. It is necessary at this point to define limited and unlimited maintenance: Limited Maintenance is field level maintenance. Repair is accomplished by swap out of entire units/modules utilizing cryptographic maintenance aids. Preventive maintenance is also defined as limited maintenance. Unlimited Maintenance is depot level maintenance. Repair is accomplished at the component level.

Most shipboard technicians are trained to perform only limited maintenance. Unlimited maintenance technicians are normally assigned to cryptographic repair facilities (CRF) and intermediate maintenance activities (IMA).

Only personnel who are graduates of an approved course of instruction for either unlimited or limited maintenance of specific cryptographic equipment or associated cryptoancillary equipments shall be permitted to install, maintain, or repair such equipment. If no maintenance action or external wiring changes is involved, cryptographic equipment may be installed/deinstalled by other than a certified limited or full maintenance technician. This exception does not apply to initial cryptographic equipment installations, which must be accomplished by a certified maintenance technician.

The Communications Security (COMSEC) Maintenance Training and Experience Record, DD Form 1435 (fig. 3-14), ensures that cryptographic equipment will be installed, maintained, and repaired by fully competent personnel. Instructions for completing the form are in OPNAVINST 2221.3.

The DD Form 1435 shall be completed for each technician who completes a COMSEC maintenance course. This form may also serve as the graduation certificate. Following graduation, this form shall constitute a chronological record of all COMSEC training and maintenance experience received by the

Table 3-1.–Command Identifiers Used with CANTRAC

Command Identifiers	Producing/Curriculum Control Command
A	Chief of Naval Technical Training
B	Commander, Naval Medical Command
C	Chief of Naval Technical Training (Aviation Skill Courses)
D	Commander, Naval Air Force, U.S. Atlantic Fleet
E	Commander, Naval Air Force, U.S. Pacific Fleet
F	Commander, Submarine Force, U.S. Atlantic Fleet
G	Commander, Naval Surface Force, U.S. Atlantic Fleet
H	Commander, Naval Surface Force, U.S. Pacific Fleet
J	Commander, Training Command, U.S. Atlantic Fleet
K	Commander, Training Command, U.S. Pacific Fleet
L	Commander, Submarine Force, U.S. Pacific Fleet
M	Commandant, Marine Corps
N	Naval Aviation Logistics Center
P	Chief of Naval Education and Training
Q	Chief of Naval Air Training
R	Commander Naval Reserve Forces
S	Other Commands not assigned above
X	Recruit training
Y	Chief of Naval Technical Training (Aviation Support Equipment Training)
Z	Chief of Naval Technical Training (Segmented courses for Reserve Training)

technician, and shall become a part of the technician's permanent personnel record. Each form shall be reviewed and updated every 12 months and before a permanent change of station (PCS). (Technicians trained to perform only limited maintenance are excluded from this review requirement.) The original form shall be retained in the individual's service record and the EMO may maintain a copy in his files.

Supervisory personnel shall review each technician's DD Form 1435 to ensure that the training and experience requirements on a particular equipment are met before that technician is assigned responsibility for its installation and maintenance.

CATALOG OF NAVY TRAINING COURSES (CANTRAC)

The *CANTRAC*, NAVEDTRA 10500, contains information on schools and courses under the purview of the Chief of Naval Education and Training (CNET). CNET responsibilities include providing for centralized production of *CANTRAC*. The *CANTRAC* is made up of identifying numbers, skill codes, and narrative.

COURSE IDENTIFYING NUMBER

The Course Identifying Number (CIN) used in *CANTRAC* consists of seven or eight characters. The first character is a letter of the alphabet, which identifies the course sponsor. For example, the command that has curriculum control, provides resource support for the course, or authorizes its establishment and conduct. Command identifiers are shown in table 3-1. If for example an A were to appear as a command identifier, it would indicate the course sponsor as the Chief of Naval Technical Training.

SKILL CODES

The skill code is taken from the Department of Defense skill identifying code. This code consists of a numeric/alpha two-position code for officer skills and three-digit code for enlisted skills. The skill codes are taken from the *DOD Occupational Conversion Manual (DOD 1312.1M), Enlisted/Officer/Civilian.* The DOD skill codes are arranged sequentially.

The sequence number is assigned by mutual agreement between the course sponsor and the catalog producer. The code occupies four positions and is numeric. Its primary purpose is to sequence courses within the same skill code for cataloging purposes.

The following illustrates an example of a Course Identifying Number (CIN):

Example: The CIN for the Combat Systems Electronics Administration Course, Atlantic Fleet, is A-4B-0019.

Table 3-2.–Keyword Index of CANTRAC Course Titles

PG 04	KEYWORD INDEX OF CANTRAC COURSE TITLES
CRS NUMBER	COURSE TITLE
A-104-0129	AN/SPA-25A/B/C/D/E/F SERIES RADAR REPEATER AND SB-1505 RADAR SWITCHBOARD MAINTENANCE
A-104-0205	AN/SPA-25G RADAR INDICATOR AND CV-3989/SP SIGNAL CONVERTER MAINTENANCE
A-104-0156	AN/SPA-50B/C RADAR INDICATOR MAINTENANCE
A-104-0178	AN/SPA-66 RADAR REPEATER MAINTENANCE
A-104-0136	AN/SPG-51C DIGITAL =TARTAR RADAR
A-104-0201	AN/SPG-51C RDP UPGRADE
J-113-0108	AN/SPG-53F (MODIFIED) OPERATIONAL MAINTENANCE =RADAR SET
A-113-0093	AN/SPG-53F MODIFIED RADAR MAINTENANCE
A-104-0202	AN/SPG-55B MOD-10 DIFFERENCE
A-104-0207	AN/SPG-55B MOD-10 RADAR MAINTENANCE =TERRIER
A-104-0194	AN/SPG-55B MOD-9 RADAR DIFFERENCE
A-104-0197	AN/SPG-55B MOD-9 RADAR MAINTENANCE = TERRIER
C-103-2012	AN/SPN-35A MAINTENANCE
C-103-2023	AN/SPN-41 MAINTENANCE
C-103-2013	AN/SPN-42A ACLS MAINTENANCE
.	. .
.	. .
.	. .
.	. .
S-221-0032	AN/SPS-49(V) OPERATION =AEGIS AIR SEARCH RADAR SYSTEM
A-104-0176	AN/SPS-49(V) RADAR SET MAINTENANCE
A-104-0209	AN/SPS-49 (V)8 RADAR SET MAINTENANCE
.	. .
.	. .
.	. .
.	. .
.	. .
.	. .
K-130-1117	AN/SQQ-89(V)-T ON-BOARD TRAINER OPERATOR ADMINISTRATION
K-130-1131	AN/SQQ-89(V)1/3 ACTIVE SONAR LEVEL 2 TECHNICIAN
J-2G-0542	AN/SQQ-89(V)1/3 EVALUATOR SPECIFIC MODULE
K-130-0283	AN/SQQ-89(V)1/3 OPERATOR =SONAR
K-130-1132	AN/SQQ-89(V)1/3 PASSIVE SONAR LEVEL 2 TECHNICIAN
K-130-1102	AN/SQQ-89(V)1/3 WATCH SUPERVISOR =SONAR

Example: Commander identifier, "A" indicates it is a CNET sponsored (table 3-1.)

DOD Skill Code, "4B" reflects this course is for officers; descriptions are arranged sequentially by this number.

The 0019 is by the Sequence Code within the skill code. It is listed as the 19th course in the catalog index.

The function of the *CANTRAC* is to provide a consolidated, centrally produced, and computerized catalog presenting courses in a standardized form. The *CANTRAC* is organized in three volumes. Volume 1 is printed in hard copy, while volumes 2 and 3 are on 4 x 8 microfiche. An example of the microfiche cataloging is provide as table 3-2.

VOLUME 1

Volume l is the Introductory, General Information, and Quota Control Notes. This volume includes all general information not subject to frequent changes, and it is printed in hard copy and published annually. This volume contains three sections:

1. **Section 1**–Introduction. Introductory comments, organization of *CANTRAC*, explanations of pertinent terms, headings, and course number breakdown.

2. **Section 2**–General Information on Facilities. Lists such information as seasonal uniform changes, quarters availability, mess availability, and any other pertinent information relative to schools operated by the Navy. These training sites are grouped under the functional commander having responsibility for the training and in some cases in sequence by state or grouped by area (i.e., for COMTRALANT, all Norfolk areas sites are listed first).

3. **Section 3**–Quota Control Notes. When sufficient information cannot be presented in the Quota Control segment of the course description in Volume 2, refer to this section.

VOLUME 2

Volume 2 is the *CANTRAC Course Descriptions and Convening Schedules.*

Courses are arranged in numerical sequence by Course Identifying Number (CIN) disregarding the command identifier. Course descriptions contain CIN, location, course data processing code (CDP), prerequisites, personnel reporting procedures, skill identifier for which training is applicable, the purpose for and scope of training, and identifies who has quota control for the course. Class schedules appear as the last data field of the description, showing calendar year and dates. Some courses do not have regular convening dates and are convened upon request. If no dates are available, the *CANTRAC* will state "No Dates Available." This information is subject to frequent change and published with the course description for use as a planning tool. The prospective student will obtain the exact date of his class during the process of acquiring his quota. Volume II will normally be published twice each fiscal year, in October and April. An example of a course description catalog entry is provided for in figure 3-15.

VOLUME 3

Volume 3 contains the Skills Profiles. Skill profiles are concise listings of the performance skills and knowledge required in the work center that are currently taught in a course. They provide supervisors with a base from which to develop on-the-job training programs to optimally employ personnel.

Keyword Index. The keyword index of course long titles will be produced with each edition of the *CANTRAC* and is located in the first pages of Volume 3 (see table 3-2). Course titles are listed in alphabetical order by keywords appearing in the title. Titles and related course numbers may appear five or six times in the index, depending on how many keywords appear in the title. Course titles with identical keywords will be grouped together. This index enables you to derive a CIN from a course title if you are not sure of it. This volume will normally be revised and published twice each fiscal year, in October and April.

OBTAINING SCHOOL QUOTAS

The following is a list of logical steps for the EMO to apply in evaluating the need for and obtaining school quotas:

1. Determine personnel training needs, and the location of the schools that can provide the instruction. On-the-job training should be the main stay to any training program when both equipment and trained resources are available.

2. Analyze deficiencies in the master training plan (MTP) using the Enlisted Distribution and Verification Report (EDVR), EPMAC 1080.

3. Review the EDVR report, section 6, and making a list of those NECs that are documented for your specific equipment/installation.

4. Review the EDVR report, sections 1 and 5, to determine the NECs aboard or scheduled aboard in the next 7 months and making a list of those NECs needed.

5. Ensure that the billet allowance meets the ship's needs. Changes in major equipment during overhaul or modernization will require changes in allowance NECs. When changes to the allowance are necessary as a result of equipment changes or inadequate support, the procedures to be followed in making these changes are set forth in the *Manual of Navy Total Force Manpower Policies and Procedures,* OPNAVINST 1000.16.

* HIS * CATALOG OF NAVY TRAINING COURSES

DATE OF LAST CATALOG REVISION: 89/08/28

COURSE SECURITY: UNCLAS

A-104-0209

AN/SPS-49(V)5 RADAR SET MAINTENANCE

LOCATION AND CDP:
FTC NORVA, 151H
SSC ANNEX SD, 151T

MASL NUMBER: P137090 NORFOLK
P137091 SAN DIEGO

LENGTH: 110 days P, 91 days M

CLASS OF SCHOOL/COURSE: C1

SKILL IDENTIFIER FOR WHICH TRAINED: NEC 1510

PURPOSE:

Provide instruction in Technical Maintenance of the AN/SPS-49(V)5 Radar Systems.

SCOPE:

To instruct Electronic Technicians in skills and knowledge required to perform preventative and corrective maintenance on the AN/SPS-49(V)5.

PREREQUISITES:

Graduates of ET (A) School of E4 and one year's fleet experience on AN/SPS-49.

QUOTA CONTROL: ACDU USN: NMPC 406D; OTHERS: See Volume I

PERSONNEL REPORT TO:

Commanding Officer, Fleet Training Center, Norfolk, VA. Check-in in uniform at Naval Station, BLDG. 48. Students proceed to Bldg. N-25A, Room 103 after check in.

Officer in Charge, Advanced Electronics Schools Dept, Service School Command Annex, Bldg. 3143, Naval Station, San Diego, CA 92136. Check-in in uniform at Naval Station, Bldg. 56 Room 147 during normal working hours. During non-working hours, report to Naval Station, Bldg. 56, Window 2. Students should report prior to 2400, the day preceding class convening date. BEQ assignments are made by BEQ Management Center, Bldg. 3362. Students proceed to Bldg. 3143 after check in.

SPECIAL INFORMATION:
See Skills Profile in Volume III.

TRAINING PLAN COORDINATOR: 03132

MODEL MANAGER CDP: 151H

SOURCE RATING: ET

CONVENING SCHEDULES:	CDP	LOCATION	SHRTITLE	YR	DATES
	151H	FTC NORVA	AN/SPS-49(V)5 MA	90	0716 1105

************************((CONTINUED ON NEXT FRAME))************************

* I15 * CATALOG OF NAVY TRAINING COURSES

151T	SSC ANNEX SD	AN/SPS-49(V)5 MA	91	0617
			90	0827 1001
			91	0211 0211 0610 0610

Figure 3-15.–Sample from Catalog of Navy Training Courses.

6. Review the MTP for Non-NEC Requirements (i.e., Visual Tempest Familiarization and Antenna Maintenance).

7. Check and record training course information from the appropriate catalog.

8. Plan the school quota request well in advance of class convening dates.

9. List the ship's in port, yard, or availability periods. Correlate this list with the class convening dates. This should minimize training and operational conflicts.

10. Provide the operations officer with official quota request and other supporting data. Quotas request procedures are outlined in chapter 7 of the *Enlisted Transfer Manual* (TRANSMAN), NAVPERS 15909.

11. Request funding to support the quota. If this training is in the local area, funding will not be required and the member will go at no cost to the government. If the training is 20 weeks or less, the parent activity will fund the quota. For quotas that require TYCOM funding, (i.e. factory training), consult current TYCOM TAD instructions. Although NMPC funding is normally reserved for PCS Orders, chapter 7 of the *Enlisted Transfer Manual,* provides guidance for requesting that NMPC pay for a school.

The school quota request for a NMPC-controlled school is forwarded to the rating control section of NMPC. If there is a quota available, it will be returned by NMPC along with the type of quota, class convening date, and the authority for transfer. However, if the request is denied because of a fully assigned quota at the school, the EMO should maintain liaison with the school to take advantage of any quota cancellations. If there should be a cancellation within 3 working days of the class convening date, NMPC will normally reassign the quota rather than the school. Further information on service schools is contained in the *Enlisted Transfer Manual,* (TRANSMAN) NAVPERS 15909, and *CANTRAC,* NAVEDTRA 10500.

The EMO should verify the security clearance requirements of the school using *CANTRAC* and ensure that the candidate's orders are annotated with the appropriate clearance statement.

Commander Training Force Atlantic (COMTRALANT) quotas are filled by Fleet Training Center, Norfolk, Virginia. Commander Training Force Pacific (COMTRAPAC) quotas are filled by COMTRAPAC at San Diego, California (unless otherwise indicated).

FLEET TRAINING ASSESSMENT PROGRAM (FLETAP)

Have you ever questioned how to get CMS quotas when all classes were filled for the next year? Or why ship's servicemen are not trained to cut women's hair? Or why PHs are assigned to aircraft carrier billets, yet lack adequate flight deck safety training? The answer is training deficiencies. They exist. But a program exists that is designed to specifically identify such deficiencies, then track and resolve them.

The Fleet Training Assessment Program (FLETAP) was established in support of the CNO's training strategy to provide continuing assessment of the quality of Navy training. Training deficiencies from the air, surface, and submarine communities have been brought to a successful resolve as result of FLETAP.

FOUR-STEP PROCESS

Services of FLETAP is available to help solve training deficiencies through a four-step process:

1. Identify the deficiency through direct fleet input (i.e. ship, squadron, MOTU, type commander).
2. Validate the deficiency. Is the deficiency a real problem, or did someone fail to use the directives already in place?
3. Correct the deficiency. Develop a POA&M from the command or schoolhouse responsible for the training.
4. Verify the accuracy of the corrective action: Did the POA&M actually correct the deficiency or does the deficiency still exist?

The Chief of Naval Educational Training, who is the FLETAP Program Manager, works with representatives from COMTRALANT (LANTAP) and COMTRAPAC (PACTAP) in carrying out this program.

FLETAP exists to identify, evaluate, and correct deficiencies. If you suspect a training deficiency within the fleet, a phone call will initiate the process. FLETAP managers may be reached at the following AUTOVON numbers:

COMTRALANT	(AUTOVON 564-5854)
COMTRAPAC	(AUTOVON 957-3346)
CNTECHTRA	(AUTOVON 966-5591)

Full details and format for formal submission of deficiencies can be found in CINCPACFLT/ CINCLANFLTINST 1541.4.

SHIPBOARD TRAINING

Shipboard training is the most relied upon instruction for achieving the Navy's mission. Because the program is administered in an onboard environment, the student benefits from actual hands-on application. This results in a more realistic approach to achieving the Navy's training objectives with the least amount of disruption for the individual and the command.

ELECTRONICS TRAINING

The primary purpose of the electronics training program must be to ensure that personnel assigned to the electronics division know how to maintain electronic equipment to ensure its peak performance. The EMO is responsible for establishing and supervising this training program. In addition, he is responsible for training equipment operators since the effectiveness of electronic equipment is dependent upon its proper operation. The quantity and kinds of electronic equipment, the number and capability of the personnel onboard, and the mission of the ship dictate specific training needs.

The EMO is responsible for the effectiveness of the division training program including what texts and training aids are available and which are most suitable. This information may be obtained from several sources:

1. Onboard equipment technical manuals
2. The modules of the Navy Electricity and Electronics Training Series (NEETS)
3. NAVSUP *Forms and Publications Catalog*, NPFC 2002
4. *List of Training Manuals and Correspondence* Courses, NAVEDTRA 10061
5. Electronic Information and Maintenance Books (EIMB), NAVSEA Stock No. 0967-LP-000-XXXX (NAVSEA TM SE000-00-EIM-XXX)
6. Current and recent issues of *Engineering Information Bulletins* (EIB), NAVSEA Stock No. 0967-LP-001-XXXX (NAVSEA SO111-XX-EIB-EXX)
7. Current Navy film catalogs
8. Rate training manuals pertinent to the division
9. Other texts suitable for electronics study
10. Publications Applicability List (PAL)

The major burden of shipboard instruction will rest with the petty officers. Therefore, each must become a well-qualified instructor to truly fulfill the individuals' role in the Navy. A natural tendency in the selection of an instructor for a particular subject is to choose the most qualified person on the subject. This practice should ensure the highest quality of instruction, but it tends to place the entire burden of instruction in the hands of a few senior petty officers. It also tends to stifle the enthusiasm of the junior petty officers. In order that instructor techniques can be developed at all division levels, you should make it a point to choose instructors from the ranks of both the junior and senior personnel.

To teach a subject, the instructor must be completely familiar with it. In the case of a junior petty officer, this will most likely entail considerable research and study. This research will help both the instructor and the group being instructed. Provision should be made in the training program for instruction in training techniques. The Navy's Instructor Training schools conduct courses for training shipboard instructors. The course is only one week in length and is extremely beneficial to both the individual and the command. Personnel trained at these schools should be used to form the nucleus for instructor-training aboard ship.

Before a lesson plan is prepared, one important point should be remembered–instructors are the experts; they should be fully knowledgeable on the subject area. If as an instructor, you are hazy on an area, get out the books and refresh your memory prior to the day of the presentation. An instructor who has not adequately prepared loses credibility.

FEEDBACK

Possibly the best feedback you will ever receive about your training will be to observe the performance of the trainees on the job. If evidence exist of poor technical performance on repair work, preventive maintenance, or any other activity for which the technician has been trained, the EMO, as well as the senior petty officers should be alert for signs of skill deficiencies. These weaknesses can then be addressed in future training.

In planning training, the EMO should ask the technicians what they think should be taught.

Additionally, he should analyze the advancement-in-rate examination results for the division. Very often these results are ignored even though weak areas of knowledge are pinpointed on the examination profile sheet.

FORMAL TRAINING SESSIONS

If lesson plans (instructor guides) are available, they should be carefully screened to ensure they contain the needed subject content and all of the points that are to be emphasized–the need-to-know material. If lesson plans are not available or are inadequate for the needs of your personnel, new lesson plans should be prepared. Figure 3-16 shows a sample lesson plan format.

TITLE:	WRITE TITLE AND LESSON NO.
OBJECTIVES:	LIST LEARNING OBJECTIVES; (List the learning objectives the instructor desires to meet with the lesson. Make objectives realistic.)
MATERIAL:	1. TRAINING AIDS: (List training aids needed to teach this lesson.) 2. REFERENCES: (List the sources from which this material was obtained.)
INTRODUCTION:	The instructor should introduce the lesson at this point and create interest in the lesson by possibly relating a short story to catch the trainees interest. (Related story should key up the importance of knowing lesson.)
PRESENTATION:	The vital information to be taught should be placed in this portion of the lesson plan in outline form. It should be outlined in such a manner as to provide the instructor with a coordinated flow of information.
APPLICATION:	A list of questions should be prepared in advance to see if the trainees have absorbed the present material. (Answers to the questions should be included for the instructor to refer to.)
SUMMARY:	The instructor should then review the vital elements of the presentation.
TEST:	A small quiz may be administered though not required.
ASSIGNMENT:	An assignment may be given to reinforce the lesson. Not mandatory.

Figure 3-16.–A lesson plan outline.

A training plan is easy to formulate because there are so many available indicators of weaknesses. *The development of the plan is easy; the actual training is what will prove to be much more difficult.* Your challenge will be to properly execute the training program. Your effectiveness will be readily seen in the skill level and morale of the people you have trained.

CLASS SCHEDULING

Formal class presentations should be scheduled as early in the day as possible (shortly after morning quarters is an ideal time). At this time, people are rested, ready to start the day, and in a more receptive mood than they would be if they had already worked a full day and were waiting for liberty call. There are always factors that interrupt class schedules. By planning well in advance and ensuring that all persons attending the formal class are made aware of the schedule, interference from outside events can be minimized. Training sessions should be kept short and scheduled over a number of days. Too much material covered at any one time may produce poor results because of some of the following situations:

- Interruptions resulting from ship evolutions
- Loss of interest because of the length of the class
- Loss of interest resulting from the technical nature of material covered

CLASS LOCATION

A suitable location should be found to hold the training session. This is often a problem on small ships, since spaces are cramped and room is at a premium. At a shore station, training rooms are usually available for formal training. An adequate space for a classroom should be:

- Comfortable as possible
- Well-lighted
- Structured so that the entire class can see the instructor and vice versa
- Free from outside noise
- Adequate seating
- Equipped with adequate training aids/devices

SHIPBOARD CLASSES COMBINED WITH ON-THE-JOB TRAINING

The EMO establishes classes to review the fundamentals of electronics and electricity. These classes will help personnel better understand the theory behind their on-the-job practical work as well as safety precautions. Additionally these classes will improve their performance when participating in Navywide examinations. PQS, lesson plans, and outlines should be used as aids for efficient instruction. When lectures are conducted in topical areas covered by PQS theory/system section, lesson plans need not be prepared as the PQS format serves the same purpose.

The majority of shipboard training is received on the job. Since the ultimate purpose of classroom instruction is to supplement on-the-job training, class work must be tied in as closely as possible with the job environment.

To make the training as useful as possible, practical as well as theoretical problems must be considered. One of the first practical subjects taught is the correct use and care of tools. This subject must be emphasized both on the job and in the classroom through discussion, demonstration, and practice. The operations and stowage of general-purpose electronic test equipment (GPETE) must be a vital part of this process. Emphasis should also be on the stowage of GPETE; after working all night it is all too easy to leave an oscilloscope on the deck at the place of repair thinking it will be OK. One roll of the ship will have the EMO filling out a survey form and explaining to the OPS boss or combat systems officer why a replacement oscilloscope must be bought out of an already over extended budget.

Encourage the technicians to discuss job-related problems in class. They should explain the symptoms of an equipment failure, describe what they did to determine the cause of the failure, and what they did to remedy the trouble. Bring out the technical manual and the service notes section of the *Electronics Installation and Maintenance Book*, NAVSEA SE 000-00-EIM-0XX, for the equipment in question. Frequently, taking the group to the equipment itself provides a better understanding of just what caused the failure and what was done to diagnose and remedy it. Equipment display is a dynamic part of instruction. In this way, the technicians, as a group, will learn from each other's individual experiences on the job.

OPERATOR TRAINING

Being familiar with the equipment is a must for the operator. The informed operator has confidence and professionalism in his job, and the technician is saved many needless hours making operational adjustments.

The following is a description of what can and does happen and the frustration that can occur on a typical Navy ship that does not effectively use technicians in their operator training program. During the morning the technician:

1. Sets up a uhf transmitter on frequency.

2. Begins work on a defective uhf transceiver, but at the end of 20 minutes, the duty ET is called to investigate the primary tactical circuit and finds that the bridge loudspeaker amplifier has been accidentally turned off.

3. Resumes work on the uhf transceiver; but, at the end of 10 minutes, the ET is called by the radioman to check an hf transmitter and finds the transmission selector switch in the wrong position.

4. Answers a bridge message that another ship has reported the primary tactical voice circuit "garbled"; when investigated finds audio feedback path from handset earphone to microphone. He reduces handset volume and eliminates the problem.

5. Returns to work on uhf transceiver; but is asked by the radioman in the uhf space to check the tuning of several uhf transceivers.

Almost 50 percent of this technician's time could have been saved from disruption by the proper training of the operator personnel. *Operator training isn't time expended; it is time saved.*

It is the responsibility of the senior electronics petty officer to train or ensure the training of operator personnel. With this training, they can properly and safely perform their corrective and preventive maintenance procedures. An operator's duties should be limited to nontechnical procedures or to the performance of simple maintenance operations for which adequate training has been given.

An operator should be trained to perform preventive maintenance only on that equipment to which he may be assigned according to the Planned Maintenance Schedule. The technician assigned maintenance of that specific equipment should be the person designated to train the operator.

ELECTRONICS CASUALTY CONTROL TRAINING

At no other time is training so critical than at general quarters. All electronics casualty control (ECC) personnel must have a superior knowledge of battle station first aid. Each member of ECC must be skilled in counteracting the damage to an electronics space, whether it be structural or equipment related. Obviously, an important skill is identifying dangerous electrical hazards while fighting electrical fires. The ECC's foremost responsibility is to quickly repair electronic systems vital to the ship's ability to engage in its primary mission.

Each technician in ECC is trained to maintain and operate a variety of electronic equipment. Of course, this must start with a good working knowledge of all standard test equipment. Second only to a thorough knowledge of test equipment, the technician must be skilled in electronic equipment operation and theory to maintain and repair such equipment. The most important training is system fault recognition; for without this, the technician will not know which unit in the system has failed.

ECC watch training begins by conducting exercises simulating the use of electronic equipment in an operational environment. Watch training is essential in fitting ECC into the whole battle organization. Simulations have their place, but they do not fully test ECC's ability to react to all system failures that might hamper a ship's ability to conduct an operation or survive a battle. Realistic exercises are also needed to add confidence to watch training and battle preparation. By keeping prime equipment online and monitoring their status constantly, ECC maintains its capability to contribute to the successful outcome of any operation or battle.

Being courageous in the face of enemy action is, indeed, admirable. But against a better prepared and trained foe, you would probably lose the battle. When actively engaged with the enemy, training will become the determining factor. If this is true, ECC must become the "educated bullet." ECC watch standing and general quarters exercises enhance the primary objective of furthering a ship's ability to effectively perform its primary mission.

As the EMO, you must ensure that all personnel assigned to the electronics division are properly organized and trained in established ECC procedures. These procedures must be delineated in your electronic doctrine, and the guidelines established should be exercised frequently. This will ensure they meet the needs of your command and all personnel are familiar with current accepted practices.

The Atlantic and Pacific Fleet Training Centers for refresher training can provide you with the guidelines for evaluating the performance and structure of any ECC organization. You can use the guidelines as a checklist to evaluate the performance of your organization. A properly organized and trained electronics division must be able to successfully perform these exercises, not only for grading purposes, but also for the experience of operating in a battle environment.

The *Electronics Technician 1 & C*, NAVEDTRA 10192-F (chapter 8) provides information on the ECC organization.

CSTT/SERT TRAINING

The Combat Systems Training Team (CSTT) is the most experienced shipboard personnel responsible for training combat systems personnel in the operation and maintenance of installed equipment, as well as supervising the conduct of combat systems related exercises. The CSTT will have the Ship's Electronics Readiness Team (SERT) as its nucleus, and is responsible for consolidating operator/technician total combat systems training. The objective of the SERT is to provide a core of combat systems level trained technicians with the knowledge and skills required for the effective execution of total combat systems preventative and corrective maintenance. SERT will be covered more in chapter 17 of this book.

PERSONNEL QUALIFICATION STANDARDS (PQS)

PQS is mandatory and will be the primary means of watch station/team member qualifications. This program is used to qualify officer and enlisted personnel to perform their assigned duties. A personnel qualification standard is a written compilation of knowledges and skills derived from a task analysis. Personnel must demonstrate they possess these skills before they can qualify for a specific watch station or perform as a team member within an assigned unit. A *watch station*, as it applies to the PQS, refers to those watches assigned by a watch bill and, in the majority of cases, operator oriented. Performance as a team member within the unit refers to the knowledge and skills appropriate for standardized qualifications. These knowledge and skills are not peculiar to a specific watch station or piece of equipment but apply more broadly within the unit.

PQS is printed in a qualification guide format. It asks the questions a trainee must answer to verify his readiness to perform a given task. It also provides a record of his progress and final certification.

The PQS Development Group publishes a PQS Catalog, NAVEDTRA 43100-5, which lists all PQS material in the supply system. Updates to this catalog are issued periodically. The individual stock numbers are included to assist each unit in ordering from the Naval Publications and Forms Center, 5801 Tabor Ave., Philadelphia, PA 19120. Requisitions must be submitted in accordance with procedures set forth in the *Navy Stock List of Publications and Forms,* NAVSUP Publication 2002. PQS Progress Charts are stocked at local SERVMARTs. Requests for information regarding PQS products that are being scheduled for future development and are not presently listed in the PQS catalog should be addressed to: Naval Education and Training Support Center, Pacific, Code N7, San Diego, CA 92132-5105.

Each PQS is developed by determining the skills required at a specific watch station. General theory and equipment systems are then identified to ensure there is adequate background knowledge to perform the duties required by that watch station. To achieve this organization, each PQS has three main subdivisions.

THE 100 SERIES–FUNDAMENTALS

Each qualification standard begins with a fundamentals section covering the basic knowledge needed so that you may understand the specific equipment or duties as well as an analysis of those fundamentals that apply more broadly. Its content has a direct application as a self-study tool for those who have not received formal school training or for school graduates who wishes to review the subject.

A portion of the fundamentals section of each qualification standard may be devoted to expanding the trainee's vocabulary by calling for definitions of technical terms used throughout the standard.

Because the safety of personnel is of great concern Navywide, the first fundamental section of each PQS addresses the safety precautions that must be mastered by every individual before performing the watchstation/workstation/maintenance action requirements. Specific or unique safety precautions that apply to a particular piece of equipment or system are addressed in the system the 200 Series.

THE 200 SERIES–SYSTEMS

In this section, each qualification standard breaks down the subject equipment or duties into smaller, more easily understood sections called systems. When the equipment/duties are broken down, many small functional systems are revealed. The simpler systems can be identified and covered more quickly.

A system is arranged for learning at two levels: components and component parts. The user of the qualification standard needs only to master these to be able to understand the organization of the equipment or duties. A qualification standard will list only those items which must be understood for the proper operation and/or maintenance of that particular system. It will not include every item appearing on a parts list in the technical manuals.

Qualification standard systems are designed to follow the law of primacy (first things first). If the trainee focuses on learning how the equipment functions during normal operation, he will be better able to identify problems as they develop or even before they occur; enabling him to successfully control or prevent casualties.

THE 300 SERIES–WATCHSTATION/ MAINTENANCE ACTION

This section tests the trainee's readiness to perform a designated task. The terminology in the PQS considers a sailor to be "on watch" whenever he is operating the equipment whether "on shift," "on call" or "in the shop." The goal of the watchstation/maintenance action section is to guide the trainee in categorizing, analyzing, and performing the step-by-step procedures required to obtain qualification.

PQS must be used by you as the EMO/division officer as a method of training/qualifying new personnel reporting aboard and for cross-training/requalifying experienced personnel. The concept of standards for personnel qualification is not new in the Navy. For many years, various forms of qualification standards have been in use. Observing the performance of new technicians in a shop routine helps the shop supervisor to decide when the technicians are ready to independently stand a watch or work on equipment. The first lieutenant applies a similar approach to hands-on performance evaluation in the qualification of helmsmen and boat coxswains. The detailed checkoff list approach to watch station qualification in submarines has been used for many years with great success. Development of a step-by-step watch stander's PQS for a particular installation has given the EMO/division officer and shop supervisor a method of ensuring that all pertinent information is presented to new personnel reporting aboard. The PQS developed to date have proved to be very beneficial to those commands that have fully implemented PQS as an element of their training program.

The success of the PQS program in your divisional shop depends upon you. For you to make this program a success, the following must exist:

1. An adequate and well-maintained PQS reference library of technical, procedural, and rate training manuals.

2. An effectively managed overall division/shop training program.

3. A program to prepare work group supervisors for the job of PQS qualifier. Once qualified provide the necessary supervision and assist for these designated personnel.

4. Realistic individual qualification goals and time limits.

5. A means for monitoring individual qualification progress.

Further information on the concepts, management, logistics and implementation of the PQS program may be found in the *Personnel Qualification Standards (PQS) Management Guide,* NAVEDTRA 43100-1.

When a PQS does not exist for the needs of your ship, station, or unit, the *Personnel Qualification Standards (PQS) Program,* OPNAVINST 3500.34C, directs units to develop their own Job Qualification Requirements (JQR). These JQRs must be approved by TYCOM or appropriate major staff. The JQR title is used to distinguish locally developed qualifications from the fleetwide mandatory PQS. JQRs also allow the developing organization greater flexibility in tailoring the format, content, use, and revision. This makes it possible to custom fit the needs of the organization to that of the user.

NEWLY REPORTING PERSONNEL

When new electronics personnel report aboard, the individual should fill out a Division Officer's Personnel Record Form, NAVPERS 1070/6, as shown in figure 3-17. This form is to be reviewed along with the individual's service record for background information covering that individuals' formal education, professional experience, and performance evaluations. This information will serve as a basis for the technician's personal interview with you as the EMO. Ensure as a minimum that the date reported block is filled in; this will save you a trip to the personnel office when evaluations are due. The form should be as complete as possible. From the information you gain during the interview and consultation with the senior technician, you can determine where the individual may be best assigned within the electronic repair organization. This interview will most effectively make use of his special abilities.

To motivate personnel to improve their general education, the EMO must also be alert to programs and courses offered through the educational services office. On small ships, the EMO may be required to perform the duties that are normally associated with the education services office.

During the personal interview, you must be ready and eager to talk with any of your personnel about their problems, either professional or personal. These sessions must convey a positive attitude and interest in the individual's development and well-being. If they don't, they will prove to be of little value to either the command or the individual. These sessions will yield additional details about the electronics installation, and how the division is working, as a team, as well as how the individual is developing. These talks will also afford an opportunity for you to build toward instilling positive attitudes. Be prepared to discuss the requirements for the individual's advancement.

The following steps are recommended for indoctrinating newly reporting personnel to the department from shipboard indoctrination (I division):

1. (1st week) Initial interview by department head, assignment to the division and a brief (1 or 2 day) orientation tour of spaces under the supervision of a petty officer.

2. (1st day) Meeting of department head, division officer, chief petty officer, and leading petty officer to decide guidelines for advancement, initial qualifications, and desired goals.

DIVISION OFFICER'S PERSONNEL RECORD FORM
NAVPERS 1070/6 (Rev. 9-75)
S/N 0106-LF-010-7035

PRIVACY ACT STATEMENT

Authority to request the information in this form is derived from 5 United States Code 301, Departmental Regulations. Purpose of this form is to provide the Division Officer with readily accessible data concerning personnel in his/her division. The information is used by the Division Officer to manage and administer his/her personnel, to determine training needed, to record training completed, to maintain readily accessible data concerning performance, work assignment, and other personnel data to enable the Division Officer to guide and counsel those assigned to him/her. Disclosure of the following items of information on this form is mandatory name, rate, SSN, local address and phone number (if applicable), billet space/living space/bunk number (if applicable). Disclosure of the following item of information is voluntary, reenlistment intentions, rate desired, special qualifications, name of wife, names and ages of children. Other items of information may be obtained from member's service record. Failure to provide those required items of information listed above may result in administrative action being taken; no action will be taken if the individual refuses to disclose those voluntary items of information.

NAME		RATE	☑ USN ☐ USNR	SSN	NEC/PRI/SEC
ABLE, ALFRED		ET3		111-11-111	
DIVISION: OE	SECTION: 1	BILLET SPACE: 3-105-1-2		LIVING SPACE	BUNK NUMBER: 1
DATE OF BIRTH: 20 MAR 1972	RELIGION: BAPTIST			SECURITY CLEARANCE: SECRET	
DATE OF FIRST ENLIST: SEPT 12, 1971	DATE REPORTED ABOARD: JULY 2, 1972	EXPECTED LOSS DATE: JULY 2, 1978		REENLISTMENT INTENTIONS: RE-ENLIST	
DATE OF PRESENT RATE: JULY 1, 1972	RATE DESIRED: ET2	ELIGIBLE NEXT RATE: JULY 1, 1973		CONTINUOUS SERVICE: YES	
SPECIAL QUALIFICATIONS OR INTERESTS: ELECTRONIC HOBBYIST REMOTE AIRPLANES				GENERAL QUARTERS STATION: RADAR 1 / UNDERWAY WATCH STATION: ET SHOP	
PERMANENT HOME ADDRESS AND PHONE NUMBER: RT 1 (404)(123-4567) MACON, GEORGIA		LOCAL ADDRESS AND PHONE NUMBER: ON BOARD			
MARITAL STATUS: SINGLE	NO. OF DEPENDENTS	NAME OF WIFE			
NAMES AND AGES OF CHILDREN					
NEXT OF KIN		RELATIONSHIP	ADDRESS AND PHONE NUMBER		

PREVIOUS DUTY				LEAVE RECORD				
DATE REPORTED	UNIT	DIVISION	DESCRIPTION OF DUTY	FROM	TO	TYPE	NO. DAYS	BALANCE
DEC 19, 1971			ET"A" SCHOOL					

SEMI-ANNUAL MARKS

PERIOD ENDING	PROFESSIONAL PERFORMANCE	MILITARY BEHAVIOR	LEADERSHIP AND SUPERVISORY ABILITY	MILITARY BEARING	ADAPTABILITY
—	3.6	3.8	3.6	3.6	3.6

DIVISION OFFICER'S PERSONNEL RECORD FORM
NAVPERS 1070/6 (Rev 9-75) (Back)

AWARDS AND COMMENDATIONS

DISCIPLINARY RECORD

FORMAL EDUCATION

HIGH SCHOOL 9 10 11 12	MAJOR SUBJECTS
COLLEGE 1 2 3 4	

BASIC BATTERY SCORES

GCT	ARI	MECH	CLER	ETST	SONAR	RADIO	FLAT

GED

☐ HIGH SCHOOL ☐ COLLEGE	PART I SCORE	PART II SCORE	PART III SCORE	PART IV SCORE	PART V SCORE

NAVAL EDUCATION AND ADVANCEMENT RECORD

ITEM	TITLE	DATE COMPLETED	MARK	TITLE	DATE COMPLETED	MARK
SERVICE SCHOOLS						
MILITARY CORRESPONDENCE COURSES						
OTHERS						

PRACTICAL FACTORS		SERVICE-WIDE RATING EXAMINATIONS		
RATE	DATE COMPLETED	DATE	RATE	RESULTS

FIRST AID	SWIM	TEL. TALKER	FIRE FIGHT'G	DRIVER	TRUCK DRIVER	BUS DRIVER	COX'SN	BOAT ENG.					

PROFESSIONAL QUALIFICATION STANDARDS

WATCH	DATE COMM	% PROGRESS	DATE QUAL	WATCH	DATE COMM	% PROGRESS	DATE QUAL

Figure 3-17.–Division Officers Personnel Record Form, NAVPERS 1070/6.

PLAN OF ACTION
FOR QUALIFICATION AND ADVANCEMENT OF

______________________________ ______

(Name/Rate)

Used in conjunction with NAVPERS 1070/6 (3/67)

Interview Date ______________ Last Review Date ______________

Interviewer ____

1. General: (results of dept. meeting with cognizant Division Officer and Petty Officers)

2. Specific assignments, desired completion dates:

   a. Watchstation Qualification assignments:

	Watchstation	Points rec'd (PQS)	Weekly pts (PQS)	Completion Date
(1)				
(2)				
(3)				
(4)				

   b. Advancement requirements: (Ensure changed with each advancement)

      (1) Present grade ______ Time reqmt to next ______________

      Approx elig date ______________

      (2) Correspondence course requirement ______ Desired completion date

      ______________________ ______________________

      ______________________ ______________________

      (3) Examination requirements: (FN/SN MIL LEADERSHIP PO 3, 2, 1, C, date of eligibility.)

      Examination ______________ Elig. date __________

   c. Schools (Type and expected date to obtain quota)

   Name/Number ______ Expected Date

   ______________________ ______________________

   ______________________ ______________________

Figure 3-18.–Plan of action form (example).

3. (1st week) Second interview, issue PQS materials, assign specific watchstation goals and advancement goals, and complete a plan of action form such as the one shown in figure 3-18, or the Division Officer's Personnel Record Form.

4. (2nd week) Indoctrination into watch qualification process, progress charts, qualification petty officer, references, and so on.

5. Review of initial goals and accomplishments within 3 weeks after check-in to the department.

6. At the end of one month in the department, review progress and make a reevaluation of goals, if required.

The progress outlined above accomplishes the following: (1) it informs the individual that the chain of command within the department is concerned about his qualifications, advancement, and ultimate value to the department/ship; (2) ensures that management is in agreement with the plan of action for the individual; (3) it institutes a program of review. Initial assignments may be too high/low for the person's ability, so adjustments can be made.

The performance of enlisted personnel can be enhanced by command indoctrination program for newly reporting personnel. This program must clearly state command policy and, at the same time, informs the individual that he is an important part of the organization. The "welcome aboard" needs to be effective and ongoing.

The indoctrination training should include but not be limited to the following topics:

1. History and mission of the command
2. Unit's routine and regulations
3. Personnel procedures
4. Educational Services
5. Career benefits
6. Legal Services
7. Morale and religious services
8. Equal Opportunity/Human Resources Management
9. Drug and alcohol abuse
10. Medical and dental services
11. Safety
12. Security
13. Vehicle regulations
14. Energy Awareness
15. Standards of conduct
16. Ombudsman program

SELF-STUDY

Self-study includes Naval Personnel Correspondence Courses and Navy nonresident training courses (including PQS) that should be completed to establish eligibility for advancement. Each person must complete the prescribed Navy training courses as part of their qualification for advancement. The goal is that each person should actively seek advancement to the next higher rating and be enrolled continually in some type of training program/course. All hands should be encouraged to complete their courses in a reasonable time and to review them before they take the Navywide advancement examination. One of your primary duties as an EMO/division officer is the administration of these courses. You, along with your senior petty officers, should assist personnel in the completion of their courses. Nonresident training courses are listed in the *List of Training Manuals and Correspondence Courses,* NAVEDTRA 10061. This publication also provides procedures for ordering courses. Applications for correspondence courses are normally handled by the educational services officer (ESO).

THE NAVY CAMPUS FOR ACHIEVEMENT

The Navy Campus for Achievement (NCFA) is an educational program designed to give every Navy person an opportunity for college education.

Under this program each person desiring a college degree has the opportunity to meet with a professional education advisor to discuss his academic background and future academic ambitions. This develops an academic path or degree program designed especially to meet his personal and professional goals. This program is used more extensively when the individual is assigned ashore; however, yard periods often afford opportunities for on-campus instruction. Tuition aid and inservice VA are two financial programs that are available to assist the member in defraying the burden of the high cost of education.

NAVY'S PROGRAM AFLOAT COLLEGE EDUCATION (PACE)

One of the programs offered as a part of the Navy Campus Voluntary Education Program, is the program for Afloat College Education (PACE) for those personnel assigned to ships. Classes provided at sea are delivered by civilian professors under contract from a select list of universities and colleges. The Navy Campus contracts with these universities, colleges, and junior colleges to provide academic and vocational courses aboard fleet units. The ESO can tell you what courses are available on your ship and their convening dates. If the ship is in port, the Navy Campus education specialist can provide the needed information.

TRAINING FILMS

A valuable training resource that must not be overlooked is films; they provide supplementary information on many subjects. The *Catalog of Navy and Marine Corps Visual Information Productions,* OPNAV-P-09B1-01-88, lists all U.S. Navy training films, and is available on board all ships. However, for a complete listings of all training films, check with your local support activities, audio visual centers, and of course, your own activity's ESO.

SUMMARY

In this chapter we have discussed the EMO's role within the ship's total training organization, with the various plans and requirements for training, and the options and resources available for obtaining training.

While formal training is important, an environment that encourages an improvement in both knowledge and skills of individuals is of utmost importance.

As an EMO training and personnel administration will help you to evaluate the needs of your people. It will provide a climate in which they can learn and encourage a team concept. It will also point out schools and other formal training that are needed to maintain your equipment.

REFERENCES

Catalog of Navy Training Courses (CANTRAC), Volumes 2 and 3, NAVEDTRA 10500, Naval Education and Training Command, Pensacola, Fla., 1990.

Combat Systems Electronics Administration Course, A-4B-0019, *Student Guide,* Fleet Training Center, Norfolk, Va., 1987.

Communications Security (COMSEC) Equipment Maintenance and Training, OPNAVINST 2221.3, Office of the Chief of Naval Operations, Washington, D.C., 1984.

Electronics Technician 1 and C, NAVEDTRA 10192-F, Naval Education and Training Program Management Support Activity, Pensacola, Fla., 1987.

Fleet Training Assessment Program, CINCPACFLT/CINCLANTFLT Instruction 1541.4, 1985.

Manual of Enlisted Manpower and Personnel Classifications and Occupational Standards, NAVPERS 18068, Bureau of Naval Personnel, Washington, D.C. 1986.

Military Requirements for Petty Officer First Class, NAVEDTRA 10046-A, Naval Education and Training Program Development Center, Pensacola, Fla., 1987.

Personnel Qualification Standard PQS Management Guide, NAVEDTRA 43100-1C, Chief of Naval Education and Training, San Diego, Calif., 1987.

Prospective Electronics Material Officer Course A-4B-0018 Student Guide, Modules 10 and 11, Advanced Electronic School Service Schools Command, San Diego, Calif., 1987.

Standard Organization and Regulations of the U.S. Navy, OPNAVINST 3120.32, Office of the Chief of Naval Operations, Washington, D.C., 1973 (with updates).

CHAPTER 4

SAFETY

OVERVIEW

Describe safety precautions, promotion, education, and responsibilities relating to the electronics division.

OUTLINE

Safety education, promotion, and enforcement

Safety organization

Authority and responsibility of supervisors

Safety requirements in work areas

Hazards of electromagnetic radiation to personnel (HERP), ordnance (HERO), and fuel and other flammable materials (HERF)

Laser safety precautions

Preventive maintenance and reporting of unsafe conditions

RESPONSIBILITY FOR SAFETY

Responsibility for the safety of personnel is vested in the Commanding Officer. Article 0732 of the U.S. Navy Regulations reads as follows:

"The commanding officer shall require that persons concerned are instructed and drilled in all applicable safety precautions and procedures, that these are complied with, and that applicable safety precautions, or extracts therefrom, are posted in appropriate places. In any instance where safety precautions have not been issued or are incomplete, he shall issue or augment such safety precautions as he deems necessary, notifying, when appropriate, higher authorities concerned."

While he may, at his discretion, and when not contrary to law or regulations, delegate authority to his subordinates for the execution of details, such delegation of authority shall in no way relieve the commanding officer of his continued responsibility for the safety of his entire command.

EMO RESPONSIBILITIES

Personnel safety is a major responsibility of every electronics material officer (EMO). Electronic equipment enforces a stern safety code, and violators are likely to be electrocuted on the spot. Because of the dangers inherent in working with electronic equipment, safety precautions must be made an important part of the electronic equipment training program.

The EMO's responsibilities concerning safety generally include the areas of safety education, safety promotion, and safety enforcement. The intent of this chapter is to acquaint you with some of the various safety areas that you will see on a daily basis in the electronics division. At the end of this chapter is a listing of the major references needed to manage an effective divisional safety program.

The commanding officer ensures that his personnel are instructed and drilled in applicable safety precautions; this requires that adequate warning signs be posted in dangerous areas. This establishes a force to see that such precautions are observed. It is the responsibility of supervisory personnel to see that precautions are strictly adhered to in their own work areas, since they are responsible to the commanding officer. Furthermore, individuals concerned should strictly observe all safety precautions applicable to their work or duty. Thus, it is obvious that accident prevention is the business of every individual–not just a delegated few.

As an individual, you have a responsibility to yourself and to your shipmates to do your part in preventing accidents. You must always be alert to detect and report unsafe work practices and unsafe conditions so that they may be corrected before they cause an accident.

Each individual must:

1. Observe all posted operating instructions and safety precautions.
2. Report any condition, equipment, or material that is considered to be unsafe.
3. Warn others believed to be endangered by known hazards or by their failure to observe safety precautions.
4. Wear approved protective clothing or use protective equipment as required.
5. Report to supervisors any injury or evidence of impaired health occurring in the course of work or duty.
6. Exercise reasonable caution as appropriate to an event of emergency or other unforeseen hazardous condition.

Post-accident investigations have revealed that the majority of accidents result from unsafe practices or acts, most of which are known beforehand to be unsafe and in violation of safety practices, rules, regulations, or directives. Other human factors found to be the cause of accidents include fatigue, monotony, preoccupation at a critical moment (inattention), mental and/or physical problems, improper supervision, and the lack of motivation. Because of various factors, individuals do not always act (or react) as they were trained, instructed, or directed to act. This condition results in a high probability, for an accident–"human error."

Human error includes all the actions or inactions of an individual having a bearing on an accident or on an unsafe practice that can lead to an accident. To reduce human error as a predominant cause of accidents, all individuals are responsible for acquainting themselves with the environmental hazards surrounding them. They should condition themselves to be alert, both mentally and physically, so they can protect themselves and others by not foolishly or unnecessarily exposing themselves to hazards.

Accidents do not happen without a cause; when each individual is aware of the hazards involved with his work, fewer accidents will result. Accident prevention must be a continuous effort in which each individual gains experience and knowledge through day-to-day association with other coworkers who are aware of the hazards of their environment.

Remember! As an individual, you have a responsibility to yourself and to your shipmates. You must always be alert to detect and report hazardous work practices and conditions so they can be corrected before they cause an accident.

SAFETY EDUCATION

Often personnel will not observe safety precautions unless they are fully aware of the personal danger they subject themselves to. The EMO's first duty, therefore, is to ensure that all personnel in the division are aware of the dangers and the safety precautions for avoiding these dangers.

Shipboard life is one of the more hazardous working and living environments that exist. The existence of hazardous materials and equipment, in addition to the fact that a ship is a constantly moving platform subject to conditions such as weather, collision, and grounding, contribute to an accident prone environment. Any chain of mishaps could lead to a major catastrophe. For this reason, PRACTICAL SAFETY must be followed and the prescribed safety regulation strictly followed to prevent personal injury.

Safety precautions depend to some extent upon the type of ship. Precautions that must be strictly observed on some types of ships, such as AOs and AEs, may not have the same degree of emphasis on other types of ships. Another example would be safety precautions on nuclear powered ships that differ markedly in specific and important ways. Each ship or group of ships of the Navy is unique and will have special safety precautions to be observed. Type commanders require the electronics doctrine in the Division Organization Manual to have a safety section. This provides a ready reference for personnel to read and understand safety precautions pertaining to their own ship's equipment.

While most of the standards specified in this chapter are covered during basic training and at specific training schools, a new crew member should be given a copy of these standards and a brief orientation of their intent and importance.

Every time a mishap occurs involving a violation of one of these standards, all personnel should have the appropriate standard brought to their attention. This can be accomplished through the use of Plan of the Day notes or divisional training.

Safety training for personnel should emphasize the following points about portable electrical equipment:

1. Visually inspect portable electrical equipment before using it. Look for damaged plugs, frayed cords, broken or missing ground connections, and other component defects.
2. Never use portable electrical equipment if there is reason to believe it might be defective. Have it tested by authorized personnel prior to use.
3. Make no unauthorized repairs or alterations.
4. Do not use any personal portable electrical equipment (PPEE) aboard the ship unless it has been inspected and approved by the ship's electrical shop or electronics shop according to ship's instructions.
5. Always report any shock received from electrical equipment, regardless of how slight.

ELECTRIC SHOCK

Safety precautions written for personnel in all ratings should include information concerning electric shock, and precautions to be observed when using electrical and electronic equipment aboard ship. Points to be stressed concerning electric shock should include the following general warnings:

1. Voltages as low as 30 volts can be fatal.
2. The dangers from electric shock are much greater aboard ship than ashore.
3. There is very little difference between a slight tingle and a fatal shock.

Factors determining the extent of body damage because of electric shock are the amount and duration of current flow through the body; the parts of the body involved; and, in the case of ac, the frequency of the current. In general, the greater the current or the longer the current flows, the greater will be the body damage. Body damage is more likely to occur when the current flow is through or near nerve centers and vital organs. An alternating current (ac) frequency of 60 hertz is considered slightly more dangerous than ac current of a lower frequency or than direct current (dc). This is because ventricular fibrillation is produced with just a 60-100 mA current at 110-220 volts alternating current (vac), 60 hertz (Hz); while 300-500 mA of dc voltage is required for the same reaction. However, the same precautions that apply to 60-Hz ac also apply to dc.

Table 4-1.–Effects of 60-Hertz Value on Human Beings

Current Value	Effects
Less than 1 mA	No sensation
1 to 20 mA	Mild sensation to painful shock; may lose control of adjacent muscles between 10 and 20 mA.
20 to 50 mA	Painful shock with probable loss of control of adjacent muscles.
100 to 200 mA	May cause a heart condition known as ventricular fibrillation, which results in almost immediate death.
Over 200 mA	Severe burns and muscular contractions so severe that the chest muscles clamp the heart and stop it for the duration of the shock.

Humans differ in their resistance to electric shock; therefore, a current flow that may cause only a painful shock to one person might be fatal to another. Table 4-1 presents information on the effects of 60-hertz current flowing through the body.

Tests made by the Bureau of Standards show that the resistance of the human body may be as low as 300 ohms under unfavorable conditions such as those caused by salt water and perspiration. This indicates that it is possible for a potential difference as low as 30 volts to cause a fatal 100 milliampere current flow through the body. This should leave no doubt as to the danger involved and precautions necessary regarding electrical hazards aboard ship.

PROMOTING SAFETY

Promoting safety within the division, or on the ship in general, will require that all hands become safety conscious to the extent that they automatically consider safety in every job or operation. Through the use of safety reminders and the personal examples of technicians, safety consciousness will pass from one crew member to another.

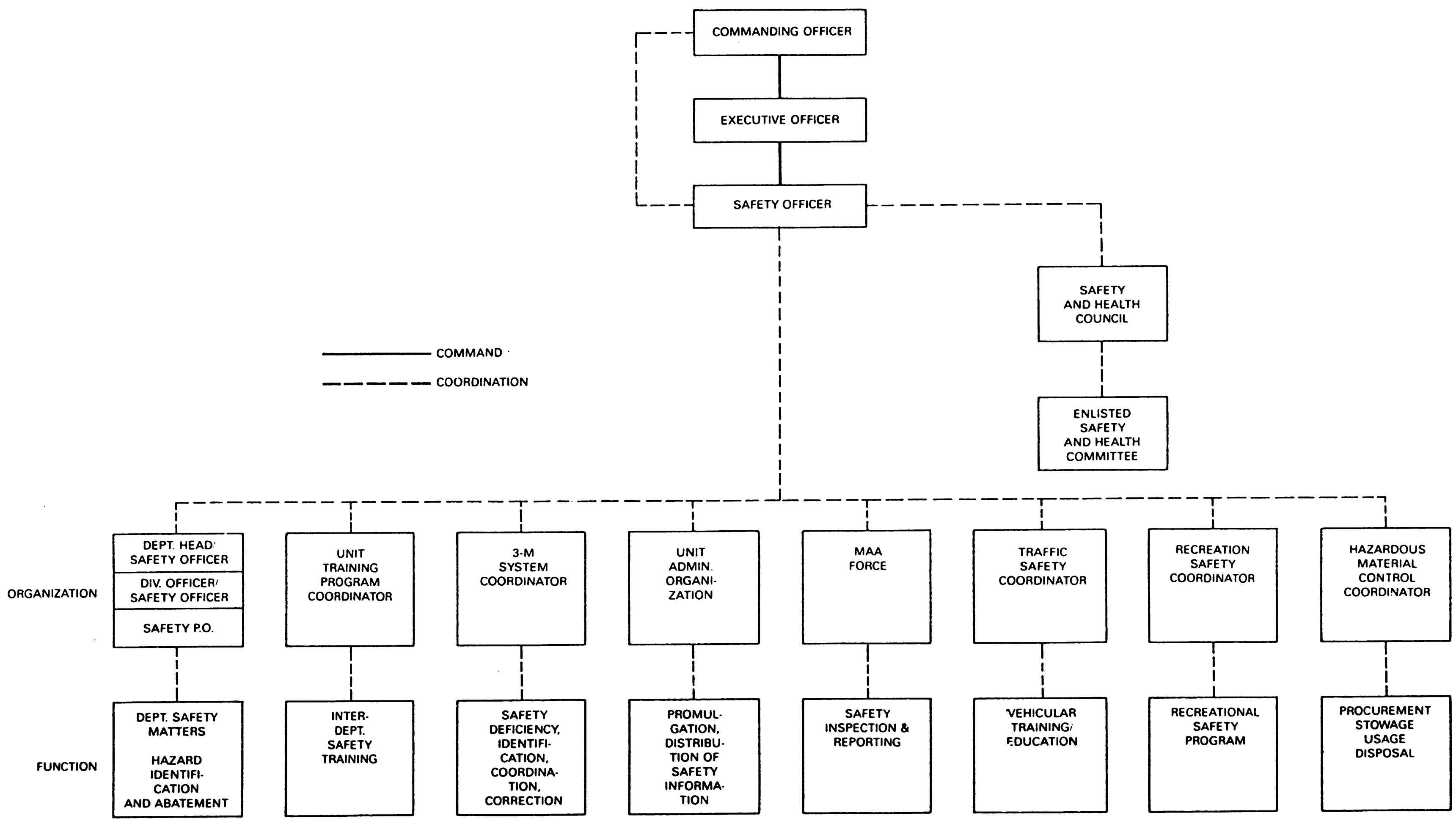


Figure 4-1.–Typical safety and health organization.

All personnel, even the "old salts," need to be reminded occasionally to work safely. Reports of senior electrical and electronics personnel involved in fatal accidents bear out this fact.

You can promote safety within the division in many ways; one method is the use of posters to serve as safety reminders. (Electrical safety posters are listed in the *EIMB, General*, NAVSEA SE000-00-EIM-100, and in NAVSUP 2002.) Safety posters should be changed or rotated regularly to draw attention to them. Posters that remain in one area for an extended period of time become a part of the bulkhead and lose their effectiveness. Warning signs are also listed in the same EIMB and should be part of every EMO's safety program.

The safety petty officer in the division can also help promote safety within the group by making periodic safety patrols or inspections. This procedure is helpful in two ways. First, it establishes control of the safety program; second, it makes members of the division mindful of the procedures necessary to ensure personnel safety. The SORM, OPNAVINST 3120.32, chapter 7, outlines the duties of the safety petty officer.

In addition, you should have occasional short group training discussions concerning electrical safety. These discussions may take place at any time without prior preparation. There may be a person in the group who has received a slight shock, and this experience can be the basis of the discussion. The person concerned should tell the exact circumstance that led up to the shock. The group then can discuss conditions under which the shock could have been more severe or perhaps fatal. The discussion may then be directed toward the prevention of such an occurrence. If possible, the source of the shock should be eliminated.

ENFORCING SAFETY

Many accident producing circumstances have already been recognized and anticipated in equipment instruction books, various safety manuals, and the ship's SORM. In totality they represent a program broadly based on safety precautions and safety regulations.

<u>Precautions</u> are measures that are directed at promoting awareness and favorably affecting attitudes. Precautions are basic to a safety program and may include the appropriate positioning of safety equipment, posting of warning signs, and the scheduling of safety discussions and demonstrations.

<u>SAFETY REGULATIONS</u> are enforceable precautionary measures designed to ensure the safety of the ship and its personnel during a specific activity. The EMO is held responsible and accountable for the safety of assigned personnel and equipment. The goal of safety is to prevent accidental injury or death, and to prevent damage to equipment.

SAFETY ORGANIZATION

To coordinate the overall shipboard effort in monitoring and evaluating the safety program, you must have a safety organization.

Figure 4-1 is an example of a safety organization taken from *Standard Organization and Regulations of the U.S. Navy*.

SAFETY OFFICER

The organization, under the supervision of the safety officer, will accomplish the following:

1. Monitor mishap prevention standards by investigation of all mishaps and near mishaps.
2. Evaluate the effectiveness of the safety program by analyzing internal and external reports.
3. Coordinate distribution of safety information including "lessons learned" from official and non-official sources.
4. Coordinate shipboard training in general mishap prevention, especially for newly reported personnel.
5. Ensure submission of occupational injury and illness reports to NAVSAFECEN.
6. Perform trend analysis of injury and illness data.
7. Followup on reports of unsafe and unhealthy conditions in accordance with *Navy Occupational Safety and Health (NAVOSH) Program Manual*, OPNAVINST 5100.23B.
8. Track corrective action on safety and health items.
9. Maintain liaison with other commands and NAVSAFECEN in matters of mishap prevention.
10. Coordinate traffic and motor vehicle safety training.

11. Coordinate recreational and off-duty safety training.

DIVISION SAFETY OFFICER

The EMO, while serving in the capacity of safety officer for his division, must:

1. Advise the department safety officer on the status of the unit's safety program within the division including any safety related item revealed through the 3-M system, such as the noncompliance with or deficiency in the Preventative Maintenance System (PMS). Also keep him advised of safety training needs within the division.
2. Be the divisional point of contact in coordinating and evaluating the unit's safety program.
3. Designate a senior petty officer, E-6 or above if available, as division safety petty officer
4. Investigate divisional mishaps and near mishaps and report unsafe or unhealthful conditions. Include recommendations to the department head for correction.
5. Ensure immediate action be taken to correct hazardous situations revealed by mishap and hazard reports, and/or inspections and on recommendations made in mishap/occupational/injury/illness reports.
6. Ensure that division personnel receive mishap prevention training.
7. Ensure that adequate and effective personal protective equipment is provided for and used by division personnel.

DIVISION SAFETY PETTY OFFICER

The division safety petty officer must:

1. Become thoroughly familiar with all safety directives and precautions concerning the division.
2. Conduct divisional mishap prevention training, and maintain appropriate recordkeeping in accordance with OPNAVINST 5100.23, 5102.1, and 5100.19.
3. Assist in mishap investigations as directed.
4. Recommend safety program improvements to the division officer.
5. Assist the division officer in his safety program implementation duties.
6. Provide technical advice on accident prevention within the division.
7. Serve on the enlisted safety committee.
8. Ensure that prescribed personal protective equipment is provided and used by division personnel.
9. Correct all safety hazards as noted on safety hazard reports.

Figure 4-2 is an example of a safety hazard report.

SUPERVISORS

Supervisors must be thoroughly familiar with the provisions outlined in applicable safety references. Supervisors have no authority to waive or alter safety regulations, nor are they to permit the violation of such safety regulations by others. They are to act immediately and positively to eliminate any potential safety hazards existing in operations under their jurisdiction. All supervisors must do the following:

1. Explain to all personnel under their immediate supervision the standard safety regulations, industrial hygiene safeguards, and precautions that must be followed. Supervisors must enforce these safety regulations.

2. Instruct and train personnel under their immediate supervision in the work that they are to perform. Whether instruction is given directly or through other experienced personnel, instructions will be provided until the supervisor is satisfied all personnel are capable of performing the work safely.

3. Ensure personnel are qualified and certified to perform the job assigned. They are to report promptly to their immediate superior all personnel who, in their opinion, are not qualified for their assigned work.

4. Investigate or assist in the investigation of all accidents involving operations, equipment, or personnel under their supervision. Report or assist in the preparation of the report on the investigation's results.

5. Identify all persons in their charge who enter or approach a RADHAZ unsafe area and determine their authority to enter and/or remain in the area. They are to exercise their authority to eject any person whose presence and/or actions are, in their opinion, detrimental to safety.

SAFETY HAZARD REPORT

1. ID NO.

A. SAFETY OFFICER SECTION

2. ISSUED BY	3 ISSUED TO
4 HAZARD NOTED — a. DATE / b TIME	5. RISK ASSESSMENT CODE (*See explanation on back before completing*)
6. LOCATION OF HAZARD	7. NATURE OF HAZARD

B. DIVISION OFFICER SECTION

1. CORRECTIVE ACTION TAKEN

2. INTERIM CORRECTIVE MEASURES

4. NAME, RANK AND TITLE	5. SIGNATURE	6. DATE FORWARDED

C. DEPARTMENT HEAD SECTION

1. ACTION TAKEN	2. EXPLANATION OF ADDITIONAL ACTION TAKEN / REQUIRED
☐ CORRECTIVE ACTION TAKEN IN ITEM B1 ADEQUATE ☐ ADDITIONAL ACTION TAKEN / REQUIRED (GIVE EXPLANATION IN C2)	

4. NAME, RANK AND TITLE	5. SIGNATURE	6. DATE FORWARDED

D. RECORD SECTION

1. INITIALS INDICATE ACTION TAKEN IN SECTIONS A, B AND C

TITLE	INITIALS	DATE
SAFETY OFFICER		
EXECUTIVE OFFICER		
COMMANDING OFFICER		

2. IS CSMP ENTRY REQUIRED?

☐ YES ☐ NO

3. IF YES, GIVE NAME OF SHIP BELOW:

USN ______________________

Figure 4-2.–Safety hazard report.

A. Risk Assessment. Each identified/validated hazard shall be assigned a Risk Assessment Code (RAC) by the activity safety office. The RAC represents the degree of risk associated with the deficiency and combines the elements of hazard severity and mishap probability. The RAC is derived as follows:

1. Hazard Severity. The hazard severity is an assessment of the worst potential consequence, defined by degree of injury, occupational illness or property damage which is likely to occur as a result of a deficiency. Hazard severity categories shall be assigned by Roman numeral according to the following criteria.

(a) Category I - Catastrophic: The hazard may cause death, or loss of a facility.

(b) Category II - Critical: May cause severe injury, severe occupational illness, or major property damage.

(c) Category III - Marginal: May cause minor injury, minor occupational illness, or minor property damage.

(d) Category IV - Negligible: Probably would not affect personnel safety or health, but is nevertheless in violation of a NAVOSH standard.

2. Mishap Probability. The mishap probability is the probability that a hazard will result in a mishap, based on an assessment of such factors as location, exposure in terms of cycles or hours of operation, and affected population. Mishap probability shall be assigned an Arabic letter according to the following criteria:

(a) Subcategory A - Likely to occur immediately or within a short period of time.

(b) Subcategory B - Probably will occur in time.

(c) Subcategory C - May occur in time.

(d) Subcategory D - Unlikely to occur.

3. Risk Assessment Code (RAC). The RAC is an expression of risk which combines the elements of hazard severity and mishap probability. Using the matrix shown below, the RAC is expressed as a single Arabic number that can be used to help determine hazard abatement priorities.

HAZARD SEVERITY	MISHAP PROBABILITY			
	A	B	C	D
Category I	1	1	2	3
Category II	1	2	3	4
Category III	2	3	4	5
Category IV	3	4	5	5

RAC
1 - Critical
2 - Serious
3 - Moderate
4 - Minor
5 - Negligible

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Figure 4-2.–Safety hazard report–Continued.

6. Forbid any major repairs or modification to any transmitting equipment or ordnance, except in accordance with the specific instructions of the commanding officer.

7. Enforce observance of the safety regulations concerning the protective clothing and equipment of personnel.

8. Report in writing to the commanding officer any requests, suggestions, and comments received regarding safety standards.

In some cases, doing a job the safe way may take a little longer or may be a little less convenient; however, the importance of doing all work in accordance with applicable safety precautions cannot be overemphasized.

SAFETY REQUIREMENTS IN WORK AREAS

Safety requirements concerning the various shop and work areas aboard ship are prescribed by the *Safety Precautions for Forces Afloat*, OPNAVINST 5100.19; *Naval Ships' Technical Manual*, chapters 300, 313, 400 and 634; the *EIMB, General*, NAVSEA SE000-00-EIM-100, and other instructions. Table 4-2 provides a

Table 4-2.–Stock Number Quick Reference List for Safety Items

STOCK NUMBER QUICK REFERENCE LIST

The following is a quick ready reference for your use when searching for NSN's of various signs, placards, etc.

SIGNS & PLACARDS

Danger High Voltage 7 1/2" × 5 3/4"	110177-LF-225-2100
Danger High Voltage 8" × 4"	110177-LF-225-6700
Danger High Voltage 4 " × 2 1/2"	110177-LF-225-3100
Electrical Safety Precautions 10 1/2" × 16"	110177-LF-225-1100
Electrical Safety Precautions 10 1/2" × 16"	110177-LF-211-8500
Electrical Safety , Radio Room 8" × 10 1/2"	110177-LF-214-3100
Unauthorized Alterations, Electronics	110177-LF-214-3200
Radio Room Safety Precautions When Going Aloft	110177-LF-214-3300
CIC Equipment Readiness Check	110177-LF-214-0000
Danger Smoke Pipe Gases, Precautions	110177-LF-226-2900
Caution, Radioactive Tube Types	110177-LF-213-9600
Radioactive Tubes, Electron	110177-LF-213-9700
Keep Out, Unauthorized Personnel	110177-LF-225-1600
Restricted Area, Keep Out	110177-LF-226-4100
Rescue Breathing	110177-LF-226-3400
No Smoking	110177-LF-221-6300
Watch Quarter and Station Bill	110177-LF-223-5500
Multiple Source Signs	110166-LF-047-0145

RF RADHAZ WARNING SIGNS

Due to Pending Changes In These Signs, Stock Numbers Are Not Yet Available. To Get Current Information On RADHAZ Signs Consult NAVSEA STD 407-5291780( ) Which Is Available At MOTUs and SIMAs. Additionally, MOTUs Stock RADHAZ Signs For Distribution.

VARIOUS FORMS

Safety Check Tag (NAVSEAFORM 5100/5)	110116-LF-051-0025
Danger Tag (NAVSHIPSFORM 9890/5)	110105-LF-641-6001
Caution Tag (NAVSHIPSFORM 9890/8)	110105-LF-641-3001
Tagout Sheet (NAVSEAFORM 9210/9)	110116-LF-092-1046

Table 4-2.–Stock Number Quick Reference List for Safety Items–Continued

HARD TO FIND ITEMS

Shorting Probe (25KV)	5920-01-029-4176
Gloves, Class "3", Heavy Duty	
Size 10	8415-00-266-8691
Size 11	8415-00-266-8692
Voltage Tester, Electric	6625-00-132-1196
Working Lanyard	4240-00-022-2518
Safety Lanyard	4240-00-022-2521
Safety Harness	4240-00-022-2522
Safety Climbing Sleeve Assembly	4240-01-042-9688
SALA Fall Prevention Device	1680-00-229-0853
SCOTCHRAP #51 Seaming Tape	7510-00-550-6498

GLOVES, ELECTRICAL WORKERS

In accordance with OPNAVINST 3100.23B, Chapter 20, the Navy has adopted the ASTM (American Society for Testing and Materials) Standard D120. New gloves have different voltage ratings for the classes and a corresponding color code.

Each glove shall be marked with a label and be the color specified for each voltage class: Class 0–red, Class 1–white, Class 2–yellow, Class 3–green and Class 4–orange. The voltage rating of the gloves is as follows:

Class	Max. use of voltage AC
0	1,000
1	7,500
2+	17,000
3	26,500
4*	36,000

These gloves are availabe through the supply system under the following stock numbers:

NSN	Size	Sleeve	Class	Voltage
01-158-9453	9	10.5	0	1,000
01-158-9454	9 1/2	10.5	0	1,000
01-158-9455	10	10.5	0	1,000
01-158-9456	10 1/2	10.5	0	1,000
01-158-9457	11	10.5	0	1,000
01-158-9458	11 1/2	10.5	0	1,000
01-158-9459	12	10.5	0	1,000
01-158-9449	9	14	1	7,500
01-158-9450	10	14	1	7,500
01-158-9451	11	14	1	7,500
01-158-9452	12	14	1	7,500
01-158-9446	9	14	2	17,000
01-158-9447	10	14	2	17,000
01-158-9448	11	14	2	17,000
01-158-9445	9	18	3	26,500

*There is presently no Class-4 glove available in the Naval Supply System.
+TRE/DMSR Evaluators require Class 2 Gloves.

stock number quick reference list for various safety signs, placards, forms, and so on. Be sure that you consult NAVSUP P2002 to ensure current stock numbers.

Safety, from the viewpoint of electronics personnel, requires full appreciation of the various factors and hazards involved. Adequate safety measures such as the use of suitable enclosures, provisions for grounding, protective interlocks, etc., are required in the manufacture of electronic equipment. Electronics spaces and work areas require additional protective features. The remainder of this chapter contains general guidelines concerning electronic related spaces and programs. First, we have a brief listing of safety requirement, which is further expanded later for some of the areas. Ensure that you consult the appropriate references for specific details and up-to-date information.

INSIDE WORK AREAS

The following rules should be observed for all inside work areas:

1. The work area will be equipped with authorized safety shorting probes in all electronic spaces.

2. Radioactive tubes are to be properly identified and stowed.

3. Warning signs and posters concerning high voltage, safety precautions, operating instructions, rescue breathing signs, radio frequency radiation hazards, etc., are to be posted in or near all spaces where electronic equipments are installed or repaired.

4. Operational voice communications between all electronic spaces is required for emergency communications: X6J, 22 MC, or J-dial.

5. Emergency lighting must be adequate.

6. Rubber gloves capable of insulating against voltages up to 17,000 volts must be readily available to electronics personnel. The rubber gloves must be tested in accordance with current PMS procedures.

7. Portable CO_2 fire extinguisher must be readily available.

8. Equipment having multiple source voltages must be labeled with a multiple source warning label. A switch to disconnect equipment from its sources of power and synchro voltages is also required.

9. Portable electrical equipment and power tools must be grounded through the use of an approved three-prong plug, or must be double insulated.

10. Spaces are not to be used for unauthorized stowage.

11. All personally owned electrical/electronic equipment shall be inspected and tagged before its use aboard ship by cognizant electrical/electronic shop personnel and reinspected at prescribed intervals for continued use aboard ship in accordance with ship's instructions.

12. Ship's electrical circuit tag-out procedures shall have strict adherence and be enforced at all times. Under no circumstances will equipments or switches be operated or moved when tagged with a DANGER tag (red in color). A CAUTION tag (yellow in color) will be used to provide temporary special instructions. Tag-out must be in accordance with OPNAVINST 3120.32.

13. When working on or in close proximity to live circuits, you should use only one hand.

14. Hazardous materials must be properly stowed, used, and disposed of.

OUTSIDE WORK AREAS

Outside work areas should ensure the following rules are adhered to:

1. Warning Signs–Required signs (such as DANGER STACK GAS, WARNING RF RADIATION HAZARD, and DANGER HIGH VOLTAGE) are properly posted.

2. Antenna Shields/Cages–Shields/cages are properly constructed and installed to meet requirements.

3. Antenna Disconnect Switches–Installed on all antennas as required.

4. Wire Antennas–They are properly constructed and installed, meeting all safety requirements.

5. Deck Covering–The proper installation of nonskid that meets the requirements for outside work areas.

6. Handrails, Grab Rods, and Ladders–Both installation and bonding meet safety requirements.

7. Safety Harness–A proper safety harness must be available for working aloft or over the side.

8. Saf-T-Climb Fall Prevention System–Ensure that the system is properly installed, bonded, and that correct materials were used.

9. Man Aloft Procedures–Must be followed by personnel when working aloft.

10. RADHAZ & HERO–Radiation hazards must be recognized by personnel and steps taken to correct hazardous situations.

11. Bonding–Will be in accordance with MIL-STD-1310.

RADIOACTIVE TUBES AND SPILL KITS

The hazardous materials information system (HMIS) contains a listing of radioactive tubes along with proper stowage techniques and disposal procedures. NAVSUP P-485 contains detailed custody procedures. Use proper procedures for disposal. Federal and state regulations vary.

RADIOACTIVE SPILL KITS

If an electron tube containing radioactive material is broken, follow the basic procedures for cleaning the area covered in the EIMB, *General*, Section 3. A radioactive spill kit with all the materials to clean the area quickly and properly is required. The ship must have at least one radioactive spill disposal kit for its electronic spaces. More may be needed depending on the number and location of these spaces in which radioactive tubes are used or stored. Each kit should contain the following items:

1. Container–Must be large enough to hold all clean-up materials and pieces of broken radioactive tubes and must be airtight. A three-pound coffee can with a plastic lid or 30/50 caliber ammo box will serve as a suitable container. The container shall be clearly marked "RADIOACTIVE SPILL DISPOSAL KIT."

2. Rubber gloves–Two pairs of surgical latex gloves to prevent contact with contaminated material.

3. Forceps or hemostats–Used for picking up large pieces.

4. Masking tape–One roll of 2-inch-wide tape for picking up small pieces.

5. Gauze pads or rags–One stack of 4-inch gauze pads (50 pads or more) for wiping down the area. **Sponges are NOT to be used.**

6. Container of water–A small container of water (approximately 2 ounces) in an unbreakable container, for wetting the gauze pads or rags.

7. Boundary rope and appropriate signs–Used for marking the contaminated area.

8. Dust masks–Disposable dust masks for protection from inhalation of dust.

9. Radioactive material stickers–For labeling the material to be disposed of. (These can be locally manufactured).

10. 2 - 12-inch plastic bags–For containing the used material.

11. Procedures–Step-by-step clean-up procedures to be followed should be included in each radioactive tube disposal kit.

12. Other items as recommended by type commander and the fleet training group.

All equipment containing radioactive tubes must have a standard warning label attached where it would be noted upon entry to the equipment for maintenance.

REFERENCES TO CONSULT CONCERNING RADIOACTIVE TUBES:

- *Department of Defense Hazardous Materials Information System (HMIS)*, DOD 6050.1-L
- *Radiation Health and Protection Manual*, NAVMED P-5055
- *Afloat Supply Procedures*, NAVSUP P-485
- *EIMB, General*
- *EIMB Radiac*
- *Safety Precautions for Forces Afloat*
- *Naval Ships' Technical Manual*, Chapter 400

TECHNICAL ASSISTANCE

For technical assistance and advice regrading identification, stowage, or disposal of radioactive tubes, contact:

Officer In Charge

Naval Sea Systems Command Detachment

Radiological Affairs Support Officer

(NAVSEADET, RASO)

Naval Weapons Station

Yorktown, VA 23691-5098

RUBBER MATTING AND SHEETING

To eliminate likely causes of accidents and to afford maximum protection to personnel from the hazards associated with electric shock, only the approved floor matting for electric and electronic spaces shall be used. In many instances, after accidents have occurred, investigations showed the operating locations and areas around electric and electronic equipment were covered with only general-purpose floor matting. This type of matting should not be used because its electrical characteristics do not provide adequate insulating properties to protect personnel from the possibility of electric shock; also, the material is not fire-retardant.

For the protection of personnel, when engaged in work on electric and electronic equipment, steps should be taken to ensure that only the approved rubber floor matting currently specified in military specification MIL-M-15562 is used. The approved matting is made of fire-retardant material. Use of this matting will serve as a safety measure around electric and electronic equipments where electrical potentials up to but not exceeding 3000 volts may be encountered. Section 3 of the *Naval Ships' Technical Manual*, Chapter 634, contains information on the preparation, installation, and cleaning of rubber matting.

MATTING AND SHEETING MAINTENANCE

The careful design and fabrication of the floor matting material minimizes the possibility of accidents. However, to ensure that the safety factors which were incorporated in the manufacture of the material are effective, and that the matting is completely safe for use, operation and maintenance personnel must make certain that all foreign substances that could possibly contaminate or impair the dielectric properties of the matting material are promptly removed from its surface. For this reason, scheduled periodic visual inspections and cleaning are a necessity. During visual inspections, personnel should make certain that the dielectric properties of the matting have not been impaired or destroyed by oil impregnation, piercing by metal chips, cracking, or other causes. If it is apparent that a section or an entire length of matting is defective for any reason, it should be removed and replaced immediately by new matting material. Table 4-3 is provided to assist you in locating stock numbers for various approved matting and sheeting.

Table 4-3.–Types of Matting

Electrical grade (dielectric) sheet, MIL-M-15562, Type I	
Green marbleized, synthetic rubber	NSN-9Q7220-01-025-1695
Beige marbleized, polyvinyl chloride	NSN-9Q7220-01-024-9039
Blue marbleized, polyvinyl chloride	NSN-9Q7220-01-024-9040
Terra cotta marbleized, synthetic rubber	NSN-9Q7220-01-024-9041
Blue marbleized, synthetic rubber	NSN-9Q7220-01-106-0450
Beige marbleized, synthetic rubber	NSN-9Q7220-01-106-0451
Portable mat, MIL-M-15562, Type II, smooth surface	
Solid or marbleized blue	NSN-9Q7220-01-267-4630
Solid or marbleized green	NSN-9Q7220-01-913-8751
Solid black	NSN-9Q7220-01-255-0765
Diamond tread pattern	
Green diamond tread	NSN-9Q7220-01-056-1944
Gray diamond tread	NSN-9Q7220-01-057-1897

REQUIRED LOCATIONS

Required Locations of Electrical Grade Sheeting or Matting are listed in *NAVSHIPS' Technical Manual*, chapter 634, table 634-1. However, if the compartment is basically electrical, install electrical grade sheet (Type I) throughout the entire space.

In addition to table 634-1, the following are guidelines where electrical grade insulating deck coverings are to be installed:

1. Operating areas in the front and rear of propulsion control cubicles, power and lighting switchboards, test switchboards, interior communications switchboards, fire-control switchboards, and shipboard announcing system amplifiers and control panels.
2. The area around electronic equipment where personnel who are tuning, operating or servicing energized equipment may come in contact with a voltage potential.
3. The area around workbenches in electrical and electronics shops where electrical or electronic equipments are tested and/or repaired.
4. The area around access plates and portable plates.

INSTALLATION OF ELECTRICAL GRADE MATTING

The two ways of covering a deck to prevent hazardous electrical shock are as follows:

1. Cover the deck with an approved deck material specified for the space, such as deck tile and an electrical insulating portable or runner type deck matting around the electrical hazard areas.

2. Install an electrical grade sheet by cementing it over the entire deck. This can be accomplished by submitting a 2-kilo to RSG requesting the Type I or III electrical grade sheeting be installed in accordance with NSTM 634.

Deck Preparation

Second only to maintaining matting or sheeting is the proper preparation of the deck for the installation of the covering. *NAVSHIPS Technical Manual*, Chapter 634, contains instruction on the preparation of the deck surface for cementing Type I or III electrical grade sheeting for permanent installation.

For portable installations, the mat should be installed over the minimum area necessary to prevent electric shock, but not less than 3 feet wide. There must be an outline of the perimeter of the portable matting stenciled on the deck. Inside this stenciled perimeter, the "ELECTRICAL GRADE MATTING REQUIRED WITHIN MARKED LINES" must also be stenciled with 3/4-inch or larger size letters. All exposed corners of matting shall be rounded.

Seams

- Electrical insulating deck material should be installed so that there are no seams within three (3) feet of an electrical hazard. If this in not possible to accomplish, do the following:
- Seams should be fused chemically or heat welded with a special hot air gun
- Where it is not practical to heat weld or chemically seal the seams due to matting being installed over false decking, seams should be sealed with a 6-inch strip of polyvinyl chloride (PVC) tape.

WORKING ALOFT

No person may go aloft on masts, stacks, or kingposts without first obtaining permission from the officer of the deck (OOD) in accordance with OPNAVINST 5100.19. Before granting permission, the OOD must ensure that the Working Aloft Check Sheet (fig. 4-3) has been properly routed and completed. When the ship is underway, the commanding officer's permission is required to work aloft. The OOD will ensure appropriate signal flags are hoisted. (KILO for personnel working aloft; KILO THREE for personnel working aloft and over the side.) Prior to commencement of work and every 15 minutes thereafter, he will have the word passed over the 1 MC, "DO NOT ROTATE OR RADIATE ANY ELECTRICAL OR ELECTRONIC EQUIPMENT WHILE PERSONNEL ARE WORKING ALOFT." Additionally the OOD will inform ships in the vicinity that personnel will be working aloft to ensure they take appropriate action on operation of their electrical and electronic equipment. Departments concerned shall ensure that all radio transmitters and radars that pose radiation hazards are placed in the STANDBY position and a sign placed on the equipment that reads: SECURED. PERSONNEL ALOFT. DATE ____ TIME _____ INITIALS _____.

WORKING ALOFT CHECK SHEET

USS ______________________ Time/Date ____________

1. Personnel will be going aloft at (location) _____________ for accomplishing the following work ____________

____

2. Prior to allowing personnel to go aloft, accomplish the following:

Initials

_______ a. If underway, obtain the commanding officer's permission.

_______ b. DANGER tag-out all rotating equipment, such as radar antennas, in the vicinity of the work area.

_______ c. Place a sign on all HF, MF, and LF transmitters and all radars whose danger zone encompasses the work area. The sign should read:

SECURED. PERSONNEL ALOFT
DATE ___________ TIME ___________ INITIALS ___________

_______ d. Ensure personnel going aloft are wearing a parachute type safety harness with a Dyna-Brake® safety lanyard, working lanyard, and climber safety device (if a climber safety tail is installed). Ensure that PMS has been accomplished on all equipment prior to use.

_______ e. Notify the engineering officer of the watch/engineering duty officer to ensure that safety valves are lifted only in an emergncy when personnel are aloft (main control should notify the officer of the deck of an impending emergency as soon as possible to permit warning of personnel aloft).

_______ f. If work is to be accomplished on or in the vicinity of the whistle, secure power to the whistle (steam, air, electricity) and DANGER tag-out.

_______ g. Ensure that personnel are briefed on safety prior to going aloft. This should include, as a minimum, keeping the lanyard attached with a minimum of slack to a fixed structure at all times; changing the lanyard connection point as work progresses; keeping good footing and grasp at all times.

_______ h. Ensure all tools are attached to personnel with preventer lines; or, if passed up, have lanyards attached which are firmly secured before removal from the bucket.

_______ i. Ensure that assistance is provided to keep areas below the working area clear and for passing tools or performing rigging.

_______ j. Ensure that personnel working in the vicinity of stacks, or other areas where they may be subject to exhaust fumes, are wearing proper respiratory protection equipment.

_______ k. Do not permit work aloft, except in an emergency, if wind speed is greater than 30 knots, roll is in excess of 10°, pitch is in excess of 6°, or if ice or thunder storms threaten.

_______ l. If in port, notify officers of the deck/command duty officers of adjacent ship(s) to ensure that high-powered radio and radar transmitters will not be energized and endanger personnel going aloft.

_______ m. Fly the KILO or KILO THREE flag, as appropriate, if in port.

_______ n. Prior to personnel going aloft, have the following passed over the 1MC: "DO NOT ROTATE OR RADIATE ANY ELECTRICAL OR ELECTRONIC EQUIPMENT WHILE PERSONNEL ARE WORKING ALOFT".

_______ o. If a crane is used to suspend personnel, ensure that the crane has a current certification and the work platform is approved by NAVSEA for handling personnel.

3. Conditions have been established to permit personnel working aloft.

____
Command Duty Officer/Officer of the Deck/Time

Working Aloft Commenced ______________
Working Aloft Completed ______________

Note: Initials certify completion of an item. If an item is not applicable, indicate "NA" on initial line.

Figure 4-3.–Example of Working Aloft Check Sheet.

Since many areas on the exterior of a ship are inaccessible to the crew from decks or built-in work platforms, it becomes necessary to go aloft to reach these areas. "Aloft" shall be defined as any mast, kingpost, or other structure where the potential for a fall exists. Probably the greatest hazard associated with working aloft is the danger of a fall. Other hazards include the dropping of objects, radiation burns, and asphyxiation.

Most ships in today's Navy are aviation capable. It is imperative that ship's crews be educated on the importance of foreign object damage (FOD) control. EMOs must ensure assigned personnel who work on the mast and other topside areas receive training on the importance of controlling FOD. After completing any work topside, technicians must ensure that all tools and materials are removed from the work area. Any tools or materials left topside may cause damage to aircraft or injury to personnel. Metallic items left in these areas may also create electromagnetic interference problems.

When working aloft follow these listed steps:

1. Use a climber sleeve assembly in conjunction with the safety harness where a climber safety rail is installed.

2. Attach safety lanyards to all tools, if practicable. Never carry tools up and down ladders. Rig a line and raise/lower tools in a container.

3. Stop work when the ship begins to roll in excess of 10 degrees, or to pitch in excess of 6 degrees, when windspeed is greater than 30 knots, and when an ice storm/lightning threatens.

4. The petty officer-in-charge shall mark off an area below the zone of work and keep all unnecessary personnel clear. If the slightest chance of collision exists, personnel shall be moved to safety.

5. Read any safety placards posted in the area prior to commencing work.

6. Wear respirators when working near stacks or exhaust.

7. When performing hot work, replace personal safety and staging/boatswain (bosun) chair fiber lines with wire rope. Personal safety lines shall be CRESS wire rope.

SAFETY CLIMB EQUIPMENT/RAILS

Wear a parachute type safety harness with a safety lanyard, working lanyard, and tending line (as required) with double locking snap hooks. The harness shall be inspected in accordance with established PMS prior to use.

In accordance with *General Specifications for Navy Ships*, Section 622, a climber safety rail shall be installed at each permanently installed topside ladder on masts, kingposts, and other similar topside structure that provides access to a fall-hazardous location at which a person is expected to wear a safety harness. Climber safety rails shall be installed in accordance with NAVSHIPS drawing 80064-804-4563125, Rev. C, and bonded in accordance with MIL-STD-1310. Where safety rails are installed, and where a climber must transfer from one ladder to another, or from a ladder to a platform, padeyes shall be provided at those locations to enable the climber to make a transfer while tethered at all times to either a padeye or the climber safety rail.

The safety harness assembly consists of the following components:

1. Safety harness with lanyards
   (NSN-9G4240-00-402-4514)

2. Working lanyard nylon
   (NSN-9G4240-00-022-2518)

3. Safety lanyard with dynabrake
   (NSN-9G4240-00-022-2521)

4. Safety harness
   (NSN-9G4240-00-022-2522)

5. Safety climbing sleeve
   (NSN-9G4240-01-042-9688)

Additionally, NAVSHIPS drawing 80064-804-4563125, Rev. C, states that all climber safety rails must be made of CRESS steel. For information on parts availability, contact your local MOTU, RSG, SIMA, or Naval Safety Center Detachment.

Where rigid-rail type installation is not practical (i.e., for ladders less than 12-inches wide or peg-rung ladders on pole masts), a retractable-wire type installation is to be used. The SALA fall prevention device is the only authorized retractable wire type fall prevention device available through the national stock system. The NSN for the SALA fall prevention device is 9V1680-00-229-0853. This device itself presents hazards and must be bonded in accordance with MIL-STD-1310.

SHORTING PROBES

It is of the utmost importance that technical and maintenance personnel, who engage in repairs of

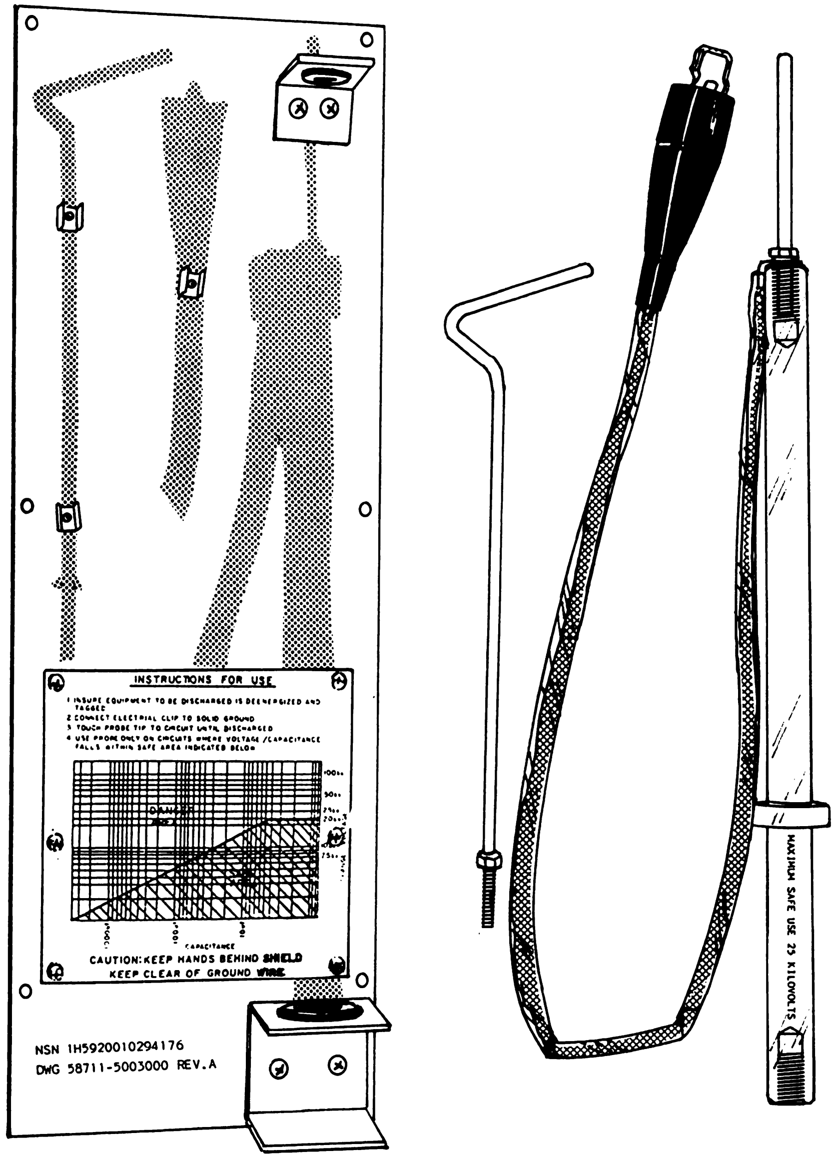


Figure 4-4.–Shorting Probe and Holder Assembly.

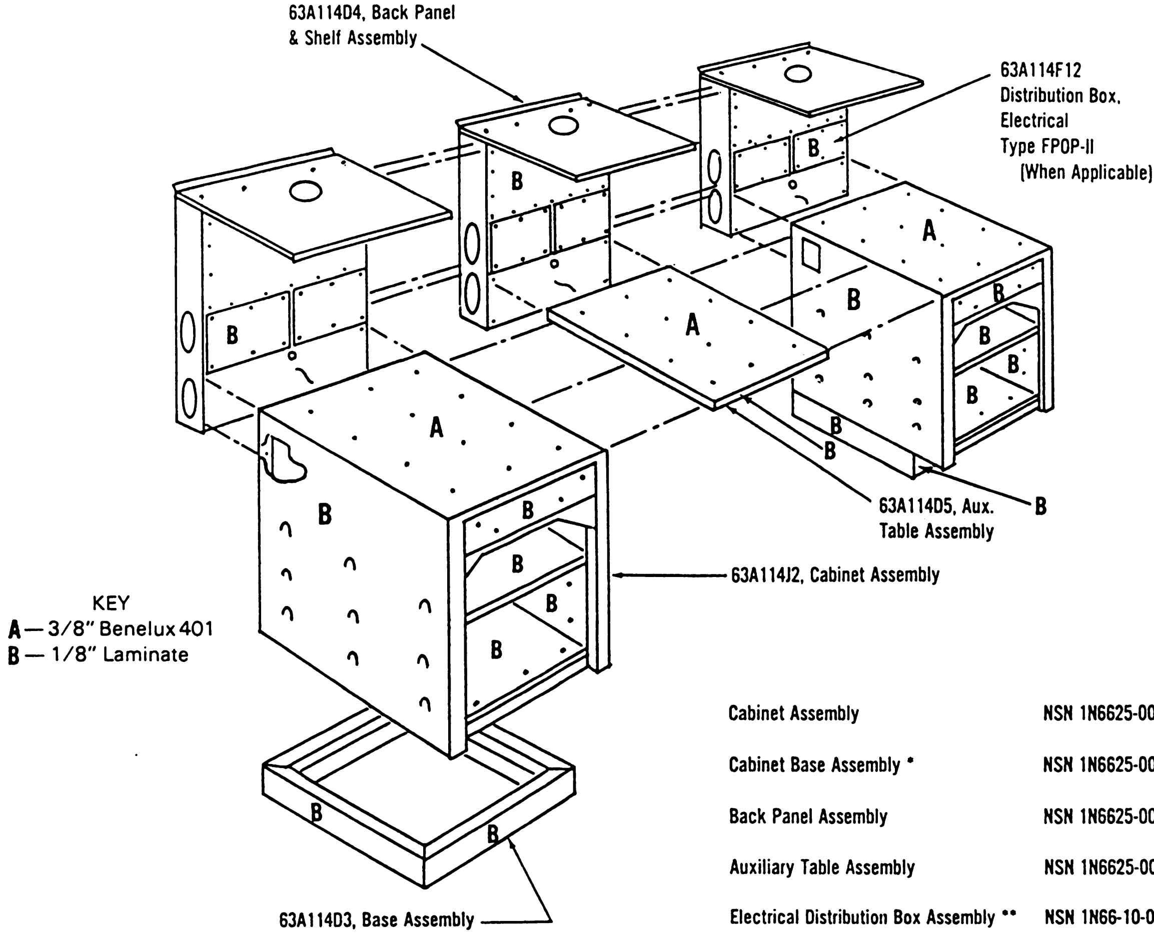
circuits which employ large capacitors, pulse forming networks, and the like, use only an authorized safety shorting probe to discharge the circuits.

The only type of shorting probe that is approved is rated for use to 25,000 volts. Figure 4-4 illustrates the approved shorting probe with its mounting assembly NAVSEA Drawing 58711-5003000, Rev. A, NSN9G-5975-01-029-4176.

Because of the possible misuse of the threads in the hand-hold section of the probe, NAVSEA has recommended that a #20 nylon screw be installed in the hand-hold end helicoil thread insert (EIB 932). Additionally the head of this screw must be cut off after installation to prohibit removal.

An inspection of the shorting probe should be made before each use. The grounding clip should be soldered to the ground cable. A crimped joint can come loose, and because it is held in place by the rubber boot clip, will appear to give a good ground while it is really not discharging residual voltages.

When using the general-purpose safety shorting probe, always be sure first to connect the grounding clip to a good ground connection. If necessary, scrape the paint off the grounding metal to make a good contact. Then, while holding the safety shorting probe by the handle behind the protective shield, touch the end of the metal rod to the point to be shorted-out. Touch each point to be shorted-out several times to make sure that the circuit is completely discharged.



Cabinet Assembly	NSN 1N6625-00-851-2156
Cabinet Base Assembly *	NSN 1N6625-00-851-2157
Back Panel Assembly	NSN 1N6625-00-851-2158
Auxiliary Table Assembly	NSN 1N6625-00-851-2159
Electrical Distribution Box Assembly **	NSN 1N66-10-00-839-8026

* Not part of old design and optional for use with new cabinet assembly. Provides 4" elevation and toe space. Required for shore base installations only.

** Optional with shipboard installations.

Figure 4-5.–Authorized electrical and electronic workbench.

Always be extremely careful and make absolutely sure that you do not touch any of the metal parts of the safety shorting probe while touching the probe to an exposed "hot" terminal. It pays to be safe; use the safety shorting probe with care.

Certain electronic equipments are provided with built-in special-purpose safety shorting probes. These probes are not considered "general-purpose," and are to be used only with the equipment with which they are provided and only in a manner as directed by the technical manuals for the equipment. THEY SHALL NOT BE REMOVED AND USED ELSEWHERE.

RUBBER GLOVES

Whenever it is necessary to work with portable electric tools or equipment in damp locations, or when it is necessary to work on live electrical circuits or equipment, electrical grade insulating rubber gloves shall be worn.

Leather gloves shall be worn over electrical grade rubber gloves whenever the rubber gloves could be subjected to being cut by sharp or abrasive objects.

Rubber insulating gloves shall be stowed in the box in which they came. Preventive maintenance as set forth in the Planned Maintenance System (PMS) shall be performed on the gloves prior to stowage. Avoid folding the gloves frequently. This results in cracks that will greatly reduce the insulating capability. Table 4-2 lists the classes and stock numbers of electrical grade rubber gloves.

WORKBENCHES

For the safety of electronics personnel and for standardization, *General Specifications for Navy Ships*, section 665, states the only authorized workbench for repair of electrical/electronic equipment in electrical/electronic work spaces is the one shown in NAVAIR Drawing 63-A-114J, illustrated in figure 4-5.

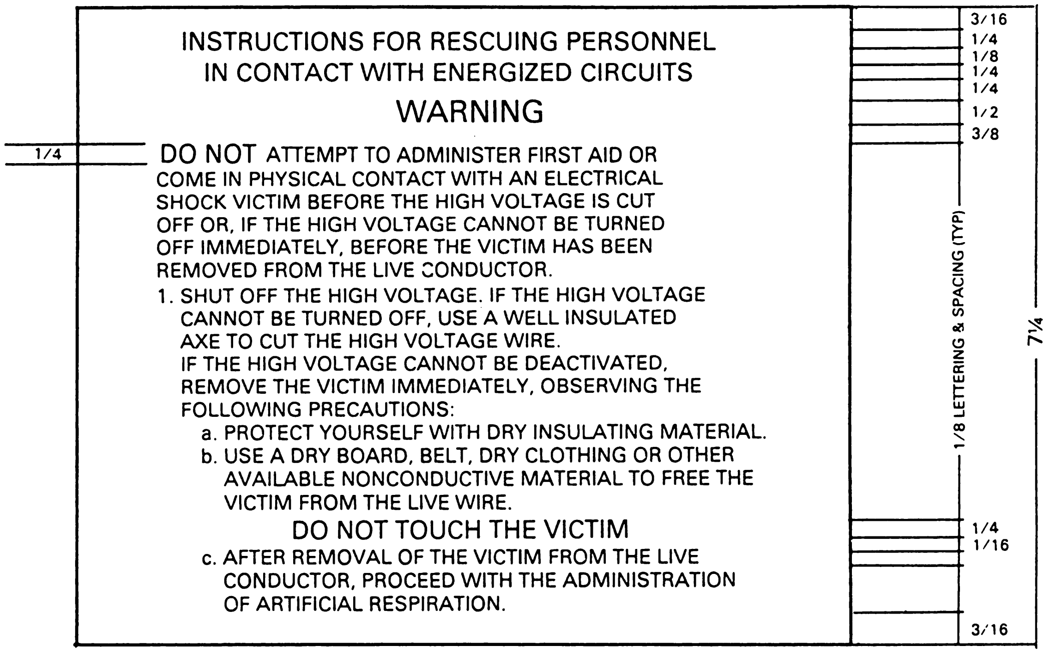


Figure 4-6.–Sign showing method of rescuing personnel in contact with energized circuits.

Insulating Requirements

– General Specifications for Navy Ships requires the top and front of electrical/electronic workbenches to be insulated with 3/8 inch approved high-pressure laminate.

– Kneeholes and all other exposed metal areas require insulation with 1/8 inch high-pressure laminate.

– The deck surrounding the workbench must be insulated with electrical grade matting in accordance with NSTM chapter 634.

To further reduce the chance of electric shock:

1. Bond and ground the workbench in accordance with MIL-STD-1310.

2. Install a grounding bus for maintenance grounding.

3. Post a warning sign above the workbench that reads:

-DANGER-
ELECTRIC SHOCK
DO NOT TOUCH ENERGIZED CIRCUITS

4. Install a disconnect switch to secure power to the workbench in the case of electric shock. Installation should be in accordance with general specifications for Navy ships. The disconnect switch should be installed within the same compartment but in an area away from the workbench. Additionally it must be labeled as the workbench disconnect switch.

5. A sign detailing an approved method of rescuing personnel in contact with energized circuits must also be posted. This sign should be locally produced in accordance with figure 4-6.

References to consult concerning workbench safety:

– NAVAIR Drawing 63-A-114J

– *Fathom* Magazine, AAAVAC Safety Center, Spring 88 issue

– *Shipboard Bonding Grounding and Other Techniques for Electromagnetic Compatibility and Safety*, MIL-STD-1310

– *General Specifications for Navy Ships*

– *Test Equipment Stowage Guide, ST000-AB-GDY-010/GPETE*

– *Electronic Information Bulletin, 015*

PERSONAL ELECTRICAl/ELECTRONIC EQUIPMENT

One of the items in both the Electrical and Combat Systems sections of the *U.S. Naval Safety Center Ship Safety Review Guide* asks the question, "Are all

PERSONAL ELECTRIC/ELECTRONIC EQUIPMENT REQUEST

____
Date

From: ____________________ (Name/Rate)

To: ____________________ Division Officer

Via: Electrical Officer/Electronics Material Officer

1. I request permission to have on board the following personally owned electrical equipment. If approved, I understand I am to keep it in good physical condition and must have it reinspected each six month period and when damaged.

Equipment ____________________ Model ____________________

Make ____________________ Serial No. ____________________

Signature ____________________

First Endorsement

____
Date

From: Electrical Officer/Electronics Material Officer

To: ____________________ Division Officer

1. The above listed equipment has been inspected, meets the minimum safety requirements for shipboard use, has been tagged, and has been entered on the Ship's Master Electrical Guide List.

____
Electrical Officer/Electronics Material Officer

Second Endorsement

____
Date

From: ____________________ Division Officer

To: ____________________
Name/Rate

1. The above listed equipment is authorized for use on board. It must be returned for an electrical safety test and inspection every six months. Failure to comply may result in removal of the equipment from the command.

____
Division Officer

Figure 4-7.–A Personal Electric/Electronic Equipment Request Form.

personally owned and ship's entertainment equipments provided with a grounded plug and a three-conductor cable? Additionally, are isolation transformers installed where required?" The reference to use in answering these questions is the *Naval Ships' Technical Manual*, chapter 300.

In reading over the reference, personnel joyfully pounce on the section "Exempt Equipment." This paragraph states, "Electrical and electronic equipment that meets the requirements of paragraph 300-2.34.2 (Nonconducting-[Plastic or partially plastic and metal] cased electric/electronic equipment) is exempt from the isolation and grounding requirements. Typical equipments in this category are shavers, toothbrushes, portable radios, tape recorders, calculators, and power packs for such equipment." Further, section 300-2.34 states, "Nonconducting cased portable tools and equipment do not require grounding cords and plugs, provided the equipment meets both of the following requirements.

1. Passes an initial inspection for rugged, safe construction.

2. Has a minimum of 1 megohm dc resistance from any phase to any exposed metal part such as chuck housing, mounting screws, ear plug jacks, or antennas or metal chassis."

There are many different portable tools and equipment on the market today. This has led to the Navy adopting a policy of using those tools and equipment when feasible. No specific guidance can be provided to cover all portable tools and equipment, but the burden for accepting or rejecting portable electrical and electronic equipment for shipboard use falls on the electrical or electronics officer or another designated official. This designated person will perform the initial inspection of these devices when they are brought aboard, whether for shipboard use or personal use.

All hands shall request permission from their division officer to bring personal electrical/electronic equipment aboard. A Personal Electric/Electronic Equipment Request Form, similar to figure 4-7, must be submitted.

Ultimately, all personally owned electrical/ electronic equipment, including equipment that may fall into the exempt category, must be inspected by the cognizant electrical/electronics shop before it is used aboard ship. Final acceptance or rejection, tagging, and the reinspection interval are at the discretion of the OIC of the cognizant shop making the inspection.

If the portable tool or equipment has the words double insulation or double insulated stamped on its enclosure, it can be assumed to be of rugged safe construction. This stamping designation is an Underwriters' Laboratory requirement; however, this requirement is only applicable to selected types of equipment. A large number of the portable equipment which have not been stamped double insulation or double insulated will be acceptable if they meet the two requirements previously mentioned.

When equipment meets these requirements, it is acceptable with a two-prong plug and cord. However, if the equipment was originally provided with a grounding cord and plug, this type cord and plug must be retained throughout the life of the device. Equipment stamped double insulation or double insulated should have only two-prong plugs and cords. At the discretion of the inspection authority, three-prong plugs and cords may be installed on other equipment, if, in their opinion, the ground conductor can be conveniently connected to the exposed metal parts, and the modification does not compromise the equipment's operation or enclosure integrity.

Electronic equipment, such as radios, television receivers, recorders, musical instruments, and amplifiers that do not meet the requirements of paragraph 300-2.34, shall have a built-in power transformer which completely isolates the primary or line side of the transformer from the secondary or equipment side. The isolation of the primary and secondary sides of the transformer must never be inferred merely from the presence of the power transformer. It must be checked by measuring the insulation resistance from each line terminal of the transformer to the chassis and exposed metal parts of the equipment. If the insulation resistance is of the order of several megohms, the transformer is satisfactory and the equipment need only be provided with a three-prong grounded plug and a suitable cord. The grounding conductor of the cord is connected to the chassis and exposed metal parts of the equipment at one end and to the ground contact of the plug at the other end. This arrangement will ground the chassis and exposed metal parts of the equipment but will not ground the power supply. If the equipment does not have a power transformer which isolates the primary from the secondary side, an isolation transformer must be installed at the owner's expense to perform this function. A grounded plug and suitable cord should be used with the grounding conductor of the cord connected to the chassis and the power conductors of the cord connected to the primary of the isolation transformer. Some electronic devices have filters connected from the primary windings of the power transformers to ground. These filters are permitted when their dc resistance exceeds 500,000 ohms and the filter capacitor is no larger than 0.1 microfarad.

References to consult concerning personal electrical/electronic equipment:

– *Naval Ships' Technical Manual*, Chapter 300

– *SORM*

– *Navy Safety Precautions for Forces Afloat*

– *EIMB, General*

WARNING

THIS EQUIPMENT ENERGIZED FROM MULTIPLE SOURCES. TURN OFF THE FOLLOWING TO FULLY DE-ENERGIZE THIS UNIT.

CIRCUIT	SWITCH LOCATION	SWITCH IDENTIFICATION

NAVSEA 4700/31(7-81) S/N 0116-LF-047-0155

Figure 4-8.–Multiple source warning label.

MULTIPLE SOURCE LABELS AND SAFETY CUTOUT SWITCHES

This area deals with the subject of multiple sources of power to equipments, and the employment of multiple source labels, and the requirements for safety cutout switches.

MULTIPLE SOURCE LABELS

A potential electrical shock hazard may exist in equipment undergoing repair if the equipment is powered from multiple sources, even when the main power is turned OFF. This equipment should have a label attached that lists all incoming power circuits as well as the power disconnect switch location and identification of the power disconnect switch. Multiple sources include but are not limited to primary/alternate power, synchro and gyro inputs. Figure 4-8 illustrates the multiple source warning label.

Maintenance technicians are responsible for completing and affixing the label in a conspicuous place on the equipment. Drawings, manuals, instruction books, etc., should be consulted to ensure accurate information. Although the label can be marked with pencil or felt tip pen, those completed with a ball point pen or typewriter have proved to be better.

SAFETY CUTOUT SWITCHES

Electronic equipment connected directly to the ship's electrical power distribution system shall be provided with switches for disconnecting the equipment from the electrical power distribution system and any other power sources. These disconnect switches shall be located within the compartment or space in which the equipment is located. When practical, electronic equipment distribution panels or boxes with switches, when located within the compartment or space, shall be used for equipment disconnect. Single disconnect switches should be located as close as practical to the equipment they serve. All remotely located items of an electronic system shall have safety disconnect switches that will allow independent disconnect of the electrical power.

Circuit Disablement

Each item of electronic equipment with inputs of 30 (rms) volts or greater existing within the equipment that cannot be disabled by the system's main power switch, shall have disconnect switches or protective devices and special warning signs (label plates). Radar indicators are included in this requirement. The maintenance (input signal) disconnect switch for radar indicators shall be installed as close as practical to its associated indicator.

ANTENNA SAFETY DISCONNECT SWITCH

Safety disconnect switches should be installed for all rotatable antennas (except submarine and ECM antennas) to disable antenna rotation and equipment radiation prior to personnel entering the antenna swing circle. The antenna safety disconnect switch should be located as near the antenna as practical and be easily accessible. The antenna safety disconnect switch should not have by-pass capabilities except for systems that require a battle short switch.

References to consult concerning multiple source labels and safety cutout switches:

- *EIMB, General*
- *EIMB Installation Standards*
- *EIMB RADAR*
- *General Specifications for Navy Ships*

BATTERIES/COOLANTS/CLEANING SOLVENTS AND SOLUTIONS

The greatest danger from wet cell (lead acid) batteries is hydrogen gas produced during the charging of the battery. Care must be taken to keep all flames and sparks or flame/spark producing items away from wet cell batteries. Eye protection (in the form of chemical-goggles) should also be used (NSN 4240-00-764-5152).

NICKEL CADMIUM BATTERIES

Nickel cadmium (NiCad) batteries are only to be charged in series, never in parallel, with a proper constant current charging rate. They must be maintained at a temperature below 113°F if possible, and short circuits must be avoided.

MERCURY BATTERIES

Mercury batteries may explode if misused. The following precautions should be taken to minimize that possibility:

1. Never discharge a mercury cell battery after its voltage has dropped below 70% of its normal voltage capacity.
2. Never place a direct short on a mercury cell battery.
3. Discard spent batteries as soon as possible at the first shore installation.
4. Store batteries in a well-ventilated, cool, fireproof area.

LITHIUM BATTERIES

Lithium batteries are potential hazards if misused. Do not tamper with a lithium battery before, during, or after discharge. It can explode while rapidly discharging and up to 30 minutes after a rapid discharge. Whatever the state of charge, never pierce, crush, burn, intentionally drop, dismantle, modify, or otherwise carelessly mishandle lithium batteries. Do not short circuit, charge, or use in any equipment other than the equipment(s) specified for the battery.

Specific procedures for battery stowage, charging, and disposal can be found in the following references:

- *EIMB, General*
- *Safety Precautions for Forces Afloat*
- *Afloat Supply Procedures*
- DOD Hazardous Materials Information System (HMIS)

POLYCHLORINATED BIPHENYLS (PCBS)

Most transformers and similar components contain coolants, usually in the form of oils. Some of these coolants contain polychlorinated biphenyls or PCBs. Research in the late 1970s revealed that PCBs are toxic to man and the environment. Following these findings, restrictions were placed on the manufacture and use of PCBs. The Navy, in turn, implemented a program in 1981 for controlling the use of PCBs.

PCBs are very stable chemicals with many favorable characteristics, including high heat capacity, noncorrosivity, low flammability, and low electrical conductivity. Unfortunately, PCBs cause adverse health effects, including irritation to the skin, eyes, and lungs during even relatively brief exposures.

PCBs eaten by people or animals end up being stored in their fat tissues and can cause metabolic defects and tumors. PCBs can be absorbed through the skin and at higher temperatures, they vaporize into a toxic air contaminate.

Technicians who are subject to coming in contact with transformers or capacitors must be trained in the potential hazards of PCB exposure. NAVSEA has distributed a list of components that contain or are suspected to contain PCBs. These items must be labeled, and a contingency plan developed in case of a leak or spill. Detailed information on PCBs is provided in *Shipboard Management Guide for Polychlorinated Biphenyls* (PCBS), NAVSEA-S9593-A1-MAN-010.

CLEANING SOLVENTS/SOLUTIONS

The technician who smokes while using a volatile cleaning solvent is inviting disaster. Unfortunately, many such disasters have occurred. For this reason, the Navy does not permit the use of gasoline, benzine, ether, or like solvents for cleaning purposes, since they present potential fire or explosive hazards. Only, nonvolatile solvents shall be used to clean electrical or electronic apparatuses

In addition to the potential hazard of accidental fire or explosion, most cleaning solvents can damage the human respiratory system, in case of prolonged inhalation. The following list of "DO NOT's" will serve as an effective reminder to technical personnel who must use cleaning solvents:

1. DO NOT work alone in a poorly ventilated compartment.
2. DO NOT use carbon tetrachloride. This is a highly toxic compound.
3. DO NOT breathe directly over the vapor or any cleaning solvent for prolonged periods.
4. DO NOT spray cleaning solvents on electrical windings or insulation.
5. DO NOT apply solvents to warm or hot equipment since this increases the toxicity hazard.

The following steps are positive safety precautions which shall be followed when using cleaning solvents.

1. Use a blower or a canvas wind chute to blow air into a compartment in which a cleaning solvent is being used.
2. Open all usable port holes and place wind scoops in them.
3. Place a fire extinguisher close by, ready for use.
4. If feasible, use water compounds instead of other solvents.
5. Wear rubber gloves to prevent direct contact with solvents.
6. Use goggles when a solvent is being sprayed.
7. Hold the nozzle of the solvent close to the object being sprayed.

Where water compounds are not feasible, inhibited methyl chloroform (Trichloroethane) shall be used instead of the dangerous carbon tetrachloride. Methyl chloroform is an effective cleaner and as safe as can be expected when used with reasonable care–adequate ventilation and observance of fire precautions. When using inhibited methyl chloroform, avoid direct inhalation of the vapor.

For additional information on the safety precautions to be observed when using solvents, consult the following references:

– *EIMB, General*
– *Navy Safety Precautions for Forces Afloat*
– Hazardous Materials Information System (HMIS)
– *Naval Ships' Technical Manual*, Chapters 100 and 670

HAZARDS OF ELECTROMAGNETIC RADIATION

Electromagnetic radiation (EMR), also referred to as radio frequency radiation (RFR), can neither be seen nor easily sensed. Studies have shown that frequencies between 10 kilohertz (kHz) and 300 gigahertz (gHz) present a hazard. Therefore, its presence must be measured by use of special sensitive instruments, or by theoretical calculations. These measurements are to ensure the safety of personnel involved in various activities within the electromagnetic environment. A discussion of the various methods used to sense the presence of electromagnetic energy is beyond the scope of this section. However, the importance of remaining alert to the danger of overexposure to electromagnetic radiation as well as to the dangers of other radiation hazards is emphasized.

Radiation hazards are broken down into three categories:

– **Hazards of Electromagnetic Radiation to Personnel (HERP)**
– **Hazards of Electromagnetic Radiation to Ordnance (HERO)**
– **Hazards of Electromagnetic Radiation to Fuel (HERF)**

All of these will be discussed in more detail in the following paragraphs.

HAZARDS OF ELECTROMAGNETIC RADIATION TO PERSONNEL

The energy impinging on an object in an electromagnetic field may be reflected or absorbed. Only the absorbed energy constitutes a biological hazard. The amount of penetration of energy into the body and its absorption depends upon the physical dimensions of the body, the electrical properties of the tissues, and the wavelength of the electromagnetic energy.

When electromagnetic energy is absorbed by tissues of the body, heat is produced. If the organism cannot dissipate this heat energy as fast as it is produced, the internal temperature of the body will rise, resulting in damage to the tissue and, if the rise is sufficiently high, in the destruction of the organism. The body's ability to dissipate heat successfully depends upon many related factors: environmental air circulation rate, humidity, air temperature, body metabolic rate, clothing, power density, amount of energy absorbed, and the duration of exposure.

Certain organs of the body are considered to be more susceptible than others to the effects of RF radiation. Organs such as the lungs, the eyes, the testicles, the gall bladder, and portions of the gastrointestinal tract are not cooled by an abundant flow of blood through the vascular system. Therefore, these organs are more likely to be damaged by heat resulting from excessive exposure to radiation. Information presently available and experience indicate that, of the organs just mentioned, the eyes and testicles are the most vulnerable to microwave radiation. Therefore, becoming **partially blind** or **temporarily sterile** is a possibility.

The Bureau of Medicine and Surgery has established safe exposure limits for personnel who must work in an electromagnetic field based on the power density of the radiation beam and the time of exposure in the radiation field. Before we discuss these further, there are some terms that you must become familiar with.

Specific Absorption Rate (SAR)–This is the rate at which nonionizing RFR is absorbed by the body. The threshold at which adverse biological effects begin is recognized as 4 watts per kilogram of body mass (W/kg). With a safety factor of 10 added, the accepted threshold is 0.4 W/kg for the whole body, averaged over any 6-minute (0.1 hour) period. A special limit for "hot spot" or limited body exposure has been set at 8.0 W/kg, averaged over any 1 gram of body tissue for any 6-minute period. Although this rate of absorption is very important in determining whether or not a safety hazard exists, it is very difficult to measure. Measuring this rate of absorption can also be dangerous since it requires actual exposure of body tissue. A related measure that gives an acceptable indication of SAR is Permissible Exposure Limit.

Permissible Exposure Limit–This is a limit to RFR exposure based on measurements of the radiation's electric field strength (E) or magnetic field strength (H) taken with instruments. You can use available charts to determine whether the strength of the field presents a biological hazard to personnel located at the point where the measurements were taken. PEL readings are the basis for determining RADHAZ safety boundaries.

Permissible Exposure Time (PET)–This is the maximum time of exposure to a specific power density for which PEL will not be exceeded when the exposure is averaged over any 6-minute (0.1 hour) period. See Table 4-4.

While every effort must be made to protect personnel from harmful exposure to rf radiation, it is not considered necessary or desirable that blanket restrictions on ship antenna radiation be imposed to achieve optimum safety. The existence of such policy will tend to restrict maintenance and checkout procedures, which can otherwise be carried our safely, provided certain precautions are taken to keep personnel clear of hazardous areas. These precautions include the following:

1. Visual inspection of feed horns, open ends of waveguides, and any opening that emits electromagnetic energy shall not be made unless the equipment is definitely secured for the purpose of such an inspection.

2. Make sure that all radar antennas, which normally rotate, are rotated continuously or are trained or elevated to a known safe position while radiating.

3. Train and elevate nonrotating antennas away from inhabited areas, ships, piers, dry dock and pier cranes, and such, while radiating.

4. Aircraft employing high-power radars shall be parked, (or the antennas oriented) so that the beams are directed away from personnel work areas.

5. Where the possibility of accidental exposure might exist, maintenance personnel are required to have a person stationed topside, within view of the antenna but well out of the beam. This individual will be in communication with the operator while the antenna is radiating.

6. Ensure that radiation hazard warning signs are properly posted and boundary lines are established in accordance with the ship's current RADHAZ

Table 4-4.–Permissible Exposure Time Limit–Partial List

XMITTER	MODE	FIXED BEAM HAZARD			MOVING BEAM		
		DISTANCE		MAX EXP	PERSONNEL	DISTANCE	
		METERS	FEET	TIME (1)	HAZARD	METERS	FEET
AN/APX-72		1	3	6	N/A	–	–
AN/APX-72A		1	3	6	N/A	–	–
AN/SPS-29, B, C, E	All	24	80	0.3	Yes	5	17
AN/SPS-37		46	150	0.08	Yes	11	35
AN/SPS-37A		76	250	0.5	Yes	6	19
AN/SPS-40, A, B,		29	95	0.5	Yes	1.5	5
AN/SPS-43		46	150	0.2	Yes	10	33
AN/SPS-43A		79	260	0.3	Yes	5	17
AN/SPS-48E	Burnthru	427	1400	0.09	Yes	6	19
AN/SPS-49		61	200	1.53	No	–	–
AN/SPS-52, A, B, C		131	430	0.74	No	–	–
AN/SPS-53, A, D, E, J, K, L		1	3	6	No	–	–
AN/SPS-58, A, C		1	3	6	No	–	–
AN/SPS-60		1	3	6	No	–	–
AN/SPS-62		1	3	6	No	–	–
AN/SPS-64		1	3	6	No	–	–
AN/SPS-66		1	3	6	No	–	–
AN/SPY-1		427	1400	0.23	No	–	–
AN/SRQ-4		1	3	6	No	–	–
AN/TPN-30	AZ/EL	18	60	3.2	No	–	–
AN/TPX-42A(V)8		1	3	6	N/A	–	–
AN/ULQ-6A, B, C		5	15	2.2	N/A	–	–
AN/UPX-12B		1	3	6	N/A	–	–
AN/UPX-17		1	3	6	N/A	–	–
AN/UPX-23		1	3	6	N/A	–	–
AN/UPX-25(V)4		1	3	6	N/A	–	–
AN/UPX-27		1	3	6	N/A	–	–
AN/URN-20, B, C, D(V)1		1	3	6	N/A	–	–

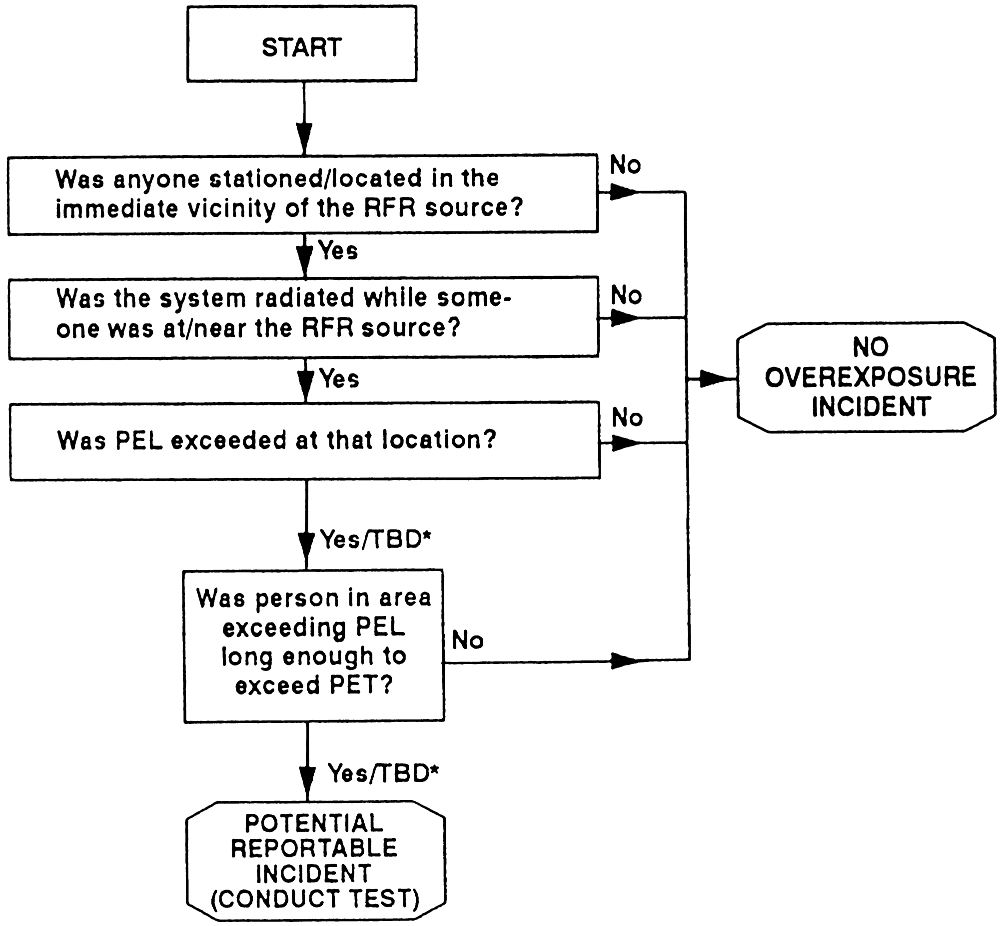


Figure 4-9.–Personnel LAAF RFR exposure decision chart.

certification. Signs and certifications will be discussed later in this section.

7. When operating or servicing a shipboard radar, operation and maintenance personnel shall observe all rf radiation hazard signs posted in the operating area. This is to ensure that the radar is operated so that personnel on deck or in the superstructure of the ship, or personnel working on or operating pier or dock cranes are not subjected to hazardous levels of rf radiation.

8. All personnel shall observe rf hazard warning signs, which point out the existence of rf radiation in a specific location or area.

If you suspect that a person has been over exposed to EMR, follow the flow chart in figure 4-9. If your suspicions are confirmed, the exposure is considered an incident and must be reported as required by *Protection of DOD Personnel From Exposure to Radio Frequency Radiation*, DOD Instruction 6055.11. The following are reportable incidents:

- For whole body, or partial body exposure of the head/eyes, reporting is required if the exposure is five or more times greater than the PEL for a period exceeding PET.
- For partial exposure of the other areas of the body (except head/eyes), reporting is required when exposure to RFR is 20 or more times greater than the PEL for a period exceeding PET.

NOTE

At frequencies below 300 MHz, RFR exposure is considered to be an exposure to the whole body. Above 300 MHz, RFR exposure can be focused on a limited area of the body, this may be caused by an rf leakage source or a directed beam antenna, resulting in partial body exposure.

RF BURNS

An rf burn occurs when a person comes into contact with a source of rf voltage in a manner that allows rf current to flow through the area of contact. Resistance of the skin to the current flow at the area of contact causes heat. The effect of the heat on a person at the point of contact ranges from a noticeable warmth to a painful burn. The sensations of rf burns and local muscle spasm normally associated with contacting 60-hertz ac or high dc power-source voltage are not present.

Mild rf burns are usually accompanied by small white spots on the skin; the odor of scorched skin may also be detected. More severe burns, while not necessarily covering a larger area, may penetrate deeper into the flesh and produce painful and slower healing injuries. For our purposes, "hazardous" will be defined as the rf voltage level sufficient to cause pain, visible skin damage, or an involuntary reaction. The term hazard does not include the lower voltage that cause annoyance, a stinging sensation, or mild heating of the skin. **The Naval Ships Engineering Center has prescribed that an open circuit rf voltage exceeding 140 volts on an object in an rf radiation field be considered hazardous.**

Numerous fleet reports of rf voltages being present on crane hooks have been received. These voltages were of sufficient potential in some instances to cause rf burns. They were induced in crane structures and wire ropes by transmitting antennas operating close by.

Some crane/antenna problems can be eliminated by relocation of antennas, but each installation requires special considerations. The locations of ship's antennas are determined by optimizing the desired radiation patterns with the physical limitations imposed by other features dictated by the ship's function. Often, the relocation of antennas, although physically permissible, is not feasible because of the location of the associated transmitters.

Rf voltages have been measured aboard ships indicating resonance effects between 2 and 30 MHz. It has been found that it is possible to reduce coupling of rf voltages induced in crane structures and rigging by careful use of frequency.

A better approach, however, is the use of rf high voltage insulator links, which provide protection for personnel against rf burns. Refer to *Link RF High Voltage Insulator for Ship Cranes*, MIL-L-24410 (SHIPS). The required high electrical resistance, low capacitance, high tensile strength, ruggedness and fail-safe features of the insulator links are provided by two separate bands of fiberglass filament wound on two zinc-coated steel saddles. The inner band carries the full working load; the outer band is capable of carrying the full working load should the inner band break.

Refer to the *Radio Frequency Burn Hazards Manual*, NAVSEA 0967-LP-317-7010, for types and stock number of insulator links.

When proper precautions measures are taken, the operation of electronic transmitting equipment having a rated output not greater than 250 watts, average, (at any frequency) will not cause harm to personnel while handling rigging. HOWEVER, PERSONNEL SHOULD BE CONSTANTLY ALERT TO THE FACT THAT EVEN UNDER THE ABOVE OPERATIONAL LIMITS, ELECTRONIC TRANSMITTING EQUIPMENT CAN CAUSE HAZARDOUS VOLTAGES TO BE INDUCED IN THE STANDING RIGGING AND OTHER PORTIONS OF A SHIP'S STRUCTURE, PARTICULARLY THOSE STRUCTURES AND OBJECTS (i.e., AIRPLANES AND HELICOPTERS) WHICH PROTRUDE FROM THE SHIP IN THE SAME PLANE AS THE RADIATING SOURCE. The rf voltages induced in a ship's structures, rigging, or other objects will cause burns to personnel when contact is made with conductive objects. The burn hazard problem, its causes and remedial techniques, are discussed in *Technical Manual, Radio Frequency Burn Hazards Reduction*, NAVSEA 0967-LP-317,7010.

HAZARDS OF ELECTROMAGNETIC RADIATION TO ORDNANCE (HERO)

The use of electrically explosive devices (EEDs) for ignition of booster rockets, detonation of warheads, stage separation in multistage rockets, high-speed operation of switches and valves, and many other purposes is increasing. The development of some weapons includes a continuous effort to reduce weight and space, lower power requirements, assure positive response, and increase reliability and safety. However, these are not always complementary goals.

Modern radio and radar transmitting equipment produces high-intensity radio-frequency (rf) fields. Such fields can cause premature actuation of sensitive EEDs contained in ordnance systems. The HERO problem was first recognized in 1958 and prime factors causing the problem have been increasing ever since. The use of EEDs in ordnance systems has become essential; while at the same time, the power output and frequency ranges of radio and radar transmitting equipment are continually being extended.

It is possible for rf energy to enter an ordnance item through a hole or crack in its skin or to be conducted into it by firing leads, wires, screwdrivers, and the like. In general, ordnance systems that have proved to be susceptible to rf energy are most susceptible during assembly, disassembly, loading, unloading, and handling in rf electromagnetic fields.

The most likely results of premature actuation are propellent ignition or reduction of reliability by dudding. Where out-of-line safety and arming (S&A) devices are used, the actuation of an EED may be undetectable unless the ordnance is taken apart. If there are no S&A devices, or if rf energy bypasses the devices, the probability of warhead detonation exists.

Three HERO classifications for ordnance items have been established, based upon the probability that the item will be adversely affected by the rf environment. The classifications are broadly described as follows:

1. Hero safe. An ordnance item that is sufficiently shielded or protected so that it is immune to adverse effects when used in its expected shipboard rf environments.

2. Hero susceptible. Ordnance that contains EEDs that have been proved by tests to be adversely affected by rf energy to the point that safety and/or reliability is/are in jeopardy when the ordnance is used in rf environments.

3. Hero unsafe. Any electrically initiated ordnance item that becomes unsafe when:

   a. Its internal wiring is physically exposed.

   b. Tests being conducted on the item require additional electrical connections to be made.

   c. Electroexplosive devices (EEDs) having exposed wire leads are present, handled, or loaded.

   d. The item is being assembled or disassembled.

   e. The item is in a disassembled condition.

Additionally any ordnance containing EEDs, which has not been classified as HERO safe or susceptible by either test or design analysis is classified as HERO unsafe ordnance.

Techniques for the reduction of HERO will vary greatly depending upon the susceptibility of the ordnance involved, and the frequencies and power density of the radiation involved. Ship's personnel can cope with HERO restrictions by reducing power, increasing the distance between ordnance and the transmitter antenna, performing tasks in shielded areas, or securing the transmitter.

As the EMO, you may be tasked with writing and maintaining the ship's HERO Emission Control (EMCON) Bill. This bill is a set of directions for implementing HERO restrictions on a ship or shore station. Its purpose is to prescribe (through advance planning) the easiest and most efficient method to manage the conflict between high-power transmitting equipment and HERO SUSCEPTIBLE ORDNANCE. The degree of relief from HERO rf restrictions that can be obtained by following a HERO EMCON bill is dependent upon two factors:

1. The amount and type of ordnance that is involved, and

2. A knowledge of the rf environment at locations where handling and loading occur.

NAVSEA OP3665 is an essential publication that provides specific guidance to assist you in working with a HERO EMCON bill.

HAZARDS OF ELECTROMAGNETIC RADIATION TO FUELS (HERF)

The increase in radiated rf energy from high-powered communications and radar equipments installed on ships in recent years has also increased the hazard that volatile fuel-air mixtures will ignite from the rf energy. This problem has been largely offset, however, by the shift to less volatile fuels. Under normal operating conditions, volatile mixtures are present only near aircraft fuel vents, open fuel inlets during over-the-wing fueling, or near fuel spills.

For ignition of fuel vapors to occur, three conditions must exist simultaneously:

1. For a given ambient temperature, the mixture must contain a specific ratio of fuel vapor to air.

2. There must be enough energy contained in the arc or spark to produce the appropriate temperature for ignition.

3. The gap length of the arc must be long enough to sustain the heat in the arc long enough to initiate the flame.

Each of these conditions is likely to vary for every situation, and there will likely be one or more sets of conditions existing simultaneously which are just right for ignition. Although all three conditions will probably not occur simultaneously, the consequences of an

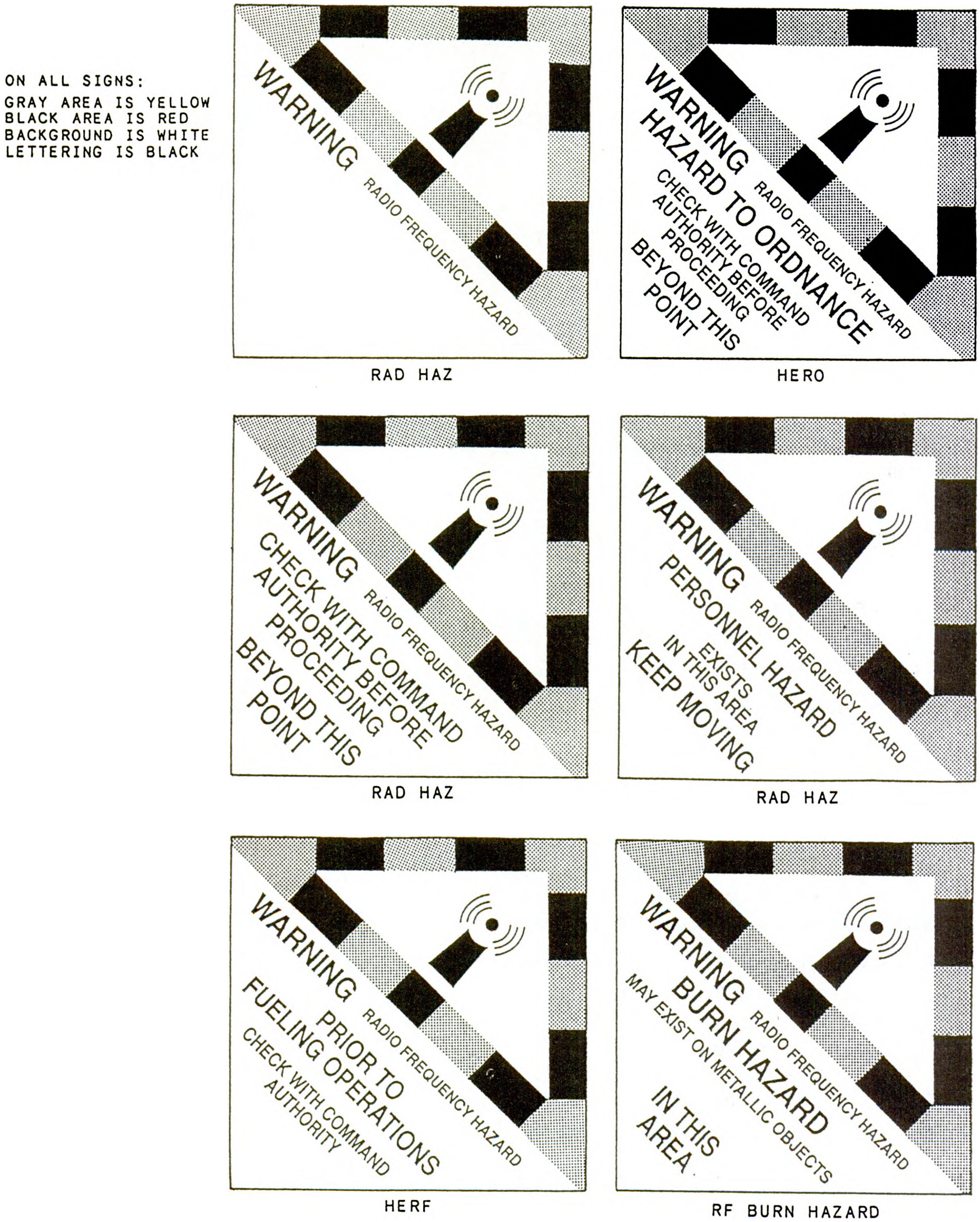


Figure 4-10.–RADHAZ warning signs.

accidental explosion makes it very important to be careful.

The rf arc hazard can be eliminated by following either of two procedures: securing all transmitters during the fueling operation or restricting hazardous fuel handling to a Radio Frequency Field Free Area. See the warning label illustrated by figure 4-10, type 4. Both of these procedures impose restrictions of flight or ship's operations. So, in view of the low probability of rf-initiated fires, the following approaches are suggested:

1. The energy received by the aircraft can be reduced to a point where dangerous arcs are unlikely. This can be accomplished by reducing power of the transmitters to the minimum necessary for reliable communications and, in the case of aircraft carriers, spotting fueling operations as far from transmitting antennas as possible.

2. Situations which are likely to produce arcs can be avoided. This can be done by ensuring that tie downs are tight enough for good electrical contact, avoiding loose wires or cables in critical areas, securing controls so that no movement of control surfaces will occur, and excluding personnel not needed for the fueling operation from the critical areas during fueling.

RADHAZ CERTIFICATIONS

The purpose of RADHAZ certification is to identify rf hazards to personnel and fuel, and to prescribe measures to avoid these hazards.

RADHAZ certifications are required:

- After installation or major modification of transmitting equipment capable of causing RADHAZ problems.
- For the lead ship of each class,
- or, as directed by Commander, NAVSEA-SYSCOM.

Certification is conducted by SUPSHIP, shipyards or test teams as directed by NAVSEA. The certification will identify hazardous areas and establish PEL boundaries, as well as provide guidance for the installation of RADHAZ signs. In the event that a current certification is unavailable, contact the (WCAP) representative at your local MOTU for guidance.

Periodic surveys will be conducted to verify compliance with RADHAZ certification requirements.

RADHAZ WARNING SIGNS

The following is a description of the currently approved RADHAZ warning signs and their intended use/placement for personnel protection. Figure 4-10 provides their physical dimensions, wording, and format.

In order that DOD standards be more closely aligned with national and international standards, DOD instructions were changed to conform with those standards. This has resulted in a requirement to change the format of RADHAZ safety signs. On 27 June 1990 the sign format as depicted in figure 4-10, and the material (anodized aluminum) on which these signs are printed was selected–the large (14 inches per side) and the small (5 inches per side). The large signs are reserved for shore station use. The small signs may be used either aboard ship or ashore.

Wholesale replacement of existing RADHAZ signs is NOT authorized. These new signs are for new requirements or when existing signs become illegible.

TYPE 1. WARNING RADIO FREQUENCY HAZARD . . . KEEP MOVING

The type 1 sign advises personnel not to linger in an area surrounding hf antennas where the RFR permissible exposure limit (PEL) can be exceeded. Although there is no danger from exposure to hf radiations for short periods, personnel shall not remain within an hf antenna PEL boundary (defined by a 4-inch red line/circle on the deck) longer than 3 minutes within a 6 minute period.

When required, install type 1 sign(s) at eye level (or where easily seen) outside the PEL boundary. When applicable, post a sign at each end of the boundary.

TYPE 2. WARNING RADIO FREQUENCY HAZARD . . . BEYOND THIS POINT

The type 2 sign precludes personnel from proceeding past a designated point unless they comply with established RADHAZ avoidance procedures. These procedures are promulgated in ship's doctrine, normally in accordance with the "MAN ALOFT BILL." Deck markings to define exclusion areas are not required or appropriate.

Where applicable, install type 2 signs at eye level at the bottom of vertical ladders or suspended at waist level between the handrails of inclined ladders. When type 2 signs are used as temporary barriers, such as when weapons direction radars are radiating, they shall be installed at waist level on a nonmetallic rope. This installation of the signs will require that personnel approaching the area take positive action to pass.

Type 2 signs shall not be used to limit access to an area that is not subject to RADHAZ, nor installed inside a RADHAZ area where personnel have already been exposed to RADHAZ before the sign can be viewed.

TYPE 3. WARNING RADIO FREQUENCY BURN HAZARD . . . BURN HAZARD

The type 3 sign advises personnel to use special handling procedures when touching metallic objects which can cause an rf burn or simply to not touch them. Those objects have proved to be an rf burn source when illuminated by energy from a nearby hf transmitting antenna. Although the hazard may exist only at certain frequencies or power levels, personnel should regard the object as a hazard unless the transmitter is secured.

NOTE: Whenever possible, the rf burn source should be replaced with a nonmetallic substitute or relocated/reoriented to eliminate the hazard before resorting to a type 3 sign for personnel protection.

A type 3 sign should be installed on the rf burn source or in the immediate vicinity where it can be seen easily. When used on cargo handling running rigging, type 3 signs are to be mounted on the hook insulator and personnel are to be warned to not touch the wire/rigging above the insulator. More than one type 3 sign should be installed on larger burn sources that can be approached from multiple directions.

TYPE 4. WARNING RADIO FREQUENCY HAZARD . . . FUELING OPERATIONS

The type 4 sign advises of the hazards of electromagnetic radiation to fuels (HERF). These requirements apply only to ships carrying aviation gasoline (AVGAS) or automotive gasoline (MOGAS). Marine diesel fuel and JP-5 jet fuel are not considered to have a HERF problem and require no special electromagnetic safety precautions during fueling. Most naval ships do not carry gasoline. An exception to this is amphibious ships carrying gasoline powered landing vehicles. In the absence of a HERF survey to provide more specific restrictions, when fueling or transferring AVGAS or MOGAS, observe the following precautions:

1. Secure all transmitting antennas located within the quadrant of the ship in which fueling is being conducted.
2. Ensure RADHAZ cutouts for microwave radiators are not overridden during fueling, which could result in the illumination of fueling areas.
3. Do not energize any radar or communications transmitter on either the aircraft or the motor vehicle being fueled or transmitters located on adjacent aircraft or motor vehicles.
4. Do not make or break any electrical, static ground wire, or tie down connection, or any metallic connection to the aircraft or motor vehicle while it is being fueled. Make the connections before fueling commences. Break them afterwards.

Install type 4 warning signs at AVGAS/MOGAS fueling stations.

TYPE 5. WARNING RADIO FREQUENCY HAZARD . . . SPECIAL CONDITION

The type 5 sign has a blank area in which special precautions necessary for safe operations can be typed. Its purpose is to advise personnel of procedures to be followed when other RADHAZ warning signs are not appropriate to ensure personnel safety. Examples of data appropriate for a type 5 sign include:

- Inform OOD before placing system in radiate.
- In manual mode, do not depress below horizon between _____ and _____ degrees relative.
- Ensure temporary exclusion barriers are in place before radiating.
- Do not stop antenna between _____and ___ degrees while radiating.

A type 5 sign is normally installed below decks in a system equipment room. This sign should be installed where it can be viewed easily by system operators while they are positioned for normal operation, in the vicinity of the applicable controls: e.g., radiate switch, or antenna control switch. When mounted on system cabinets or control panels, RADHAZ signs should not obscure switch labels, meters, indicators or nameplates.

TYPE 6. WARNING RADIO FREQUENCY HAZARD . . . HAZARD TO ORDNANCE

The type 6 sign advises of hazards of electromagnetic radiation to ordnance (HERO). The purpose and placement of HERO signs are explained in NAVSEA OP-3565. HERO is not included in RFR hazards certification, and HERO signs are not included in the test procedures of *Standard EMI Survey Procedures*, STD-407-5291780.

Assistance can be obtained by contacting the Weapons Correction Action Program (WCAP) representative at the local MOTU. They have access to a database that contains all of the current information relating to RADHAZ certification, which will be made available to you upon request.

TRAINING

RFR training shall be provided to all Navy personnel who work with RFR sources or work in an area where the potential may exist for exposure to RFR above PEL. General awareness training shall be provided as a part of all basic training and in conjunction with the more detailed technical training associated with a particular RFR source. Such training is to be given prior to any assignment to an RFR area. Annual refresher training as required shall be provided to reinforce and reemphasize command training objectives. All training shall be documented appropriately in the individual's service record.

REFERENCES

Information sources for hazards of electromagnetic radiation to personnel (HERP), fuel and other flammable material (HERF), and ordnance (HERO):

- *EIMB, General*
- *Electromagnetic Radiation Hazards To Personnel, Fuels, and Ordnance*
- *Standard EMI Survey Procedures*, Appendix G, RADHAZ SURVEY
- *Shipboard Bonding, Grounding, and Other Techniques for EMC and Safety*, MIL-STD-1310
- *Navy Safety Precautions for Forces Afloat*

LASER SYSTEMS

Military applications of laser systems are increasing rapidly. Common shipboard sources include laser range finders, laser guided munitions, communications equipment, fiber optics, scoring systems, landing systems and training aids. Federal safety regulations, including labeling, are applicable to all Navy lasers except those used for combat or combat training and those classified in the interest of national security. They are designated as "military exempt." The assessment of the hazard associated with a particular laser system is complex and depends on many factors.

The classification specifies the relative hazard of the laser without the need for any measurements or calculations and infers the type of administrative, and/or engineering control measures needed for personnel protection. The widespread use of laser systems increases the possibility of personnel exposure to hazardous levels of laser radiation. Consequently, laser hazard control programs are necessary to ensure personnel protection. The eye is the organ most vulnerable to permanent or disabling injury in almost all situations.

Applicable technical data for each laser shall be reviewed to determine its classification. Once the classification is established, the appropriate controls shall be implemented.

Laser classifications and general control measures are outlined in OPNAVINST 5100.19 (*Navy Safety Precautions for Forces Afloat*).

GENERAL LASER SAFETY PRECAUTIONS

During laser designator operations (LDO) and training, personnel should observe the following safety precautions:

- Personnel must be required to wear laser safety glasses with the appropriate optical density/characteristics.
- Personnel using laser designator should receive special eye examinations as a precautionary measure.
- Each laser munitions range should require strict compliance with special range regulations for laser safety.
- Never try to dismantle laser modules.
- Immediately cease designating if any person comes into the optical sight field of vision.
- Do not designate highly reflective targets like glass or chrome.
- When handling the laser designator, always assume it is powered until you have determined otherwise.
- Never point the laser designator at anyone, and ensure that the muzzle is always pointed down range.
- In training situations, always use eye safe filters if they are available.

- Binoculars should not be used to view the laser impact area. Binoculars greatly multiply the harmful effects of laser weapons on the eyes.

References to consult concerning laser safety:

- *NAVOSH Program Manual*, OPNAVINST 5100.23
- *Navy Safety Practices for Forces Afloat*, OPNAVINST 5100.19
- *Laser Safety Technical Manual*, E0410-BA-010/7034LASER
- *EIMB, General*

PREVENTIVE MAINTENANCE SYSTEM SAFETY PRECAUTIONS

The necessity of making all personnel safety conscious cannot be over stressed. Statistics show that a high percentage of accidents or casualties could have been prevented if some specific precautionary measures had been taken.

Every effort is made to indicate hazards to personnel in the "Safety Precautions" block of MRCs, and in the appropriate steps of the procedures block of MRCs. However, common sense and thorough indoctrination and training of all personnel maintaining and operating shipboard equipment is still required.

Warning

Operating procedures, practices, etc., which, if not correctly followed, may lead to injury or death. Warnings shall be listed in the safety precautions block and shall be repeated preceding the procedure involved. The phrase "Do not work alone" is added to appropriate warnings when the maintenance actions require additional personnel because of safety regulations/ precautions.

Caution

Operating procedures, practices, etc., which, if not correctly followed, may lead to damaging of equipment. Cautions are not listed in the safety precautions block; cautions will precede the instruction for the procedure involved.

Inadequacies in the MRC which could affect the safety of personnel or equipment must be reported on an urgent PMS FBR, in accordance with OPNAVINST 4790.4. PMS safety precautions will always refer maintenance personnel to *Navy Safety Precautions for Forces Afloat*, OPNAVINST 5100.19. The wise EMO directs his maintenance personnel to annotate the PMS card with the page number and paragraph of the applicable safety precautions. This ensures that personnel have looked them up and that all personnel are using the same precautions. Another area of concern with PMS is tagout. The *SORM*, OPNAVINST 3120.32, gives specific guidance on tagout procedures and instructs the reader that this guidance must be followed verbatim except as amplified by TYCOMs. Often hazardous materials (cleaning solvents, grease, oils, etc.) are used to conduct PMS. Ensure that your personnel are familiar with the handling, storage, and disposal of these materials.

SUMMARY

Safety requires both motivation and training. Your duties include disseminating safety information, seeing that hazards are clearly marked, monitoring the spaces and the personnel, and performing the required administrative duties dictated by the safety program. But besides these duties, you must also develop an everyday SAFETY-SERIOUS attitude. Be the example for your personnel. Don't cut corners or turn your back when you see a safety violation; the extra time or effort may save a life. Safety is not a subject that is apart from the other components of life aboard ship–it **is part of <u>every</u> action, <u>every</u> day, for <u>every</u> person.** As the leader of your division, you must supply the motivation and the emphasis.

This chapter has only touched upon certain areas of safety; there are many more safety related subjects. You must delve into the various references to ensure that you are meeting all of the applicable requirements. Safety related subjects addressed in instructions/notices, manuals, publications and other instructions should become part of your divisional mandatory reading and training programs.

In the next chapter, we will discuss security.

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CHAPTER 5

SECURITY

<u>OVERVIEW</u>

Describe the Navy regulations and procedures, including security classifications, handling, and the destruction of materials.

<u>OUTLINE</u>

Purpose and principles of security

Security areas

Personal security

Categories of classified information

Destruction

Violations

Crypto

Stowage

Command security programs

SECURITY REGULATIONS

Security of the United States in general, and of naval operations in particular, depends in part upon the success of safeguarding classified information. EMOs must be security conscious to the point that they automatically exercise proper discretion in performing their duties and in overseeing those of their assigned personnel. They should not think of security of information as something separate from other matters. In this way, security of classified information becomes a natural element of every task and not an additionally imposed burden.

During the daily work routine, the EMO handles information of vital importance to the military and to the nation. Some of the vast amount of message intelligence handled by naval communications at some point passes through the hands of the EMO. This data, if available to an enemy, might disclose the strength and intent of U.S. forces, and reveal a wealth of technical information relating to procedures and operations of the United States Navy. Recent highly publicized compromises have resulted in considerably tightened procedures. So, be sure to review your command security procedures carefully.

Electronics personnel have the need to use documents and publications that relate to such matters as frequencies, call signs, specifications, and procedures. The contents of these documents must be protected, because the more an enemy knows, the easier it will be for him to derive intelligence from it.

Rules and regulations on the subject of security do not guarantee results, nor do they cover every conceivable situation. The law of diminishing returns limits control measures that can be employed profitably. In administering security, a balanced and common sense outlook must be maintained. All personnel concerned must learn to exercise proper discretion when carrying out assigned duties so that observing proper security precautions becomes an automatic and integral part of the daily routine.

The Navy is a potential source of valuable information, and unceasing, systematic attempts to exploit that source are to be expected. The methods that may be used are many and varied. Planting agents within the naval establishment, photographing or stealing classified documents, tapping telephones, employing electronic sensing devices, obtaining codes and ciphers, and observing naval personnel in their off-duty time are some of the procedures that might be used. Although information obtained through these means often appears innocuous, it proves to be of real value when subjected to expert, purposeful analysis, and when combined with other fragments of information from various sources.

Even a request for a base telephone book could add to the knowledge level of covert sources.

As an EMO you will hear a great deal about the security of classified material because you will have responsibility for overseeing access to that material every day. For this reason, you should always brief newly assigned personnel on security matters and requirements. As a part of this briefing, require them to sign a statement attesting to the fact that they have received the briefing and understand the contents. Further, as a part of each command's security program, EMOs are required to read and indicate their understanding of several of the most important national laws and regulations relating to security.

Maintaining the security of classified material, however, requires more than a briefing, a regulation, or a law. Security procedures are only as effective as we make them. Security is a basic part of the EMO's assignment. This personal responsibility of an EMO to protect information cannot be transferred to anyone else. Security is more than a matter of being careful; it requires both study and practice. A thorough understanding of this chapter will not provide full knowledge of all the finer points concerning security, but it will provide a good fundamental background upon which a knowledge of security can be built. The basic reference for security is the *Department of the Navy Information and Personnel Security Program Regulation*, OPNAVINST 5510.1.

The purpose of OPNAVINST 5510.1 is to provide Department of the Navy activities and personnel with regulations and guidelines for classifying and safeguarding classified information. The objective is to ensure maximum uniformity and effectiveness in the application of the Information and Personnel Security Program policies by the Department of the Navy. It implements the Department of Defense Instructions 5200.1 (DOD Information Security Program Regulation) and 5200.2 (DOD Personnel Security Program Regulation). OPNAVINST 5510.1 incorporates the guidance on application of policies previously provided in the *Security Manager Handbook*. The provisions of this instruction apply to all military and civilian personnel and to all activities of the Department of the Navy.

To outline the basic areas covered by OPNAVINST 5510.1, its parts/chapters are identified in the following subparagraph:

PART I–PROGRAM MANAGEMENT

Chapter 1–Introduction to the Information and Personnel Security Program

Chapter 2–Program Management

Chapter 3–Security Education

Chapter 4–Compromises and Other Security Violations

Chapter 5–Counterintelligence Matters to be Reported to the Naval Investigative Service

PART II–CLASSIFICATION MANAGEMENT

Chapter 6–Classification

Chapter 7–Classification Guides

Chapter 8–Declassification, Downgrading, and Upgrading

Chapter 9–Marking

PART III–ACCOUNTING AND CONTROL

Chapter 10–Accounting and Control

Chapter 11–Printing, Reproduction, and Photography

Chapter 12–Dissemination of Classified Material

Chapter 13–Safeguarding

Chapter 14–Storage

Chapter 15–Transmission of Classified Material

Chapter 16–Handcarrying Classified Material

Chapter 17–Destruction of Classified Material

Chapter 18–Visit Control

Chapter 19–Meetings

PART IV–PERSONNEL SECURITY

You need to be thoroughly familiar with this instruction. Material presented in the SEMO course is, to a large extent, derived from the instruction and is subject to change. Therefore, EMOs should consult OPNAVINST 5510.1 for specific and current security decisions and guidance rather than the SEMO TRAMAN.

PURPOSE OF SECURITY PROGRAM

The security program deals basically with the safeguarding of information that should not be allowed to fall into the hands of foreign governments or foreign nationals because such information might be used to the detriment of the United States.

Information is subject to being compromised through careless talk, improper handling of classified material, or in various other ways. (Some of the ways in which military personnel may accidentally give away vital information are discussed in *Basic Military Requirements*, NAVEDTRA 10054.)

SECURITY PRINCIPLES

The Department of Defense security formula is based on the premise of circulation control of classified information: the control of dissemination. According to this policy, dissemination of classified information is limited to persons whose official duties require knowledge or possession of such materials.

SECURITY AREAS

Spaces containing classified matter are known as security areas. These security (or sensitive) areas have varying degrees of security interest, depending upon their purpose and the nature of the work and information or materials concerned. Consequently, the restrictions, controls, and protective measures required vary according to the degree of security importance. To meet different levels of security sensitivity, there are three different types of security areas–exclusion, limited, and controlled. All areas must be clearly marked by signs reading "RESTRICTED AREA–KEEP OUT. AUTHORIZED PERSONNEL ONLY." An additional requirement is the two-person integrity requirement in which personnel are not normally permitted to work alone in areas where Top Secret information or information controlled under Special Access program procedures is used or stored and is accessible to those personnel. This policy, however, does not apply in those situations where personnel with access are left alone for brief periods during normal duty hours. It does not require that both personnel have equal access, or that a "no lone zone" be established around Top Secret, nor are the requirements as stringent as the two-person control requirement for Communications Security Material Systems (CMS), Sealed Authentication Systems (SAS), or nuclear weapon-related information. The two person integrity requirements must be strictly adhered to during periods outside of working duty hours. When compelling operational requirements indicate the need, this requirement may be waived in specific limited instances by the CNO (OP-09N), the Fleet Commanders in Chief, the Commanders of the Naval Systems Commands, the Chief of Naval Research, the Commandant of the Marine Corps, and the Commanding Generals, Fleet Marine Forces Atlantic and Pacific.

Exclusion Area

A space requiring the strictest control of access is designated an exclusion area. This area contains classified matter of such a nature that, for all practical purposes, admittance to the area permits access to the classified material.

An exclusion area is fully enclosed by a perimeter barrier of solid construction. Exits and entrances are guarded, or they are secured and alarm protected. Only those persons whose duties require access and who possess appropriate security clearances are authorized to enter this space.

Limited Area

A limited area is one in which the uncontrolled movement of personnel permits access to the classified information therein. Within the area, access to the classified material may be prevented by escort and other internal controls.

The area is enclosed by a clearly defined perimeter barrier. Entrances and exits are guarded, controlled by attendants to check personal identification, or under alarm protection.

Operating and maintenance personnel who require freedom of movement within a limited area must have a proper security clearance. The commanding officer may, however, authorize entrance of persons who do not have clearances. In such instances, escorts or attendants and other security precautions must be used to prevent access to classified information located within the area. The combat information center is classified as a limited area.

Controlled Area

A controlled area does not contain classified information. It serves as a buffer zone to provide greater administrative control and protection for the limited or exclusion areas. Therefore, passageways or spaces surrounding or adjacent to limited or exclusion areas may be designated as a controlled area.

Proper identification is required to enter controlled areas. Additionally, control areas have control systems adequate enough to limit admittance to those having a bona fide need for access to the areas.

PERSONNEL SECURITY BASIC POLICY

No person shall be appointed or retained as a civilian employee in the Department of the Navy, accepted or retained in the Navy or Marine Corps, granted a personnel security clearance, assigned to sensitive duties, or granted access to classified information, unless appointment, acceptance, retention, clearance or assignment is clearly consistent with the interests of national security.

The security standard applied in determining eligibility for access to classified information is based on all available information: the person's loyalty, reliability, and trust-worthiness are such that entrusting the person with classified information or assigning the person to sensitive duties or to a sensitive position is clearly consistent with the interests of national security.

Appointment, enlistment, induction, or retention in the armed forces is based on all available information. There is no reasonable basis for doubting a person's loyalty to the government of the United States.

CATEGORIES OF CLASSIFIED INFORMATION

It is the policy of the Department of the Navy to make available to the public as much information concerning its activities as possible, consistent with the need to protect national security. Therefore, information is classified only to protect the national security.

Unnecessary or higher than necessary classification is to be avoided. If there is reasonable doubt about the need to classify information, safeguard it as if it were classified at least Confidential pending a determination by an original classification authority (OCA). When there is reasonable doubt about the appropriate level of classification, the information must be safeguarded as if it were classified at the higher level until an original classification authority makes a determination.

Information that requires protection against unauthorized disclosure in the interest of national security is classified using one of three designations: Top Secret, Secret, or Confidential. The markings, For Official Use Only and Limited Official Use, cannot be used to identify classified information; nor can modifying terms be used in conjunction with authorized classification designations, such as "Secret Sensitive."

Top Secret

The Top Secret classification refers to national security information or material requiring the highest degree of protection. It is applied only to information or material for which defense aspect is paramount, and of which the unauthorized disclosure could reasonably be expected to cause EXCEPTIONALLY GRAVE DAMAGE to the nation. This damage could be in the form of war, an armed attack against the United States or its allies, or disruption of foreign relations vitally affecting the national security of the United States.

The unauthorized disclosure of military or defense plans, intelligence operations, or scientific or technological developments vital to the national security are other examples of acts that could cause **EXCEPTIONALLY GRAVE DAMAGE.**

Secret

The Secret classification is limited to national security information or material that requires a substantial degree of protection, and of which the unauthorized disclosure could reasonably be expected to cause **SERIOUS DAMAGE** to the nation. Jeopardizing the international relations of the United

States, endangering the effectiveness of a program or policy of vital importance to the national security, compromising important military or defense plans, or revealing important intelligence operations are just a few examples.

Confidential

The use of the Confidential classification is limited to national security information or material that requires protection, and of which the unauthorized disclosure could reasonably be expected to cause **IDENTIFIABLE DAMAGE** to the national security. Examples of such information and material are listed below:

1. Operational and battle reports that contain information of value to the enemy
2. Intelligence reports
3. Military radio frequency and call signs allocations that are especially important, or are changed frequently for security reasons
4. Devices and material relating to communication security
5. Information that reveals the strength of the land, air, or naval forces in the United States and overseas areas; identifies or provides composition of units; or provides detailed information relating to their equipment
6. Documents and manuals containing technical information used for training, maintenance, and inspection of classified munitions of war
7. Operational and tactical doctrine
8. Research, development, production, and procurement of munitions of war
9. Mobilization plans
10. Personnel security investigations and other investigations, such as courts of inquiry, which require protection against unauthorized disclosure
11. Matters and documents of a personal or disciplinary nature, which, if disclosed, could be prejudicial to the discipline and morale of the armed forces
12. Documents used in connection with procurement, selection, or promotion of military personnel, the disclosure of which could violate the integrity of the competitive system

NOTE: Official information of the type described in 10, 11, and 12 above is classified Confidential only if its unauthorized disclosure could reasonably be expected to cause damage to the security interests of the nation. If such information does not relate strictly to defense, it must be safeguarded by means other than the Confidential classification as indicated below.

Special Markings

In addition to the security labels mentioned already, other markings also appear on sensitive material. Among these markings are such designations as, Restricted Data and For Official Use Only.

Restricted Data

All data concerned with the (1) design, manufacture, or utilization of atomic weapons; (2) the production of special nuclear material; or (3) the use of special nuclear material in production of energy bear conspicuous "Restricted Data" markings. The markings on restricted data that has been declassified under the Atomic Energy Act of 1954, must include these phrases: "Formerly Restricted Data, Handle as Restricted Data in Foreign Dissemination" (Section 144.b, Atomic Energy Act, 1954).

For Official Use Only

The term For Official Use Only (FOUO) is assigned to official information that requires some protection for the good of the public interest but which is not safeguarded by classifications used in the interest of national security.

PREPARATION AND MARKING

Each document or piece of material is classified according to the importance of the information it contains or reveals. It is important to identify individually items of information that require protection and then to consider whether compromise of the document or material as a whole would create a greater degree of damage than compromise of the items individually. The classification of the document or material must be the classification that provides protection for the highest classification of information or for the document or material as a whole, whichever is higher.

The markings required for classified material serve to identify the proper classification, to inform recipients of the assigned classification, to indicate the level of protection required, to indicate the information that must be withheld from unauthorized persons, to provide a basis for derivative classification, and to facilitate downgrading and declassification actions.

When information is assigned a classification category, the category must immediately be marked clearly and conspicuously on all documents that contain that information.

On documents, the classification marking of TOP SECRET, SECRET, or CONFIDENTIAL is stamped, printed, or written in capital letters that are larger than those in the text or document. On other types of material, the classification marking is stamped, printed, written, painted, or affixed by means of a tag, sticker, decal, or similar device in a conspicuous manner. If marking on the material is not physically possible, written notice of the assigned classification is provided to recipients of the material.

CHANGE IN CLASSIFICATION

When classified information is determined to require a different level of protection than that presently assigned, or to no longer require protection, it is regraded or declassified.

A mandatory continuing program based on a time schedule has been established for automatically downgrading and declassifying documents originated within the Department of Defense.

The automatic downgrading and declassification system was instituted to ensure that all classified matter is available to the general public when secrecy is no longer necessary. It also relieves the originators of future concern for the classified aspects of documents or materials they have produced.

Depending on the content of the material, classified information is placed into one of four groups. The assigned grouping indicates whether or not the material may be declassified automatically in the future. It also indicates when it may be declassified.

TRANSMISSION

Transmission of material is the actual transfer of custody and responsibility for a document or other material from one command to another command or other authorized addressee.

Although transmission may be accomplished by messenger, mail, wire circuits, secure radio, or other means, the purpose in every case is to keep the information out of the hands of those not authorized to have it.

The most appropriate means of transmission should be selected within the requirements of precedence and security.

MESSENGER

Classified matter is transmitted by messenger when security–not speed–is the paramount objective. The principal messenger agency for the Department of Defense is the Armed Forces Courier Service (ARFCOS). This agency is responsible for the safe transmittal of highly classified matter to military addressees and certain civilian agencies throughout the world. Every item of classified material sent via ARFCOS is in the physical custody and control of a military courier from the time of its entry into the system until the addressee or an authorized representative accepts receipt of it. Classified material that may go by registered United States mail is not transmitted by ARFCOS.

MAIL

In addition to transmitting unclassified material, the United States postal system is used to transmit classified material, except for Top Secret matter and cryptographic aids and devices. Secret matter must be sent by registered mail and must not enter a foreign postal system. Confidential material can be mailed through the United States Postal Service as certified or first class mail within the boundaries of the United States. United States Postal Service registered mail is to be used for the transmission of (1) Confidential material of NATO, SEATO, and CENTO; (2) APO or FPO addressees; and (3) other addressees when the originator is uncertain that their location is within United States boundaries. The single exception to this is that material addressed to Canadian government activities is permitted to pass through the Canadian postal service. Most of the Navy's administrative traffic is sent by mail, thus reserving radio circuits for operational traffic insofar as possible.

Mailable Secret and Confidential material is double-wrapped; the classified material is sealed inside an opaque container, which is then sealed within a second opaque container. The inner container shows the address of the receiving activity, the classification of the enclosed material (including special markings), and any applicable special instructions. It is carefully sealed to minimize the possibility of access without leaving evidence of tampering. The outer container shows the address of the receiving activity and the correct return address of the sender. The outer container DOES NOT bear a classification marking. Top Secret mail is prepared for transmission in a similar manner, but it is NOT transmitted by mail, since it must be transmitted under a continuous chain of receipts.

TRANSMISSION SECURITY

Transmission security includes all measures designed to protect transmission from interception, traffic analysis, and imitative deception. Every means of transmission is subject to interception. In radio transmission, it must be assumed that all transmissions are intercepted.

Within requirements of precedence and security, the most appropriate means of transmission should be selected. The following are the available means of transmission, in order of security: (1) messenger; (2) registered mail; (3) approved wire circuit; (4) ordinary mail; (5) nonapproved wire circuit; (6) visual; (7) sound system; and (8) radio.

SPEED VERSUS SECURITY

Three fundamental requirements of a military communication system are reliability, security, and speed. Reliability is always paramount. Security and speed are next in importance and, depending on the stage of an operation, are interchangeable. During the planning phase, for instance, security is obviously more important than speed; during the execution phase, speed may possibly surpass security in importance. This statement is not meant to imply that either requirement can ever be ignored completely. Modern high-grade crypto systems permit security with speed. In tactical operations, however, when speed is so important that time cannot be spared for encryption, and transmitted information cannot be acted upon by the enemy in time to influence current operations, messages of any classification except Top Secret may be transmitted in the clear over any wire or radio circuit. Each message must be approved and released separately. Any linkage to a previously encrypted message should be avoided. Such transmissions include the word CLEAR at the beginning of the text to indicate the message contains classified material. Upon receipt, the message is marked "Received in the clear" and is handled as Confidential. If further information must be transmitted, an entirely new message is drafted.

RADIO TRANSMISSION SECURITY

When a message is transmitted by radio, sometimes it is possible to know a few receivers, but all of them never become known. It must be assumed that an enemy receives every transmission. Properly prepared messages using modern cryptosystems may prevent an enemy from understanding a message, but a lot can still be learned. As time for a planned operation approaches, for instance, the number of messages transmitted increases markedly. Although unsure of exactly what will happen, an enemy knows that something will occur soon, and enemy forces are alerted accordingly. Strict radio silence is the main defense against radio intelligence.

The amount of radio traffic is not the only indicator used by an enemy. Statistical studies of message headings, receipts, acknowledgments, relays, routing instructions, and services are also run by an enemy. From such studies, communication experts can learn much about an opponent's operations, past and future. By means of direction finders, they can determine where messages originate, information which is a valuable aid in their studies.

Although traffic analysis by the enemy cannot be prevented, it can be made more difficult and less reliable. Such measures as the following can be taken:

1. Make maximum use of communication means other than radio.
2. Maintain strict circuit discipline.
3. Use the broadcast method where possible.
4. Rotate call signs and address groups.
5. Reduce the use of service messages.
6. Use codress messages.
7. Encrypt all classified messages.
8. Reduce test transmission to a minimum.
9. Avoid external routing instructions.

RADIOTELEPHONE SECURITY

Radiotelephone nets are operated so frequently that many operators tend to be careless. There are too many instances of interception of vhf/uhf transmissions at distances of many thousands of miles for this carelessness to continue.

Certain rules apply, and all persons having occasion to use a radiotelephone should be thoroughly familiar with them.

1. Use each circuit for its intended purpose only. Keep the number of transmissions to a minimum.

2. Think out the contents and wording before starting a transmission, so you will reveal no information of military value, even by implication.

3. Write the message down before transmission, and be practical.

4. Keep all transmissions brief, concise, and clear.

5. Transmit no classified information in plain language, including plain language references to classified titles, units, places, chart references, or persons that may reveal the nature of the headquarters, task force, or other unit concerned.

6. Avoid linkage between radiotelephone call signs and any other call signs.

7. Follow prescribed radiotelephone procedure at all times.

DESTRUCTION OF CLASSIFIED DOCUMENTS

When it becomes necessary to destroy classified documents, the recommended methods are by burning, shredding, pulping, or pulverizing. The regulations concerning destruction are in OPNAVINST 5510.1.

Destruction procedures are described as follows:

1. Classified material will be destroyed only by authorized means by personnel cleared to the level of the material being destroyed.

2. Classified material awaiting destruction will be afforded the protection of the information it contains. "Burn bags" will be safeguarded at the level of the highest classification they contain until they are completely destroyed.

3. The destruction of Top Secret and Secret material will be recorded. Destruction may be recorded on a Classified Material Destruction Report, OPNAV Form 5511/12 (see figure 5-1) or any other record that includes complete identification of the material, number of copies destroyed, and the date of destruction. Two officials will be responsible for destroying Top Secret and Secret material and will sign the record of destruction. Records of destruction will be retained for 2 years. The fact that an originator may state in a document that it may be destroyed without report doesn't change the requirement to record destruction. It only means that the originator does not have to be notified that the document was destroyed.

4. When Top Secret and/or Secret material is placed in a "burn bag" for central destruction, the witnessing official will sign the record when the material is actually placed in the burn bag. Until a burn bag is actually destroyed, it will be handled, stored, and accounted for by the protective measures required for the highest level of classification it contains. When the burn bags are destroyed, the destruction must be witnessed by two appropriately cleared personnel. The person(s) accomplishing the actual destruction need not sign the record of destruction, but it would be appropriate to require a signature for the number of burn bags destroyed. All burn bags will be serially numbered and a record kept of all subsequent handling until they are destroyed. The two persons actually accomplishing destruction will sign the record of handling or manifest. The record of handling will be retained for a period of 2 years.

5. Confidential material and classified waste are destroyed by authorized means by appropriately cleared personnel but do not require a record of destruction.

6. Assignment to destruction details will be rotated periodically. Both personnel will be cleared to the highest level of information being destroyed. They must be familiar with the regulations and procedures for safeguarding classified information.

7. A command operating a central destruction facility must post the security responsibilities of users and assume any unassigned responsibilities itself. When users are not permitted to observe complete destruction or to check the residue, the central destruction facility must assume responsibility for assuring that destruction is complete and reconstruction is impossible.

METHODS OF DESTRUCTION

The following destruction procedures must be followed to the letter. The ultimate goal is to render classified material unrecognizable and prevent later reconstruction.

Burning has been the traditional method for destroying classified material because destruction is complete and disposition of the remaining ash is relatively simple. The remaining ash need only be stirred to ensure destruction is complete and reconstruction is impossible. However, precautions have to be taken to prevent material or burning portions from being carried

CLASSIFIED MATERIAL DESTRUCTION REPORT
OPNAV FORM 5511-12 (REV. 4-63)

TO: Commanding Officer, USS NEVERSAIL

CLASSIFICATION *(Indicate when title or other identification is classified)*
UNCLASSIFIED

FROM *(Name and address of activity)*
Top Secret Control Officer

The classified material described below has been destroyed in accordance with regulations established by the Department of the Navy Security Manual for Classified Information, OPNAV INSTRUCTION 5510.1 (effective edition).

The purpose of this form is to provide activities with a record of destruction of classified material. Also, copies may be utilized for reports to activities originating material, where such reports are necessary.

DESCRIPTION OF MATERIAL

ORIGINATOR	SERIAL/DTG	DATE	COPY NO.	LOG/ ROUTE SHEET NO.	ENCLOSURES (IDENT. & NO.)	TOTAL NO. PAGES
CINCPACFLT Letter	00052	08/16/83	1	4		4

SAMPLE

OFFICER OR INDIVIDUAL AUTHORIZING DESTRUCTION *(Signature, Rank/Rate/Grade, File/Service No.)*

DATE OF DESTRUCTION
28 Aug 1983

WITNESSING OFFICIAL *(Signature, Rank/Rate/Grade, File or Service No.)*
David L. Clayton
David L. Clayton GS-12 TSCO

WITNESSING OFFICIAL *(Signature, Rank/Rate/Grade, File or Service No.)*
Barbara Szymanski
Barbara Szymanski GS-7

OP921 GPO 862-748

Figure 5-1.–Example of a Classified Material Destruction Report (OPNAV Form 5511/12.)

away by the wind or a draft. Incinerators can destroy most types of classified material but the Clean Air Act (42 U.S.C. 1857), as amended, contains restricting legislation. As pollution control criteria may vary between federal, state, and municipal jurisdictions, local officials should be consulted before purchasing an incendiary device to be used for the destruction of classified material.

Shredding machines are relatively quiet and require little skill to operate. Shredders vary in their degree of effectiveness, depending on the mechanical condition of the equipment. Shredding machines suitable for destroying classified material, except microforms, are available through the National Supply System (FSC Group 36, Part II). Two types of shredding machines are available: Strip and crosscut.

A strip shredding machine must cut the material to be destroyed into strips no greater than 1/32 inch in width. Strip shredders purchased before the date of this instruction may be used; however, new purchases must be crosscut shredders.

A crosscut shredding machine must reduce the material to shreds no greater than 3/64 inch wide by 1/2 inch long.

Ordinarily, shredding suffices as complete destruction of classified material and the residue may be handled as unclassified waste. There are, however, exceptions. Refer to CSP 1 (NOTAL) for guidance before shredding COMSEC material. Those handling SCI material must also follow special instructions for its destruction.

Certain shredders are also authorized for use in destroying classified microform. The Data Tech Model 003 and 004 shredders, for example, will completely destroy classified microform with a reduction factor not greater than 48X. Ships at sea may also destroy classified microform (except COMSEC and SCI material) by crosscut shredding and then throwing the residue into the ship's wake. The crosscut shreds must not be larger than 3/64 inch by 1/2 inch.

Pulverizers and disintegrators designed for destroying classified material are usually too noisy and dusty for office use, unless they are installed in a noise and dust proof enclosure. Some pulverizers and disintegrators may be used to destroy photographs, film, typewriter ribbons, glass slides, and offset printing. Disintegrators used for destroying classified material must have a 3/32 inch or smaller security screen. They should be obtained through the National Supply System (FSC Group 36, Part II).

Wet process pulpers with a 1/4 inch or smaller security screen may be used to destroy classified water-soluble material. Since pulpers only destroy paper products, staples, paper clips and other fasteners must be removed to prevent clogging the security screen. Wet process pulpers are available through the National Supply System (FSC Group 36, Part II).

An incinerator can be used to destroy microform totally (where permitted by local environmental regulations).

DECLASSIFYING OR CLEARING ADP MEDIA

Declassifying ADP media is a procedure to erase totally all classified information stored in the media. The *clearing* procedure erases the information, but not as completely as the declassifying procedure. The two procedures are distinguished by the specific techniques used (described in subsequent paragraphs) and the purpose for which each is done. Clearing techniques are used when the media will remain within the processing facility with the expectation that they will be reused. Declassifying procedures may be used for the same reason (in the case of magnetic tapes and disk packs), but they **must** be used when the media will be released outside the facility; i.e., for repair or permanent turn-in or release to another facility.

Cleared ADP media must still be marked, safeguarded, and controlled at the highest level of classification recorded on them before they were cleared. When the medium has been declassified, the classified information has, in effect, been destroyed. All markings identifying previous source, use, and classification will be removed. A record of destruction is required. This record is made by deleting the medium from the master list by lining through the item, and entering the disposition, date of disposition, and the initials of the individual deleting the item. Records of destruction/declassification will be maintained for 2 years. Media considered to be working papers and those at the Confidential level do not require a record of destruction.

The procedures for declassifying do not apply to media containing communications security keying material marked **CRYPTOGRAPHIC**. Those media are safeguarded as required for the highest classification ever recorded on them until they are physically destroyed.

The procedures for clearing and declassifying ADP media are as follows:

- **Magnetic tapes.** Clear by overwriting one time with any one character or declassify by degaussing with equipment approved by the National Security Agency. This equipment is available through the National Supply System (FSC Group 7D, Part I, Section B).

- **Disks, disk packs, screens, and other rigid magnetic media.** Clear with one overwrite. Declassify by completely overwriting at least three times, once with the binary digit "1," once with the binary digit "0," and once with any other alphanumeric or special character that will be left on the media. Verify the last overwrite, such as by attempting to read and print all characters other than the character used for the last overwrite. The electric current used for the overwrite must be at least equal to normal recording strength and sufficient to override any peaks or valleys that may have occurred in the power source during the recording period. Declassify inoperative equipment that cannot be overwritten by exposing each recording surface to a magnet with a field strength of at least 1500 oersted. Wipe the entire recording surface (all tracks) at least three times with a nonuniform motion of the magnet. A thin sheet of plastic (1-5 mils thick) should be used to prevent scratching the recording surfaces.

• **Magnetic media used to store analog, video, or other nondigital information.** Use the same procedures described for ADP media, except use analog signals instead of digital.

• **Internal memory, buffers, registers, and similar storage areas.** Clear by using a hardware clear switch, a power-on reset cycle, or a program designed to overwrite the storage area. Verify periodically to make sure the method is working correctly. Verification may be by random sampling or program read and compare. Declassify:

– Ferromagnetic core memory (for example, in preparation for turn in) by setting each memory location alternately to all "ones" and "zeroes" for 1000 cycles until the state is changed at least 999 times. If the core memory has malfunctioned and cannot be accessed, the memory must be physically destroyed.

– Volatile, read/write semiconductor memories, in whole or in part, by setting a "one" or a "zero" in all memory locations or by removing power from the system. Follow by a verification. This procedure is authorized only if the classified data has not resided undisturbed in the memory for more than 72 hours. (Do not use this procedure for non-volatile semi-conductor memories, such as metal nitride oxide or read-only semiconductor memories.)

• **Cathode-ray tubes (CRT).** Before release or turn-in of a CRT that has been used to display classified information, inspect each screen surface carefully under high intensity internal CRT illumination to detect evidence of burned-in information. If no classified information has been etched into the CRT phosphor, the CRT may be considered declassified and released. If the CRT screen does have burned-in classified information, retain it in the appropriate classified environment or destroy it.

• **Punched card machines (PCM) and auxiliary equipment.** This equipment is capable of retaining classified information if proper operator procedures are not followed. Clear the equipment by operating it for at least three card cycles with the input hopper empty. Also, examine the card path and adjacent areas to be certain a punched card or a portion of one is not lodged in the machine. Examination requires removing or opening access panels to the equipment. Relays, counters, and other electromechanical storage units are erasable if the equipment is capable of purging these retentive elements to their normal "reset" or "common" position, indicating the absence of data. If the equipment has a switch for the reset position, determine the validity of the additional procedures to purge the equipment. Verify that the methods used have cleared PCM by repeating the same procedures or by a second physical inspection and examination of output produced by using a specifically wired control panel that dumps all storage locations.

DESTRUCTION OF EQUIPMENT

In selecting destruction equipment, the following factors should be considered:

• Security. Do the system, its location, and its operating procedures minimize the possibility that classified information can be compromised? Consider wind loss, residue, clearing of jams, and physical security.

• Safety. Could operators be burned or injured by metal or glass fragments? Are fire and explosive hazards minimized?

• Environment. To what extent, if any, does operation of the equipment contribute to pollution of the air, water, or land?

• Reliability. How many problems could disable the system or degrade performance, and what are their probabilities of occurring? How long would it take to correct the various problems? Consider loss of required utilities.

• Local Disturbance. Does noise distract operations or others? Is system operation, including residue of disposal, dusty or messy?

• Flexibility. Can the largest and the smallest anticipated requirements be met economically?

• Simplicity. Is the system easy to operate and maintain?

DESTRUCTION OF UNCLASSIFIED MATERIAL

Unclassified material, including formerly classified material that has been declassified, FOR OFFICIAL USE ONLY (FOUO) material and unclassified messages, does not require the assurance of complete destruction. Introducing unclassified material into the classified material destruction system is not encouraged and should NOT occur except when the commanding officer or higher authority finds it necessary because of unusual security considerations or for efficiency. Unclassified/NOFORN naval nuclear propulsion documents are excepted. They will be destroyed by methods authorized for destruction of classified material. If that is not feasible, an alternative must be used to provide a reasonable degree of control during and after disposal. Specific methods will depend on local conditions, but the method used must afford protection against unauthorized recovery of Naval Nuclear Propulsion Information (NNPI).

Contrary to widespread opinion, there is not a security policy requiring destruction of unclassified messages (except NNPI). Telecommunications and major distribution centers with high volumes of classified and unclassified message traffic may find it more efficient to destroy all messages and intermingled files as if all were classified. Under some circumstances, for example, units operating in foreign ports or waters and commands situated in foreign countries, additional precautions in disposing of accumulated message traffic may be prudent. Tearing the messages into small pieces (as is done with FOUO material), defacing them before discarding or using classified destruction methods are among the choices left to the discretion of the commanding officer.

EMERGENCY DESTRUCTION

Commands located outside the United States and its territories and all deployable commands must address the destruction of classified information in their emergency plan. For commands holding COMSEC materials, additional emergency destruction policy and guidance are found in CSP-1 (NOTAL).

Emergency destruction plans must be practical and reasonable and take into account the following factors:

- Volume, level, and sensitivity of the classified material held by the activity.

- Proximity to hostile or potentially hostile countries and countries with unstable governments. Consider the degree of defense the command and readily available supporting forces can provide.

- Flight schedules or ship deployments in the proximity of hostile or potentially hostile environments.

- Size and armament of land-based commands and ships.

- Sensitivity of operational assignment (contingency planning should be considered).

- Potential for aggressive action by hostile forces.

Effective emergency destruction planning is preceded by the following measures: Reducing the amount of classified material to the absolute minimum; storing less frequently used classified material at a more secure command; to the extent possible, transferring retained material to magnetic media which is more easily destroyed than paper. This precaution will also reduce the bulk that needs to be evacuated or destroyed.

The emergency destruction plan will emphasize the procedures and methods of destruction. Clearly identify the exact location of all classified material. Include priorities for destruction, billet designations of personnel responsible for destruction, and the prescribed place and method of destruction. Additionally, if any destruction site or any particular piece of destruction equipment is to be used by more than one activity or entity, clearly delineate the order or priority for use of the site or equipment. Additionally, it should:

- Authorize the senior individual present in a space containing classified material to deviate from established plans when circumstances warrant.

- Identify the individual who is authorized to make the determination as to when emergency destruction is to begin and the means by which this determination is to be communicated to all subordinate elements maintaining classified information.

- Emphasize the importance of beginning destruction sufficiently early to preclude loss of material. The effect of premature destruction is inconsequential when measured against the possibility of compromise under emergency conditions.

- Any means of reasonably ensuring that the classified material cannot be reconstructed should be approved for use in emergency destruction. Ideally, the destruction method will provide for early attainment of a point at which the destruction process is irreversible.

- The equipment used for routine destruction of classified material should perform a major role in a command's planning for emergency destruction.

- Emergency destruction drills will be conducted at least annually to ensure that personnel are familiar with the plan and associated equipment. The drills will also be used to evaluate the anticipated effectiveness of the plan and prescribed equipment and should be the basis for improvements in planning and equipment use. Records of drills will be maintained for 2 years.

PRIORITY FOR EMERGENCY DESTRUCTION

In the emergency plan, priority for emergency evacuation and destruction of classified holdings will be assigned priorities. Priorities will be based on the potential effect on the national security should holdings fall into hostile hands. The priorities for emergency destruction are as follows:

Priority One–Top Secret material

Priority Two–Secret material

Priority Three–Confidential Material

REQUIREMENT FOR ANTICOMPROMISE EMERGENCY DESTRUCT (ACED) CAPABILITY FOR PRIORITY ONE MATERIAL

ACED capability comprises systems for destroying classified material designed to reach a stage in destruction sequence at which positive destruction is irreversible within 60 minutes at shore installations, 30 minutes in ships, and 3 minutes in aircraft. A suitable ACED capability for Priority One material must be provided in the following environments:

- Shore-based commands located in or within 50 miles of potentially hostile countries or located within or adjacent to countries with unstable governments.
- Reconnaissance aircraft, both manned and unmanned, that operate within JCS-designated reconnaissance reporting areas.
- Naval surface noncombatant vessels operating in hostile areas when not accompanied by a combatant vessel.
- Naval subsurface vessels operating in hostile areas.
- U.S. Navy "Special Project" ships (Military Sealift Command operated) operating in hostile areas.

Except in the most extraordinary circumstances, the ACED requirement does not apply to commands located within the United States and its territories or to other than Priority One material. If however, there is reason to believe that Priority One material cannot otherwise be afforded a reasonable degree of protection from hostile elements in a no-notice situation, in environments other than those listed in paragraph 1 above, a threat and vulnerability study must be made and must include, as a minimum, the following data, classified if appropriate:

- Volume and type of Priority One material held by the command; i.e., paper products, microform, magnetic media, circuit boards, etc.
- A certification that the amount of Priority One material held by the command has been reduced to the lowest possible level.
- An estimate of the time, in excess of the time frames cited previously that will be required to initiate irreversible destruction of Priority One material, and the methods by which destruction of that material would be attempted without an ACED system. Under emergency destruction conditions, it will be assumed that destruction equipment would be operated at maximum capacity and without regard to pollution, preventative maintenance, and other restraints that might otherwise be observed.
- Size and composition of the command.
- Location of the command and the degree of control it, or other United States authority, exercises over security.
- Proximity to potentially hostile forces and potential for aggressive action by such forces.
- When a requirement is believed to exist for ACED equipment not in the General Services Administration or DOD inventories, the potential requirement will be submitted to CNO (OP-09N).

EMERGENCY DESTRUCTION OF PRIORITY TWO AND THREE MATERIAL

Technology limitations place constraints on the amount of material that can be accommodated by current ACED systems. As a result, Priority One material is all that can reasonably be protected by ACED systems at this time. However, after processing Priority One material in an emergency situation involving possible loss to hostile forces, it is imperative that Priority Two and then Priority Three material be destroyed, insofar as possible, by whatever means may be available.

In addition to the use of routine classified material destruction equipment, the following methods should be considered: jettisoning or sinking. For COMSEC material, reference should be made to CSP 1 (NOTAL) for criteria for jettisoning and sinking.

For material other than COMSEC, the sea depth should be 1000 fathoms or more. If the water depth is not available, and if time does not permit other means of emergency destruction, the material should be jettisoned nonetheless to prevent its easy capture. When shipboard emergency destruction plans include jettisoning, weighted bags will be made available. If a vessel is to be sunk through intentional scuttling or is sinking due to hostile action, classified material will be locked in security filing cabinets or vaults and allowed to sink with the vessel rather than jettisoned. Other methods of destruction that should be considered include the following:

- Dismantling or smashing metallic items beyond reconstruction by any available means such as sledgehammers, cutting tools, torches, etc.

- Using disposal equipment not normally associated with the destruction of classified material, such as garbage grinders, sewage treatment plants, and boilers.

- As a last resort, and where none of the methods previously mentioned can be employed, dousing the classified material with a flammable liquid and igniting it, as an alternative to its certain loss.

REPORTING EMERGENCY DESTRUCTION

Accurate information concerning the extent of emergency destruction of classified material is second in importance only to the destruction of the material itself. Accordingly, the facts surrounding the destruction will be reported to the Chief of Naval Operations (OP-O9N) and other interested commands by the most expeditious means available. Reports will contain the following information:

- Identification of the items of classified material that may not have been destroyed.

- Information concerning classified material that may be presumed to have been destroyed.

- Identification of all classified material destroyed and the methods of destruction.

Additionally, within 6 months after the destruction, a written statement describing the character of the records and showing when and where the destruction was accomplished will be submitted to the Commander, Naval Data Automation Command (NAVDAC Code 812).

The requirement for reporting of emergency destruction of classified material will be included as part of the command's emergency plan.

SECURITY VIOLATIONS AND COMPROMISES

There are two types of security violations–those that result in a confirmed compromise or possible compromise of classified information and those that do not result in such a confirmed or possible compromise, but in which a security regulation has been violated.

Compromise is the disclosure of classified information to a person who is not authorized access. The unauthorized disclosure may have occurred knowingly, willfully, or through negligence. Compromise is confirmed when conclusive evidence exists that classified information has been disclosed to an unauthorized person. A possible compromise occurs when some evidence exists that classified information has been subjected to unauthorized disclosure or when considering the location and length of time classified information was not properly stored or controlled, it is likely to have been exposed to a person not authorized access.

The compromise of classified information can present a threat to national security. The seriousness of that threat must be determined and measures taken to negate or minimize the adverse effect of such a compromise.

A compromise obviously presents a greater threat to national security than other security violations, but other security violations must also be treated seriously because they demonstrate that a weakness exists in a command's security program. For this reason, security violations of either type must be reported and vigorously investigated and the problems causing the violation corrected rather than covered up. Incidents of an individual's failure to comply with the policies and procedures for safeguarding classified information will be evaluated to determine eligibility to hold a security clearance.

DISCOVERY OF LOSS, COMPROMISE, OR SUBJECTION TO COMPROMISE

Any individual who becomes aware of the loss, possible compromise, or compromise of classified information or material will immediately notify the

STORAGE REQUIREMENTS

	SHORE INSTALLATONS			SHIPS			AIRCRAFT		
	TS[1]	S	C	TS[1]	S	C	TS[1]	S	C
CLASS "A" VAULT	X	X	X						
CLASS "B" VAULT	X[2]	X	X						
STRONGROOM	X[3]	X[2]	X	X[5]	X[2]	X	X[5]	X[2]	X
GSA CONTAINER	X[2]	X	X	X[2]	X	X	X[2]	X[4]	X
LOCK BAR CABINET		X[2]	X[4]		X[2]	X		X[2]	X[4]
LOCKED CONTAINER OF SUBSTANTIAL METAL OR WOODEN CONSTRUCTION					X[6]	X[6]		X[6]	X[6]

1. Must be located in buildings, ships and aircraft which are under U.S. Government control (see definition below): otherwise, must be protected by an alarm system or be guarded during non-working hours by U.S. citizens.
2. Surrounding area locked and access to area controlled be U.S. personnel.
3. Container alarmed or guarded by U.S. personnel.
4. Surrounding area locked.
5. Area alarmed and patrolled every hour by U.S. personnel.
6. Surrounding area locked when not manned be U.S. personnel. Locked areas must be checked every 24 hours.

U.S. Government Control. A building, a space within a building, a naval vessel or aircraft where the Government has the authority to do whatever is necessary to prevent unauthorized disclosure of classified information. The Government can control or deny access, post guards, require identification, challenge presence, inspect packages, program elevators or take any other reasonable measures.

Figure 5-2.–Storage Requirement Chart.

security manager or commanding officer. If the circumstances of discovery make such notification impractical, the nearest NIS office or the most readily available command will be notified. The custodian of the classified information who causes that information to be subjected to compromise, or who becomes aware that information has been subjected to compromise, through unauthorized disclosure, abstraction or destruction, or through loss or theft, must report the subjection to compromise to his/her superior officer immediately. In addition, all losses and possible compromises must be reported immediately to the nearest Naval Investigative Service (NIS) field office when a preliminary inquiry is initiated. The servicing NIS field office will advise the command promptly whether NIS will undertake investigative action. Time referral is imperative to ensure preservation of evidence.

CRYPTOGRAPHIC INFORMATION

Practically all of the crypto information you will deal with as an EMO will be coded key changers, Q-kits, and specific crypto technical manuals dealing with the equipment. Depending on the ship's security organization, you may have a security container for crypto in your IFF spaces. You may have your communication crypto information stored in radio central or in the CMS vault. Be sure you hold training for your technicians consistently. This may prevent them from lulling themselves into a false sense of security. **DO NOT ALLOW YOUR TECHNICIANS TO LEAVE CRYPTOGRAPHIC INFORMATION OUT IN RADIO CENTRAL. IT SHOULD BE PROPERLY SECURED. THE TECHNICIAN SHOULD NOT LEAVE THE CRYPTOGRAPHIC INFORMATION OUT, EVEN IF THE CMS CUSTODIAN CANNOT BE FOUND. THE GUIDELINES OF FIGURE 5-2 SHOULD BE FOLLOWED.**

STORAGE OF CLASSIFIED MATERIAL

Commanding officers are responsible for safeguarding all classified information within their commands. They must ensure that classified information which is neither being used nor under the personal observation of cleared persons who are authorized access is stored as prescribed in this chapter. To the extent possible, the areas in which classified information is stored will be limited.

Any weakness or deficiency in equipment being used to safeguard classified material in storage will be reported to the Chief of Naval Operations (OP-9N).

VAULT AND STRONGROOM CONSTRUCTION STANDARDS

VAULTS

1. **Class A:**

a. **Floor and walls.** Eight-inch-thick reinforced concrete. Walls to extend to the underside of the roof slab above. When vault walls are a part of exterior walls, the vault wall must be set back from the exterior part of the exterior wall to allow 4 inches of the normal wall facing to cover the vault wall.

b. **Roof.** Monolithic reinforced-concrete slab of a thickness to be determined by structural requirements, but not less than the walls and floors.

c. **Ceiling.** Where the roof construction is not in accordance with paragraph b above, a normal reinforced-concrete slab placed over the vault area at a height not to exceed 9 feet.

d. **Vault door and frame unit.** Conforming to Federal specifications for Class 5 vault doors.

2. **Class B:**

a. **Floor.** Monolithic concrete construction of the thickness of adjacent concrete floor construction, but not less than 4 inches thick.

b. **Walls.** Not less than 8-inch-thick brick, concrete block, or other masonry units. Hollow masonry units will be the vertical cell type (load bearing) filled with concrete and steel reinforcement bars. Monolithic steel-reinforced concrete walls at least 4 inches thick may also be used, and should be used, in seismic areas.

c. **Roof.** Monolithic reinforced-concrete slab of a thickness to be determined by structural requirements, but not less than 4 inches thick.

d. **Ceiling.** Where the roof construction is not in accordance with paragraph c above, a normal reinforced-concrete slab placed over the vault at a height not to exceed 9 feet.

e. **Vault door and frame units.**

3. All vaults used to store classified material will be equipped with an emergency escape and relocking device. The escape device, not activated by the exterior locking device, must be accessible on the inside only and permanently attached to the inside of the door to permit escape by persons inside the vault. The device will be designed and installed so that drilling and rapping of the door from the outside will not give access to the vault by actuating the escape device. Vault doors conforming to Federal specifications will meet this requirement. A decal containing emergency operating instructions will be permanently affixed on the inside of the door. Each vault will be equipped with an interior alarm switch or device (such as a telephone, radio, or intercom) to permit a person in a vault to communicate with the vault custodian, guard or guard post to obtain release. Further, the vault will be equipped with a luminous light switch and, if the vault is otherwise unlighted, an emergency light.

4. Security vault doors for Class 5 and Class 6 vaults are available on the National Supply Schedule. When ordering, the finished thickness of the vault walls must be specified for the proper size of wall flanges to be provided.

5. The walls, floor, and roof construction of vaults must be in accordance with nationally recognized standards of structural practice. For the vaults described above, the concrete must be poured in place, and have a minimum 28-day compressive strength of 2,500 psi.

Figure 5-3.–Vault and Strongarm Construction Standards.

STRONGROOMS (Vault-Type Rooms)

A strongroom is an interior space enclosed by, or separated from, other similar spaces by four walls, a ceiling, and a floor, all of which are normally constructed of solid building materials. Under these criteria, rooms having false ceilings and walls constructed of fabrics or other similar material do not qualify as strongrooms. Specific construction standards are as follows:

1. Heavy duty builder's hardware will be used in construction, and all screws, nuts, bolts, hasps, clamps, bars, hinges, pins, etc., will be securely fastened to preclude surreptitious entry and assure visual evidence of forced entry. Hardware accessible from the outside area will be peened, brazed, or spot welded to preclude removal.

2. Wall and ceiling construction will be of plaster; gypsum board; metal; hardboard; wood; plywood; No. 9 gauge, 2-inch wire mesh or stronger; or other materials offering similar resistance to, and evidence of, unauthorized entry into the area. Insert type panels will not be used.

3. Floors will be constructed of materials such as concrete, ceramic tile, wood, etc.

4. Window openings will be fitted as shown in exhibit 14I, with 1/2-inch bars (separated by no more than 6 inches) and cross bars to prevent spreading, or with No. 9 gauge mesh. All windows will be opaque and kept closed at all times.

Figure 5-3.–Vault and Strongarm Construction Standards– Continued.

Each report must fully describe the weakness or deficiency and how it was discovered. Reporting is especially important when GSA-approved security containers are involved.

Valuables, such as money, jewels, precious metals, narcotics, etc., will not be stored in the same containers used to safeguard classified material. These items increase the risk of a container being opened or stolen, with the resulting compromise of the information therein.

For identification purposes in the event of emergency destruction or evacuation, a number or symbol indicating relative priority will be placed on the exterior of each security container. The external markings will not indicate the level of classified information stored in the container.

Figure 5-2 identifies the minimum requirements for storing classified material. These requirements must be used to determine the security container(s) and supplemental control required to properly safeguard classified material stored at the command.

STORAGE REQUIREMENTS

Top Secret material will be stored in a Class A or B Vault, a strongroom that meets the standards prescribed in figure 5-3, or a General Services Administration (GSA) approved security container. When located in a building, structural enclosure or other area not under U.S. government control, the vault, strongroom, or security container must be protected by an alarm system or be guarded by U.S. citizens during nonoperating hours.

Secret material may be stored in an alarmed area that affords protection equal to or better than that prescribed above. When an alarmed area is used, the physical barrier must be adequate to prevent: (1) surreptitious removal of the material; and (2) observation that would result in the compromise of the material. The physical barrier must be such that forcible attack will result in evidence of attempted entry into the room or area. The alarm system must, at a minimum, provide immediate notice to a U.S. security force of the attempted entry.

Secret and Confidential material may be stored in the manner prescribed for Top Secret; or until phased out, in a steel filing cabinet having a built-in GSA approved Group 1 or Group 1R combination lock; or as a last resort, a steel filing cabinet equipped with a steel lockbar, secured by a GSA approved combination padlock. When a lockbar container is used, the following supplemental security procedures apply:

- The keepers and staples of the steel lockbar must be secured to the filing cabinet by welding, rivets, or peened bolts.
- The drawers of the container must be held securely closed when the lockbar is in place so their contents cannot be removed by forcing open a drawer.
- During working hours, padlocks must be placed in the cabinet or locked through the staple until the cabinet is secured at the end of the day. This practice prevents tampering with padlocks or exchanging them surreptitiously.
- Precautionary measures must be taken so papers stored in the container will not protrude from the drawers when they are closed, or cannot be fished out through the cleft surrounding the drawers. One method is the insertion of stiff cardboard, such as a file folder, in a horizontal position above papers filed in the drawer.

Storage areas for bulky Secret and Confidential material must have access openings secured by GSA approved combination padlocks (Federal specification FF-P110 Series) or key operated padlocks with high security cylinders (exposed shackle, Military specification P-43951 series, or shrouded shackle, Military specification P-43607 series). If these storage requirements cannot be met afloat or aboard aircraft, Secret or Confidential material may be stored in a locked container of substantial metal or wooden construction (such as a foot locker or cruise box) secured by a GSA approved combination padlock. In such a case, the area in which the container is stored must be locked when not manned by U.S. personnel and the security of the locked area must be checked at least once every 24 hours.

COMMAND SECURITY PROGRAMS

Security is a means–not an end. Regulations that govern the security of classified material are comparable to electronic safety regulations. They do not guarantee protection, and they do not attempt to meet every conceivable situation. If strictly adhered to, however, they will provide a satisfactory degree of security.

To ensure that the required security measures are implemented, each command formulates written security procedures to reflect the command's particular requirements. These security procedures specify what is to be done, how it is to be done, who is to do it, and who is to supervise it.

In order that classified information may be controlled with maximum efficiency, the commanding officer or officer in charge of each command designates an officer to act as the command security manager. In commands that initiate, receive, or process Top Secret documents, a TOP SECRET CONTROL OFFICER is appointed. If the command is involved in processing data in an automated system, an ADP security officer is appointed. In addition, certain commands may designate a SPECIAL SECURITY OFFICER.

THE SECURITY MANAGER

The command security manager job may be assigned as a full-time, part-time, or collateral duty, but the person designated must be an officer or a civilian employee, GS-11 or above, with sufficient authority and staff to manage the program for the command.

The security manager is the principal advisor on information and personnel security in the command and is responsible for the management of the program. That doesn't necessarily mean that he or she personally handles all of the security duties described below. Many commands are organized to assign like duties to the same person. For example, the personnel officer may be handling personnel security, the administrative officer may have classified material control, the training officer may be responsible for security education sessions. Those assigned security duties may even be senior to the security manager. But, the security manager has to know what is going on in these areas, to see that the various pieces of the security program fit together, and nothing falls through the cracks. Additionally he will see that those in the command who have security duties are kept abreast of changes in policies and procedures, and will provide assistance in solving security problems. The job may involve direct supervision, oversight, coordination, or a combination of these. However the command is organized, the security manager is the key in developing and administering the command's Information and Personnel Security Program.

THE TOP SECRET CONTROL OFFICER

The Top Secret control officer (TSCO) is responsible to the security manager (if not the same person) for the receipt, custody, accounting for, and disposition of Top Secret material in the command.

The TSCO maintains a system of accountability that will record the source, downgrading, movement from one office to another, current custodian, destruction, or other disposition of all Top Secret material for which he is responsible. The words "for which responsible" have a meaning here, to allow deviations from the general rule that there is only one TSCO for the command. There may be Top Secret information in the command for which the command TSCO will not be held responsible. Provision has been made, for example, that Top Secret messages handled by communications facilities for relay or broadcast delivery only are not brought under the control of the command TSCO. Responsibilities for accounting, control, and destruction of Top Secret messages in these circumstances have been given to communications supervisors as described in *Fleet Communications*, NTP 4.

The TSCO:

- Keeps dissemination of Top Secret information to the absolute minimum necessary for proper planning or action. There will be no "standard routing" for Top Secret material in the command.
- Transmits Top Secret material within the command by direct personal contact. The TSCO doesn't have to deliver the material personally, but the material has to be delivered directly to the person who is to assume responsibility for it. Top Secret material will never be dropped in an "IN" basket.
- Maintains a continuous chain of signed receipts and disclosure records for all Top Secret material. Person-to-person contact is necessary for the receipting.
- Ensures that physical inventories of Top Secret material are conducted at least once per year.
- Maintains a current roster of persons within the command who are authorized access to Top Secret information. The TSCO should know who in the command requires access and be able to assist the security manager in determining who in the command is granted access.
- Ensures that all Top Secret material is accounted for and properly transferred when custodians are relieved of their duties. This requirement applies to the sub-custodians of the command as well as the TSCO.

SECURITY ASSISTANTS

Aside from those in the command who may have been assigned responsibilities for specific phases of the Information and Personnel Security Program, there may be personnel assigned as security assistants. Distinctions are made among assistant security managers, clerical assistants to the security manager, and Top Secret control assistants.

THE ADP SECURITY OFFICER

Each command involved in processing data in an automated system must designate an ADP Security Officer.

The ADP Security Officer is responsible to the security manager for the protection of classified information being processed in the automated system.

THE SPECIAL SECURITY OFFICER

Certain commands in the Department of the Navy are accredited for and authorized to receive, process, and store sensitive compartmented information (SCI). These commands have a designated Sensitive Compartmented Information Facility (SCIF) and Special Security Officer (SSO) responsible for the operation of that SCIF and the security, control, and use of SCI. All matters relating to SCI or SSO requirements are referred to the SSO.

THE COMMUNICATIONS SECURITY MATERIAL (CMS) CUSTODIAN

The communications security material custodian, under the supervision of the communications officer, is responsible to the commanding officer for the maintenance of the current allowance of CMS material. The CMS custodian exercises control over the receipt, correction, stowage, security, accounting, distribution, and authorized destruction of all CMS-distributed material. When the CMS Custodian is absent, the first alternate assumes the custodian's duties. The CMS custodian is not assigned any collateral duties.

For additional information, refer to the *Department of the Navy Information and Personnel Security Program Regulation*, OPNAV Instruction 5510.1.

SUMMARY

This chapter has discussed some areas of information and personnel security. It is imperative to national security that you are familiar with the contents of the *Department of the Navy Information and Personnel Security Program Regulation*, OPNAVINST

5510.1. As the EMO, you will be directly associated with classified information, material, and equipments. Apply the utmost security to applicable areas and stress security awareness and procedures to your personnel. Our national security is a must; do your part to maintain the security of classified material.

REFERENCES

Department of the Navy Information and Personnel Security Program Regulation, OPNAVINST 5510.1. Office of the Chief of Naval Operations, Washington, D.C., 1988.

Standard Organization and Regulations of the U.S. Navy, OPNAVINST 3120.32B, Office of the Chief of Naval Operations, OP-03, Washington, D.C., 1986.

CHAPTER 6

MATERIAL RESPONSIBILITIES

OVERVIEW

Describe the material responsibilities of the EMO, including the general responsibilities for equipment and maintenance.

OUTLINE

Reporting/relieving process for an EMO

Material responsibility

Equipment nomenclature

Maintenance

JETDS

PMS

Overhaul

Alterations

Inspections

INTRODUCTION

As the EMO aboard ship, your primary material responsibility is to oversee the maintenance of the electronic equipment. The size and complexity of this responsibility is determined by your ship's type and equipment configuration.

To ensure proper maintenance, you must be aware of many factors such as past performance of equipment, modifications or alterations affecting the equipment, and sources of detailed technical information.

Additionally, you must know what types and quantities of equipment are installed on board or planned for future installation and be able to assess how the operation (or lack of operation) of these equipments will affect the ship's mission. Your job will be made easier if you know the degree of onboard parts support.

The number and rates of the personnel on board, and their capabilities, directly impact your job as EMO. When you have an adequate number of well-trained personnel, your job will be primarily one of assigning and scheduling the work to be done. However, because of turn-over of personnel and changing manning levels, there may be times when you will not have enough trained personnel to make the job that simple. You must, therefore, make the best use of available talents while maintaining a continuing training program designed to improve the capabilities of the division.

The cleanliness of electronic equipment and the spaces that house it is also one of your maintenance responsibilities. Most electronic spaces are air conditioned or forced-air ventilated. The circulation of air causes deposits of foreign material in and around the electronic equipment. This, coupled with the normal buildup of dirt caused by personnel entering and leaving the space, causes a hazard to both personnel and equipment. A common personnel safety hazard occurs because the insulating ability of matting and switch handles is diminished by an accumulation of dust and heavy dirt. You should made an inspection at least weekly (daily if possible) to check for cleanliness of spaces, equipment, and air filters, and for safety hazards. Then follow up to ensure that corrective action has been taken on all discrepancies.

EQUIPMENT NOMENCLATURE

To fulfill your maintenance responsibility, you must understand the terminology used to identify equipment. The Navy uses six different nomenclature systems to identify electronics equipment. They are:

Joint Electronic Type Designation System (JETDS)

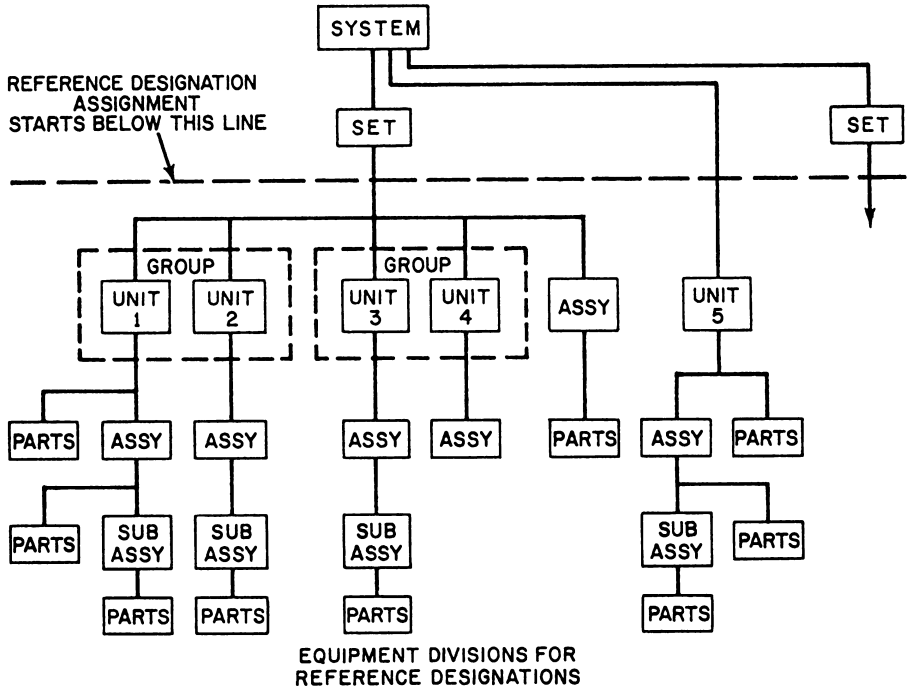

Figure 6-1.–System subdivision.

Navy Model Letter System (NMLS)

Navy Type Designation System (NTDS)

Mark and Mod Nomenclature System (MK-MOD)

Telecommunications Security System (TSEC)

Commercial

JOINT ELECTRONIC TYPE DESIGNATION SYSTEM (JETDS)

As military electronic systems grew in complexity, an orderly means of subdividing them and identifying their subsystems became necessary. JETDS was adopted by all military services, including the United States Coast Guard, in 1957 and is the most used nomenclature system. The reference for JETDS is MIL-STD-196D. In JETDS, nomenclature is formatted differently depending on whether the equipment is defined as a system, set, group, or unit. Figure 6-1 depicts a typical system layout.

System

A system is a combination of sets, groups, units, assemblies, subassemblies, and parts joined together to perform a complete operational function. Figure 6-2 is a block diagram for a typical communications system containing the necessary components for transmission and reception of voice, cw, and teletype signals. The arrows show the direction of signal flow.

Set

A set consists of one or more units and any additional assemblies, subassemblies, and parts necessary to perform a specific operational function; for example, a radio transmitting set to produce and send a radio signal.

The unshaded portion of figure 6-3 is a block diagram of a radio transmitter set, which consists of a radio frequency amplifier unit (1), a radio transmitter unit (2), and a power supply unit (3).

Group

A group is a portion of a set or system that, by itself, cannot perform a complete operational function. A group may include any combination of units, assemblies, or subassemblies. The antenna coupler group depicted in the shaded portion of figure 6-3 is composed of two units, the antenna coupler unit and the antenna coupler control unit. To operate, it requires both power and a signal from the radio frequency amplifier unit.

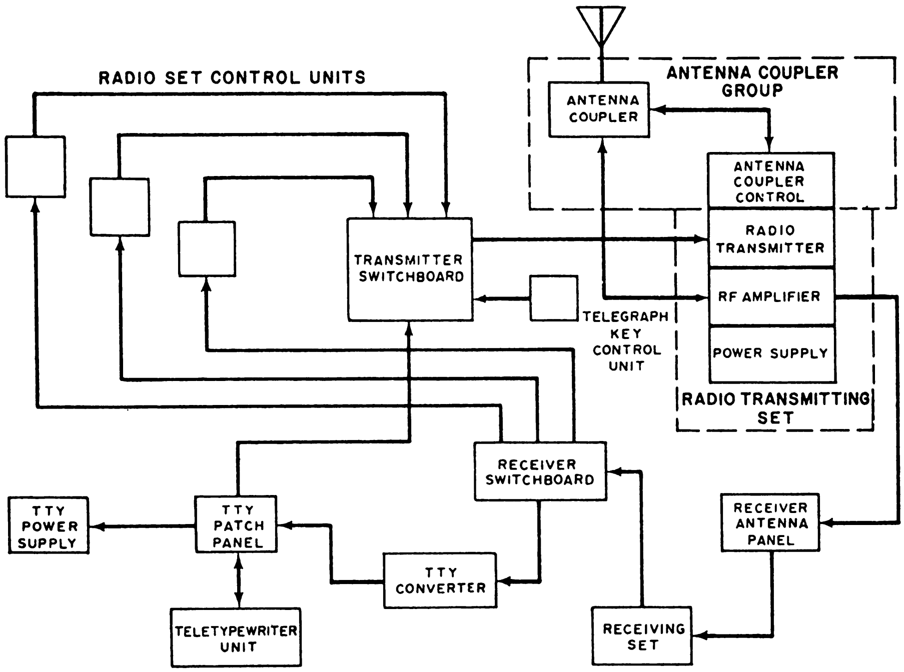

Figure 6-2.–Communications system block diagram.

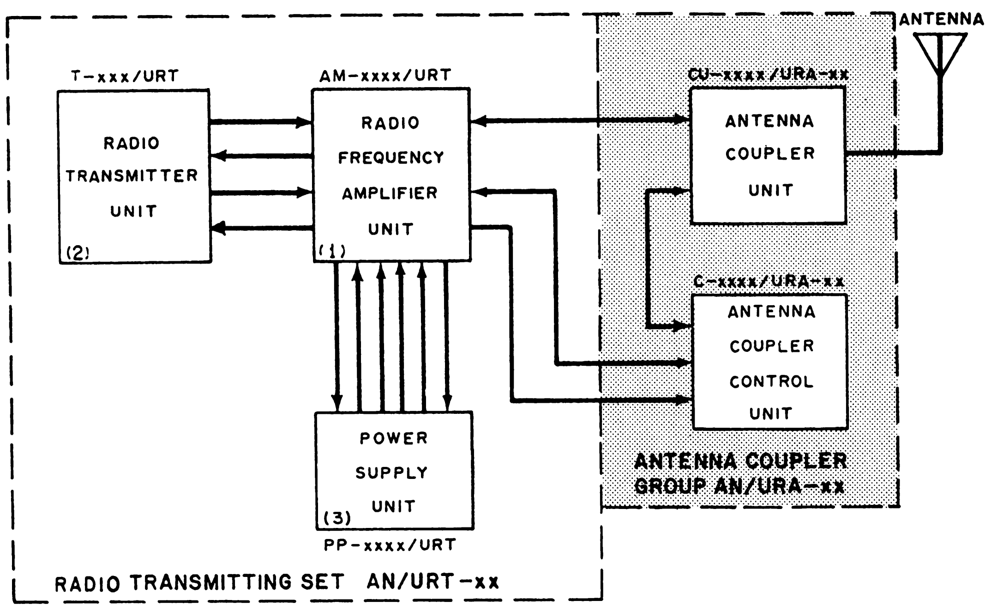

Figure 6-3.–Radio transmitting set.

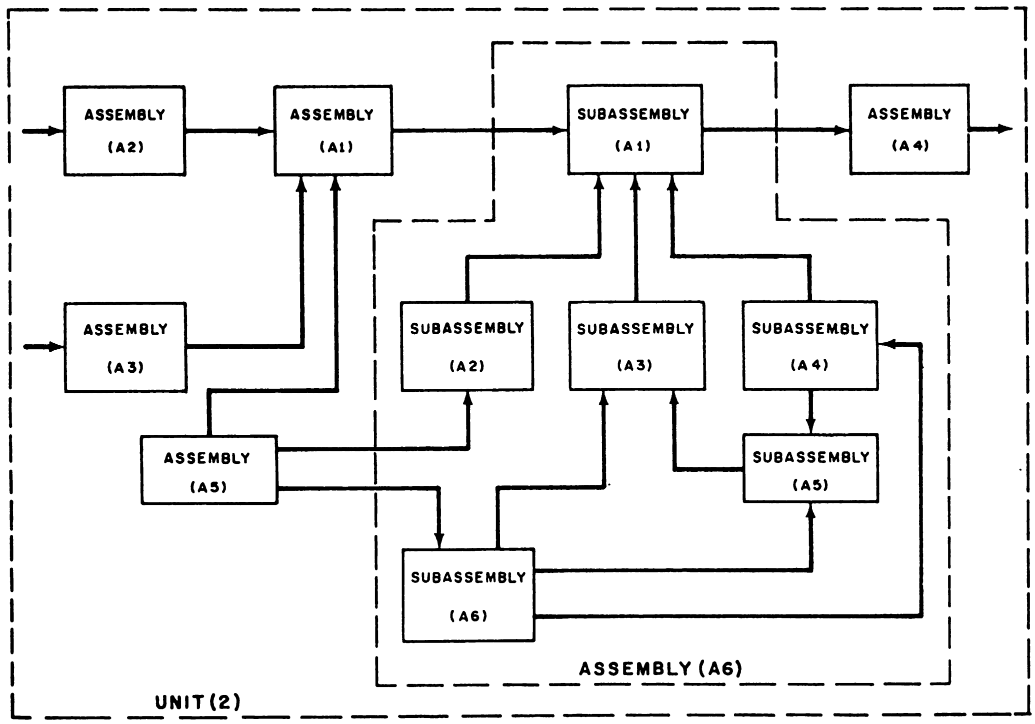

Figure 6-4.–Unit and assemblies.

Unit

A unit is an assembly or any combination of assemblies, subassemblies, and parts mounted together. Depending on its design, a unit may or may not be able to operate independently of its group or set.

Assembly

An assembly is a number of subassemblies or parts joined together to perform a specific function. Figure 6-4 shows a unit consisting of six assemblies. Assembly (A6) is composed of six subassemblies.

Subassembly

A subassembly consists of two or more parts that form a portion of an assembly or a unit. A subassembly is replaceable as a whole, but has a part or parts that can be replaced individually.

The distinction between an assembly and a subassembly is not always exact. What is called an assembly in one application may be called a subassembly in another.

Figure 6-5 shows a printed circuit board (PCB) subassembly and some of the parts that may be mounted on it. There are more complex PCBs in the fleet, but this will serve as a basis.

Part

A part is one piece, or two or more pieces joined together, that normally cannot be disassembled without being destroyed; for example, a resistor, capacitor, or transistor. Circuit symbol numbers are used to identify individual parts in an equipment.

JETDS Nomenclature Format for Sets and Systems

In the JETDS system, equipment is identified by an alphanumeric designator; for example, AN/PRC-90.

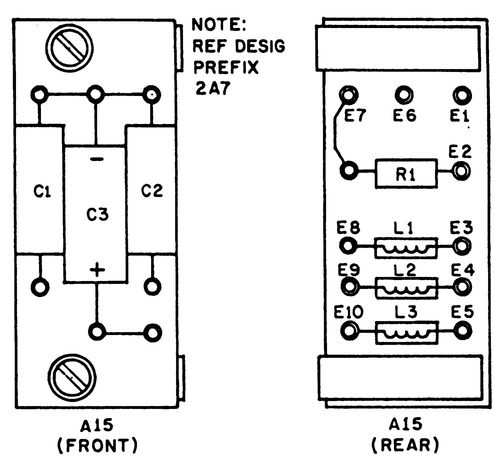

Figure 6-5.–Typical subassembly.

Table 6-1.–Table of Equipment Indicators

TABLE OF EQUIPMENT INDICATIONS			Miscellaneous Identification
Installation (1st letter)	Type of Equipment (2d letter)	Purpose (3rd letter)	
A–Piloted aircraft	A–Invisible light, heat radiation	B–Bombing	X,Y,Z–Changes in voltage, phase, or frequency
B–Underwater mobile, submarine	C–Carrier	C–Communications (receiving and transmitting)	T–Training
D–Pilotless carrier	D–Radiac	D–Direction finder reconnaissance and/or surveillance	(V)–Variable grouping
F–Fixed ground	G–Telegraph or Teletype	E–Ejection and/or release	
G–General ground use	I–Interphone and public address	G–Fire control, or searchlight directing	
K–Amphibious	J–Electromechanical or Inertial wire covered	H–Recording and/or reproducing (graphic meteorological and sound)	
M–Ground, mobile	K–Telemetering	K–Computing	
P–Portable	L–Countermeasures	M–Maintenance and/or test assemblies including tools)	
S–Water	M–Meteorological	N–Navigational aids (including altimeters, beacons, depth sounding, approach and landing)	
T–Ground, transportable	N–Sound in air	Q–Special, or combination of purposes	
U–General utility	P–Radar	R–Receiving, passive detecting	
V–Ground, vehicular	Q–Sonar and underwater sound	S–Detecting and/or range and bearing, search	
W–Water surface and under water combination	R–Radio	T–Transmitting	
Z–Piloted and pilotless airborne vehicle combination	S–Special types, magnetic, etc., or combinations of types	W–Automatic flight or remote control	
	T–Telephone (wire)	X–Identification and recognition	
	V–Visual and visible light	Y–Surveillance (search detect, and multiple target tracking) and control (both fire control and air control)	
	W–Armament (peculiar to armament, not otherwise covered)		
	X–Facsimile or television		
	Y–Data processing		

The two-letter combination AN followed by a slant (/) indicates that the JETDS nomenclature is being used and that the item is either a system or a set (may also be a "central," as in "communications central.") The next three letters are called equipment indicators and indicate the installation, type of equipment, and purpose of the equipment. Next are a tack (-) and a model number, followed by a modification letter and a miscellaneous letter, if necessary. The equipment indicator and miscellaneous letters are defined in table 6-1.

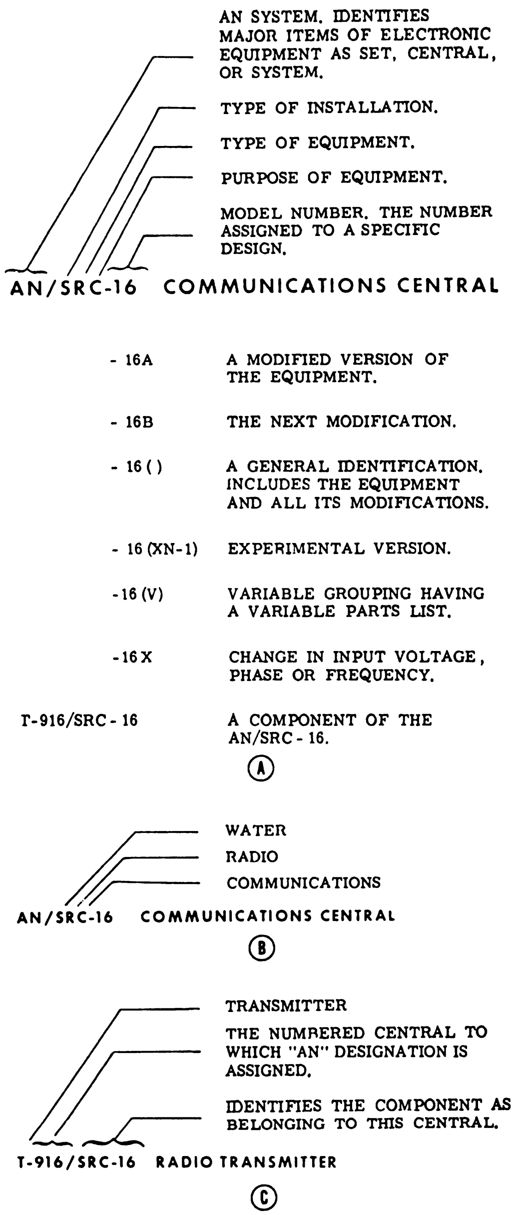

Figure 6-6.–Joint Electronic Type Designation System for Nomenclature AN/SRC-16 Radio Set.

Figure 6-6 shows the designator AN/SRC-16. Using the information in table 6-1 we can identify the equipment. The first letter "S" designates the type of installation–water. The second letter "R" designates the type of equipment–radio. The third letter "C" defines the purpose of the equipment as communications (receiving and transmitting); thus, the equipment is a shipboard radio transceiver.

You can interpret any three letter group by referring to table 6-1. The numbers immediately following the three letter group identify a particular equipment model.

A modification letter, immediately following the model number, is used to identify a set that has been modified, such as AN/SRC-16A. By referring to figure 6-6, you can see that this radio has been modified once. It still retains the basic design and is functionally and electrically (power source is the same) interchangeable with an unmodified set. If the AN/SRC-16A should be modified a second time, it would be designated AN/SRC-16B, and so on. A miscellaneous identifier (see table 6-1) may be used following the modification letter.

JETDS Nomenclature Format for Units and Groups

Equipment can be identified further by unit and group designators, such as T-916/SRC-16 (see figure 6-6). The first one or two letters are called component indicators. Next are a tack (-), a model number, and a modification letter if applicable. This is followed by a slant (/) and the indicators of the equipment or application to which the unit or group belongs (found in table 6-1). Tables 6-2 and 6-3 define unit and group indicators.

An example of a unit designator is AM-3729/URT. This designator identifies a radio frequency amplifier, model number 3729, that is used with a general utility radio transmitter. All groups of equipment are identified by a two-letter indicator as shown in table 6-3.

Component Identification

So far, we have discussed only the notation used in equipment nomenclature. Now, we will examine the coding for major components of a set (assemblies, subassemblies, and parts).

Units and groups that are components of a set are assigned sequential identification numbers (Unit 1, Unit 2, etc.; Group 1, Group 2, etc.) These numbers are further broken down into assembly numbers, subassembly numbers, and part numbers as shown in figure 6-7.

A complete list of component identifiers is too extensive to be included in this manual, but is printed in *EIMB, Reference Data*, NAVSEA SE000-00-EIM-140.

Table 6-2.–Table Of Unit Indicators

Unit Ind.	Family Name	Example of Use (not to be construed as limiting the application of the unit indicator)
AB	Supports, antenna	Antenna mounts, mast bases, mast sections, towers, etc.
AM	Amplifiers	Power, audio, interphone, radio frequency, video, electronic control, etc.
AS	Antennae, simple and complex . . .	Arrays, parabolic type, masthead, whip or telescopic loop, dipole, reflector, etc.
BA	Battery, primary type	B batteries, battery packs, etc.
BB	Battery, secondary type	Storage batteries, battery packs, etc.
BZ	Alarm units	All types.
C	Controls	Control Box, remote tuning control, etc.
*CG	Cable assemblies, RF	RF cables, waveguides, transmission lines, etc., with terminals.
CM	Comparators	Compare two or more input signals.
CN	Compensators	Electrical and/or mechanical compensating, regulating, attenuating apparatus.
CP	Computers	Mechanical and/or electronic mathematical calculating devices.
CU	Couplers	Impedance coupling devices, directional couplers, etc.
CV	Converters (electronic)	Electronic apparatus for changing the phase, frequency or from "one" medium to "another."
CW	Radomes	Radomes.
*CX	Cable assemblies, non RF	Non RF cables with terminals, test leads, also composite cables of RF and non RF conductors.
CY	Cases and cabinets	Rigid and semirigid structures for enclosing or carrying equipment.
D	Dispensers	Chaff.
DA	Loads, dummy	RF and non RF test loads.
DT	Detecting heads	Magnetic pickup devices, search coils, hydrophones, etc.
F	Filter units	Electronic types; band pass, low pass, band suppression, noise telephone, filter networks; excludes non-repaired types.
FR	Frequency measuring devices	Frequency meters, tuned cavities, etc.
G	Generators, power	Electrical power generators without prime movers (See PU)
H	Head, hand, and chest sets	Includes earphone.
HD	Environmental apparatus	Heating, cooling, dehumidifying, pressure, vacuum devices, etc.

*Not for use by contractors

Table 6-2.–Table Of Unit Indicators–Continued

Unit Ind.	Family Name	Example of Use (not to be construed as limiting the application of the unit indicator)
ID	Indicator units, non-cathode-ray tube	Calibrated dials and meters, indicating lights, etc (See IP).
IM	Intensity measuring devices	Includes SWR gear, field intensity and noise meters, slotted lines, etc.
IP	Indicator units, cathode-ray tube . .	Azimuth, elevation, panoramic, etc.
J	Interface units	Interconnecting and junction units, etc. Do not use if a more specific indicator applies.
KY	Keying devices	Mechanical, electrical and electronic keyer coders, interrupters, etc.
LS	Loudspeakers	Separately housed loudspeakers, intercommunication stations.
M	Microphones	Radio, telephone, throat, hand, etc.
MD	Modulators, demodulators, discriminators	Devices for varying amplitude, frequency or phase.
ME	Meters	Multimeters, volt-ohm-millimeters, vacuum tube voltmeters, power meters, etc.
MK	Miscellaneous kits	Maintenance, modification, etc.
ML	Meteorological devices	Miscellaneous meteorological equipment, etc.
MT	Mountings	Mountings, racks, frames, stands, etc.
MX	Miscellaneous	Equipment not otherwise classified. Do not use if a better indicator is available.
MU	Memory units	Memory units.
O	Oscillators	Master frequency, blocking, multivibrators, etc. (for test oscillators, see SG).
OS	Oscilloscope, test	Test oscilloscope for general test purposes (See IP).
PL	Plug-in units	Plug-in units not otherwise classified.
PP	Power supplies	Nonrotating machine type such as vibrator pack rectifier, thermoelectric, etc.
PT	Mapping and plotting units	Electronic types only.
PU	Power equipments	Rotating power equipment, motor-generators, dynamotors, etc.
R	Receivers	Receivers, all types except telephone.
RD	Recorder-reproducers	Sound, graphic, tape, wire, film, disc, facsimile, magnetic, mechanical, etc.
RE	Relay assembly units	Electrical, electronic, etc.
RL	Reeling machines	Mechanisms for dispensing and rewinding antenna or field wire, cable, etc.

Table 6-2.–Table Of Unit Indicators–Continued

Unit Ind.	Family Name	Example of Use (not to be construed as limiting the application of the unit indicator)
RO	Recorders	Sound, graphic, tape, wire, film, disc, facsimile, magnetic, mechanical, tape and card punch, etc.
RP	Reproducers	Sound, graphic, tape, wire, film, disc, facsimile, magnetic, mechanical, punched tape and card readers, etc.
RR	Reflectors	Target, confusion, etc. Except antenna reflectors (See AS).
RT	Receiver and Transmitter	Radio and radar transceiver, composite transmitter and receiver, etc.
S	Shelter	Protective shelter, etc.
SA	Switching units	Manual, impact, motor driven, pressure operated, electronic, etc.
SB	Switchboards	Telephone, fire control, power, power distribution, etc.
SG	Generator, signal	Test oscillators, noise generators, etc. (See 0).
SM	Simulators	Flight, aircraft, target, signal, etc.
SN	Synchronizers	Equipment to coordinate two or more functions.
SU	Optical units	Electro-optical units, such as, night vision autocollimator, scopes, sights, viewers, trackers, alignment equipment.
T	Transmitters	Transmitters, all types, except telephone.
TA	Telephone apparatus	Miscellaneous telephone equipment.
TB	Towed body	Hydrodynamic enclosures used to house transducers, hydrophones, and other electronic equipment.
TD	Timing devices	Mechanical and electronic timing devices, range devices, multiplexers, electronic gates, etc.
TF	Transformers	When used as separate units.
TG	Positioning devices	Tilt and/or train assemblies.
TH	Telegraph apparatus	Miscellaneous telegraph apparatus.
TN	Tuning units	Receiver, transmitter, antenna, tuning units, etc.
TR	Transducers	Sonar transducers, vibration pickup; etc. (See H, LS, and M).
TS	Test units	Test and measuring equipment not otherwise classified. Do not use if more specific indicators apply.
TT	Teletypewriter and facsimile apparatus	Miscellaneous tape, teletype, facsimile equipment, etc.
TW	Tape units	Preprogrammed with operational test and check out data.
V	Vehicles	Carts, dollies, vans peculiar to electronic equipment.
ZM	Impedance measuring devices	Used for measuring Q, C, L, R, or PF, etc.

Table 6-3.–Table of Group Unit Indicators

Group Ind.	Family Name	Example of Use (not to be construed as limiting the application of the group indicator)
OA	Miscellaneous groups	Groups not otherwise classified. Do not use if a more specific indicator, such as OD, OE, OG, etc., applies.
OB	Multiplexer and/or demultiplexer groups	Multiplexer groups, demultiplexer groups, composites thereof.
OD	Indicator groups	All types.
OE	Antenna groups	All types.
OF	Adapter groups	All types.
OG	Amplifier groups	All types.
OH	Simulator groups	All types.
OJ	Consoles and console groups	All types.
OK	Control groups	All types.
OL	Data analysis and data processing groups	All types.
OM	Modulator and/or demodulator groups	Modulator groups, demodulator groups, composites thereof.
ON	Interconnecting groups	All types.
OP	Power supply groups	All types.
OQ	Test set groups	All types.
OR	Receiver groups	All types.
OT	Transmitter groups	All types.
OU	Converter groups	All types.
OV	Generator groups	All types excluding power generating equipment.
OW	Terminal groups	Telegraph, telephone, radio, etc.
OX	Coder, decoder, interrogator, transponder groups	All types.
OY	Radar set groups	Do not use if a more specific indicator, such as OE, OR, OT, etc., applies.
OZ	Radio set groups	Do not use if a more specific indicator, such as OE, OR, OT, etc., applies.

CIRCUIT COMPONENT DESIGNATORS

Each level, from the set down to the smallest part, must be identified for inclusion in supply allowances, etc.

Set	AN/SPS-40B
Major Unit	MD-879/SPS-40B
Unit	3
Assembly	3A1
Subassembly	3A1A1
Reference Designator (Part)	3A1A1R1

<u>Unit numbers</u>

The unit numbers are assigned to each designated major unit.

AN/SPS-40B	–	Set
MD-879/SPS-40B	–	Unit 3
R-1788/SPS-40B	–	Unit 5
AS-1138/SPS-40B	–	Unit 12

<u>Assembly Designators</u>

Each unit contains one or more assemblies.

AS-1138/SPS-40B	12	
Drive assembly	12	A1
Antenna assembly	12	A2
	Unit	Assembly

Figure 6-7.–Circuit component designators.

Subassembly Designators

The assemblies may contain one or more subassemblies designated as A1, A2, A3, etc.

1	A1	A1
Unit	Assembly	Subassembly

The subassembly is usually a plug-in module that consists of several elements.

Reference Designators (Parts)

The subassemblies are constructed of discrete components (i.e., capacitors, resistors, terminals, sockets, transistors, electron tubes, etc.).

1 A1 A1 R1

R1 — component part

The "R" represents a resistor, however, each type of component has a symbol.

Sample component parts symbols.

E	Antenna
CR	Crystal Diode
V	Electron Tube
C	Capacitor
R	Resistor
T	Transformer

Any of the levels; unit, assembly or subassembly may have parts mounted directly on their chassis. Cabinet blower motors, filters, plugs, capacitors, resistors, etc.

Unit part	1R1
Assembly part	1A1R1
Subassembly part	1A1A1R1

Figure 6-7.–Circuit component designators–Continued.

NAVY MODEL LETTER SYSTEM (NMLS)

The Navy Model Letter System was used to assign nomenclature prior to JETDS. Although this system is no longer used, some equipments identified by this system still exist.

Equipment designators in the NMLS begin with either two or three basic letters. They are followed by a tack (-), a suffix number to indicate additional purchases of the equipment, if applicable, and a small letter to indicate modifications. Figure 6-8 shows the letter designations used in this system.

NAVY MODEL LETTER SYSTEM

EXPLANATION OF THE NAVY MODEL LETTER SYSTEM

Items in the Navy Model Letter Systems are designated by two or three basic letters–sometimes supplemented by prefix or suffix letters and/or numerals.

Equipments identical in all respects and purchased from the same contractor bear the same model designation. Additional equipment obtained for service for additional purchase is designated by a numeral following the original model letters. For example, on subsequent orders for the Model TAQ transmitting equipment, the equipment is identified by the designations TAQ-1, TAQ-2, etc. Additionally, if after acceptance by the Navy Department, NAVSEC authorizes a modification of the equipment, a lower case alteration letter is assigned to follow the model letters. For example, if a Model TAB-1 transmitter is modified after delivery by the addition of a harmonic suppressing circuit or unit, the model designation will be changed to TAB-1a. An additional modification of the TAB-1a or a modification of the TAB-1 differing from the "a" modification, will be indicated by a "b" and the equipment will be designated as TAB-1b.

Equipments of an experimental nature are assigned model letters beginning with "X" if manufactured by a Naval organization (e.g., XA, XB, etc), or with "C" if manufactured by a commercial company (e.g., CXA, CXB, CXAA, CXAB, etc).

Preliminary models of equipments, subsequently to become the property of the Navy, as required by the terms of a contract or similar authorization, are given an "X" prefix letter, separated from the basic designation by a dash. The preliminary (test) model of "Model TBU" was therefore designated "Model X-TBU."

The Navy Model Letter series is shown in the following figure.

Navy Model Letter System

Model letter series	Model subseries	Type equipment	Remarks
A		Airborne Radio and Radar Equipment.	All new assignments to Airborne Equipments shall be in the "AN" (Army-Navy) Nomenclature System.
	AB	Airborne IFF.	
	AI	Airborne Radar Intercept.	
	AM	Airborne Radio Transmitting and Receiving.	
	AR	Airborne Radio Receiving.	
	AS	Airborne Search Radar.	
	AT	Airborne Radio Transmitting.	
	AY	Airborne Radar Altimeters.	

Figure 6-8.–NMLS equipment indicators.

Model letter series	Model subseries	Type equipment	Remarks
B		Ship-Shore IFF Equipment.	
C	CX	All Commercial Experimental Equipment.	
D		Ship-Shore Radio and Radar Direction Finding Equipment.	
	DX	Assembled Direction Finder Equipments.	DF Assemblies which when used with a standard receiver form a complete DF equipment.
E		Emergency Power Equipment.	Gasoline or diesel engine generator sets.
F		Radar Fire Control Equipment.	"F" Series superseded by the BUORD RADAR MARK-MOD-Series.
F	See remarks		Subseries of "F" series in use for other than Fire Control Radar.
	FP	Facsimile Recording Equipment.	
	FQ	Facsimile Scanning Equipment.	
	FR	Frequency Shift Receiver Converter Equipment.	
	FS	Frequency Shift Keying Equipment.	
G		Airborne Radio Transmitting Equipment.	Classification canceled-Reassigned "AT" Series.
H		Hoist Train Mechanism.	Canceled-Hoist train mechanism considered as part of an equipment.
I		Intercept Radar.	
J		Sonar-Sound Listening (Receiving).	
L		Precision Calibrating Equipment.	
M		Radio Transmitting and Receiving Equipment.	
Radar Equip. Mark-Mod-		Radar Fire Control Equipment.	
N		Sonar Echo Sounding.	
	NA	Sonar Beacon.	
	NG	Echo Sounding (R/S).	
	NK	Portable Echo Sounding Recording.	
	NJ	Lightweight Echo Sounding Recording.	
	NM	Echo Sounding (magnetostriction).	

Figure 6-8.–NMLS equipment indicators–Continued.

Model letter series	Model subseries	Type equipment	Remarks
O		Measuring, Test and Operator Trainer Equipments for Models OA to OCZ inclusive. For Models OCZ on, the subseries breakdown is as follows.	
	OE	Xmtr and/or Rec. Analyzers. Vacuum Tube Voltmeters. Volt-Ohm-Milliammeters. Multimeters.	
	OF	Echo Boxes, Wavemeters, frequency meters (Non-precision).	
	OG	Signal Generators (Non-precision), Test Oscillators.	
	OK	Sonar Computers.	
	OM	Test Monitor Equipment.	
	OP	Signal and Sound Pulse or Wave Analyzers.	
	OQ	Sonar Practice Target Equipment.	
	OR	Field Intensity or Standing Wave Measuring Equipment, Noise Meters	
	OS	Oscilloscopes.	
	OT	Radar Operator Trainers.	
	OV	Vacuum Tube Analyzers or Testers.	
	OW	Sonar Test Equipment.	
	OZ	Impedance Measuring Equipment.	
P		Automatic Transmitting and Receiving Equipment Coding Equipment.	
Q		Sonar Echo-Ranging-Listening Equipment.	
	QA	E/R/L (Quartz).	
	QB	E/R/L. (R/S).	
	QC	E/R (Magnetostriction) with L (R/S).	
	QD	Depth Determining Equipment.	
	QF	Teacher & Training Equipment.	
	QG	Console Version of "QC" Series.	
	QJ	Console Version of "QB" Series.	
	QK	Scanning Sonar-Crystal.	

Figure 6-8.–NMLS equipment indicators–Continued.

Model letter series	Model subseries	Type equipment	Remarks
	QL	Frequency Modulated Sonar.	
	QX	Auxiliary Equipments to Echo Ranging Gear.	
R		Radio Receiving Equipment.	Panoramic Radio Adapters were included in this class up through Model REZ.
S		Search Radar Equipment.	
T		Radio Transmitting Equipment.	
	TP	Power Amplifiers.	
U		Remote Control.	
	UX	Mobile Remote Control.	
Y		Visual-PPI Repeaters.	
W		Sonar-Combined Ranging and Sounding.	
	WA	Combined Sounding-Ranging (Magnetostriction).	
	WB	Combined Sounding-Ranging R/S.	
	WC	Combined Sounding-Ranging, (M/S sounding) (R/S, &, M/S listening).	
	WD	Combined soundings-ranging R/S soundings) (M/S & R/S ranging and listening).	
	WE	Combined lightweight M/S Echo ranging with sounding feature removed.	
	WF	Combined Ranging-Sounding-Listening (Sonic and super-sonic listening using ADP crystals).	
X		Experimental (Navy designed).	
Y		Navigation and Landing Equipment. (Other than Direction Finders) (Beacons).	
Z		Airborne Navigation and landing.	Classification canceled-Reassigned "AY" SERIES.

Figure 6-8.–NMLS equipment indicators–Continued.

MIL-HBK-140, which is no longer in effect, is the reference for NMLS.

NAVY TYPE DESIGNATION SYSTEM (NTDS)

Under the NTDS, there are two methods for assigning nomenclature: numerical, which consists of five digits, and alphanumeric, which consists of two digits and three letters, for example 66047 (35-foot whip antenna) and 30AAP (voltage regulator). In both systems, the first two digits indicate the class of material and are defined in figure 6-9.

The next three characters indicate the order in which the class of material was assigned nomenclature and

NAVY TYPE DESIGNATION SYSTEMS

EXPLANATION OF THE NAVY TYPE DESIGNATION SYSTEM

Navy type designations are assigned to denote major units and also to most component parts likely to require replacement during the normal life of the equipment involved. There are two systems of type designations–the Numerical System of Navy Type Designations, and the Alphabetical System of Navy Type Designations.

The *Numerical System*–In the numerical system the designation is composed of a Navy type (e.g., 21426), a group of prefix letters to indicate the manufacturer of the item (e.g., CZZ) and when necessary, a suffix letter. The prefix letters and the Navy type number are separated by a dash to form the complete Navy type designation (e.g., CZZ-21426). Once *prefix letters* are assigned to a manufacturer, they remain the permanent identification of the company and precede the Navy type numbers of all material manufactured by him. Preliminary models of major units are identified by a special description consisting of the Navy type number assigned for the corresponding unit of the production equipment prefixed by the letter "X," i.e., CRV-X52041. The numerical portion of the Navy type designation is assigned in order of receipt of request, the last three or four numbers being the order, the first two being the "class." The significance of the first two digits in each type number is shown in the figure below.

The *suffix letter* is assigned to differentiate units of improved or different manufacture which are entirely interchangeable as units but, due to difference in construction, are not necessarily interchangeable with respect to their integral parts. The suffix letter is separated from the numerical portion by a dash. For example:

(a) Navy Type-61046-A insulator is identical to -61046 except that the glaze is changed from white to chocolate color.

(b) Navy Type-21426-A motor-generator set is identical to -21426 except that steel has replaced cast-iron throughout.

The *Alphabetical System*–The alphabetical system, which is used for units peculiar to radar equipments and special apparatus, is analogous to the numerical system except that the last three or four numbers of the numerical portion are replaced with alphabetical letters starting with AAA and progressing alphabetically; such as AAA, AAB, AAC . . . AAZ, ABA, ABB . . . etc. Also, the suffix letter is replaced by a suffix number; the first modification being indicated by the number "1," etc. A few examples of this system are CZZ-21AAA, CRV-46ABK, CRV-66ACY, CRV-66ACY-1, etc. The fundamental principles governing the application of both systems of Navy type designations are the same.

Class No.	Material
10	MISCELLANEOUS: To be used when a definite class is not available.
14	SPECIAL RF DEVICES (NOT COVERED BY ANY OTHER CLASSIFICATION). (Electronic switching, etc.)
18	PRIME MOVERS AND ACCESSORIES: All types except electrical.

Figure 6-9.–NTDS material class numbers.

Class No.	Material
19	BATTERIES: All types; parts and accessories.
20	RECTIFIER POWER UNITS-VOLTAGE REGULATORS-COPPER OXIDE RECTIFIERS; All types.
	A20 CRYSTAL DETECTORS.
21	MOTORS-GENERATORS-DYNAMOTORS-MOTOR GENERATORS-ROTARY CONVERTERS, ETC.- MOTOR CONTROLLERS.
22	INSTRUMENTS-ELECTRICAL INDICATING AND RECORDING.
23	CONTROL PANELS AND CONTROL UNITS. (Except Motor Controllers.)
24	SWITCHES. Manually operated.
25	SHIELDS AND SHIELDING MATERIAL: Finishes.
26	KEYS-TELEGRAPH: Manually operated.
28	PROTECTIVE DEVICES: Static types.
29	ELECTROMAGNETIC CONTACT DEVICES: All types.
30	TRANSFORMERS AND REACTORS: Power and audio.
35	OSCILLATORS-COMPETE UNITS (Audio or RF).
36	RANGING EQUIPMENT-RADIO (Localizer, Rotating Beacons, etc).
38	VACUUM TUBES-PHOTO ELECTRIC CELLS. All types.
40	PIEZO-ELECTRICAL CRYSTALS AND HOLDERS-THERMOMETERS AND THERMOSTATS.
41	COMPENSATORS-UNDERWATER SOUND.
43	TRANSMITTER-RECEIVER UNITS (Combined): Equipment in which the transmitter and receiver are not separable as units.
46	RECEIVER UNITS AND CONVERTERS (RF TO IF, etc.)-RADIO AND SOUND.
47	RF TRANSFORMERS-INDUCTORS-CHOKES.
48	CAPACITORS: All types.
49	HEAD TELEPHONES-TELEPHONE CORDS-PATCH CORDS-LOUDSPEAKERS-PLUGS-JACKS-SOCKETS-RECEPTACLES: All types.
50	AMPLIFIER, MODULATOR AND COUPLER UNITS-ELECTRONIC CONVERTERS-MIXING PANELS: All types (Complete Diplex and Duplex units.) See 14 for electronic switching.
51	MICROPHONES-HYDROPHONES-UNDERWATER SOUND ELECTRICAL PICKUP DEVICES-COMBINATION HANDSETS: All types.
52	RADIO TRANSMITTER UNITS: Includes RF drivers for underwater sound equipment, etc.
53	FILTER UNITS: All electrical types.
54	SOUND RECEIVING DEVICES-ACOUSTICAL.
55	INDICATORS AND RECORDERS: Radio, Radar and Underwater Sound. (Indicating instruments under class 22.)
56	WAVE PROPAGATION.

Figure 6-9.–NTDS material class numbers–Continued.

Class No.	Material
59	TELEVISION-PHOTO-RADIO.
60	TEST EQUIPMENT (Integral instruments under Class 22.) A6O TRAINING EQUIPMENT (Operator trainers and instruction devices).
61	INSULATORS AND INSULATING MATERIAL: Phenolic and ceramic.
62	WIRES AND CONDUCTORS-JUNCTION BOXES. A62-RF TRANSMISSION LINES AND RF CABLES, etc.
63	RESISTORS: All types.
64	STATIC RECORDERS AND ELIMINATORS.
65	REMOTE CONTROL SYSTEMS BY WIRE: Repeater systems, etc.
66	ANTENNAS-ANTENNA ASSEMBLIES. (Dummy and phantom antennas.)
67	AUTOMATIC SYSTEMS, FACSIMILE, TELE-AUTOMATIC: Automatic keyers and recorders.
68	SECRECY SYSTEMS: Sending and receiving. (Speech scrambling.)
69	DIRECTION FINDING EQUIPMENT: Radio.
70	DISTANCE FINDING. A70 RADIO ALTIMETERS.
72	PORTABLE EQUIPMENT-FIELD SETS.
73	COMBINED GAS ENGINE GENERATOR SETS.
74	PRECISION CALIBRATION AND MEASURING EQUIPMENT.
75	STANDARDS: (Including standardization notices, etc).
78	HF UNDERWATER SOUND PROJECTOR (above 10 kHz) and supporting parts.
79	LF UNDERWATER SOUND PROJECTOR (10 kHz or below).
83	FREQUENCY CONTROL SYSTEMS.
84	CONTROL BY RADIO.
85	INTERFERENCE REDUCTION.
87	EXPERIMENTAL SUPERFREQUENCY EQUIPMENT.
88	INSTRUMENT LANDING EQUIPMENTS.
89	RADIO RECOGNITION AND IDENTIFICATION DEVICES.
90	VISUAL SIGNALLING APPARATUS. (This classification for type number assignments only).

Figure 6-9.–NTDS material class numbers–Continued.

ordered (three numbers in the numerical system, or three letters in the alphanumeric system). This is followed by a tack (-) and a modification letter in the alphanumeric system or number in the numeric system.

This nomenclature may be prefixed with "NT-" which indicates Navy Type. This prefix is still widely used for antennas (i.e., NT-66047, which is a 35-foot whip antenna.) Any prefix other than NT is a manufacturer's designating symbol.

MARK AND MOD NOMENCLATURE SYSTEM

The MARK-MOD nomenclature consists of the name of the equipment and a sequence of "MK-MOD"

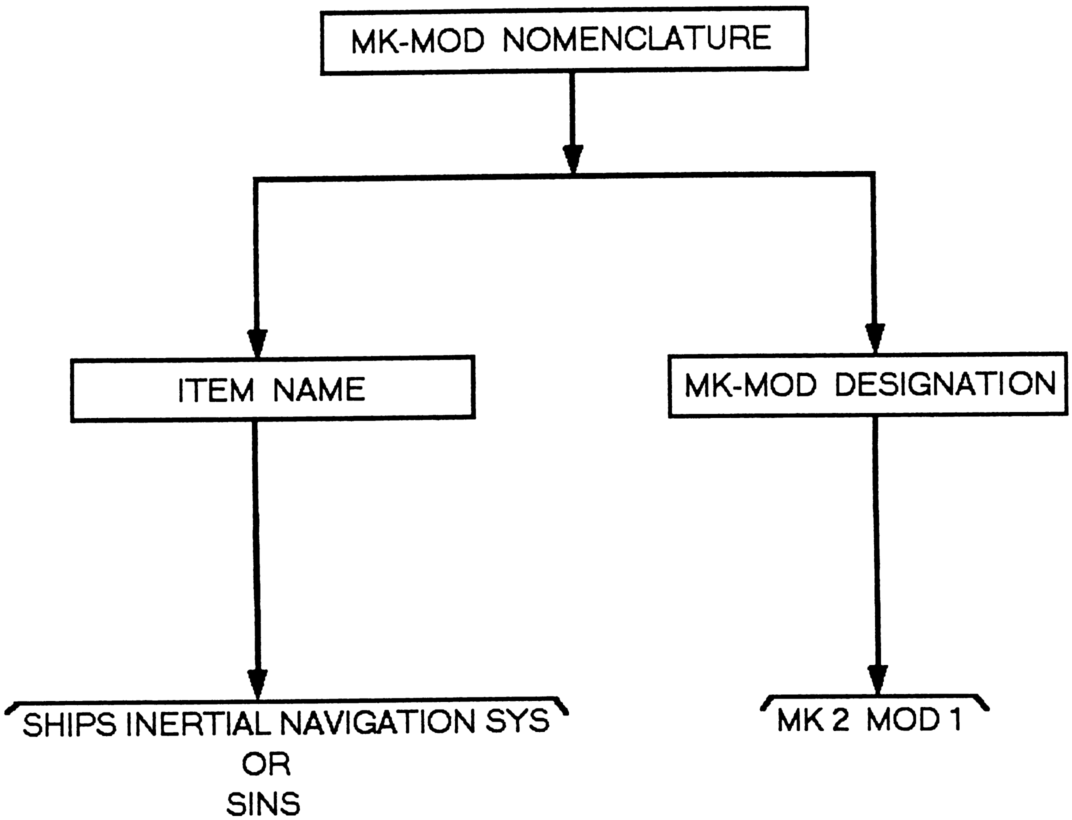

Figure 6-10.–Example of MK-MOD nomenclature.

letters and numbers as shown in figure 6-10. Unlike in the JETDS designation system, the item name must always be included with the MK-MOD designation to specifically identify an item of equipment. The MK-MOD designations are assigned in numeric sequence within each equipment type. The item name may be spelled out, but the accepted letter-group abbreviation (e.g., SINS, DRAI, MSR, WDE, WDS, etc.) are preferred for lengthy names. See figure 6-10. This system is used primarily for weapons systems, but you will see it as well in some test equipment and other equipments onboard.

TELECOMMUNICATIONS SECURITY (TSEC) NOMENCLATURE SYSTEM

The TSEC system is similar to JETDS and is assigned to all Communications Security (COMSEC) equipment and materials. This nomenclature is approved by the Director, National Security Agency (NSA), as set forth in CSP-1, Annex D.

The format for equipment is: "TSEC," followed by a slant (/), three letters (called function designators), and the item number. Function designators are broken down in figure 6-11. An example is the TSEC/KWR-37, which is a Cryptographic Teletypewriter Receiver, Model Number 37.

Assemblies, as described in JETDS, have their own format. Listed first are the item function designators, followed by a tack (-), the item number, and the suffix "/TSEC." For example, a KYB-6/TSEC is (again referring to figure 6-11) a cryptographic speech cabinet.

There are also COMSEC AIDS, which will always have the letter "A" as a second character, for example, KAM. This directs you to use the COMSEC AIDS column of figure 6-11.

COMMERCIAL NOMENCLATURE SYSTEM

The commercial nomenclature system is assigned to equipment used by the military but not assigned nomenclature under any other system. This system is most predominantly used in identifying test equipment. But it is also used to identify a variety of other special types of equipment.

Commercial nomenclature consists of a model number assigned by the manufacturer, preceded by a code that identifies the manufacturer. (Manufacturer's identification codes, MDS and Commercial and

Telecommunications Security (TSEC) Nomenclature System

THIS INFORMATION SHEET IS PROVIDED TO FAMILIARIZE THE PROSPECTIVE ELECTRONICS MATERIAL OFFICER WITH NOMENCLATURE USED WITH TSEC OR TELECOMMUNICATIONS SECURITY EQUIPMENT. FOR FURTHER INFORMATION AND AMPLIFICATION, REFER TO CSP-1 APPENDIX D

FUNCTION

K	CRYPTOGRAPHIC
H	ANCILLARY
M	MANUFACTURING
S	SPECIAL PURPOSE
N	NONCRYPTOGRAPHIC COMSEC

TYPE

A	COMSEC AID
G	KEY GENERATOR
I	DATA TRANSMISSION (CITROL)
L	LITERAL CONVERSION
N	SIGNAL CONVERSION EQUIPMENT
O	MULTIPURPOSE
P	MATERIALS PRODUCTION
S	SPECIAL PURPOSE
T	TESTING, CHECKING
U	TELEVISION (CIVISION)
W	TELETYPEWRITER
X	FACSIMILE (CIFAX)
Y	SPEECH (CIPHONY)

EQUIPMENT ASSEMBLIES

A	ADVANCING
B	BASIC, BASE, CABINET
C	COMBINING
D	DRAWER, PANEL
E	STRIP, CHASSIS
F	FRAME, RACK
G	KEY GENERATOR
H	KEYBOARD
I	TRANSLATOR, READER
J	SPEECH PROCESSING
K	KEYING
L	REPEATER
M	MEMORY OR STORAGE
O	OBSERVATION
P	POWER SUPPLY
R	RECEIVER
S	SYNCHRONIZING
T	TRANSMITTER
U	PRINTER
X	SPECIAL PURPOSE

COMSEC AIDS

A	AUTHENTICATION SYSTEM
C	CODE SYSTEM
F	COMPUTER CRYPTOGRAPHIC PROGRAM
G	GENERAL PUBLICATION
I	RECOGNITION AND OR IDENTIFICATION SYSTEM
K	KEY LIST
L	MISCELLANEOUS
M	MAINTENANCE MANUAL
N	COMPUTER KEYING MATERIAL
O	OPERATING INSTRUCTIONS
P	ONE TIME PAD
R	ROTOR
S	STRIP
T	ONE TIME TAPE
Y	KEY CARD
W	CARD READER INSERT BOARD
Z	PERMUTING PLUG

Figure 6-11.–Telecommunications Security (TSEC) nomenclature system.

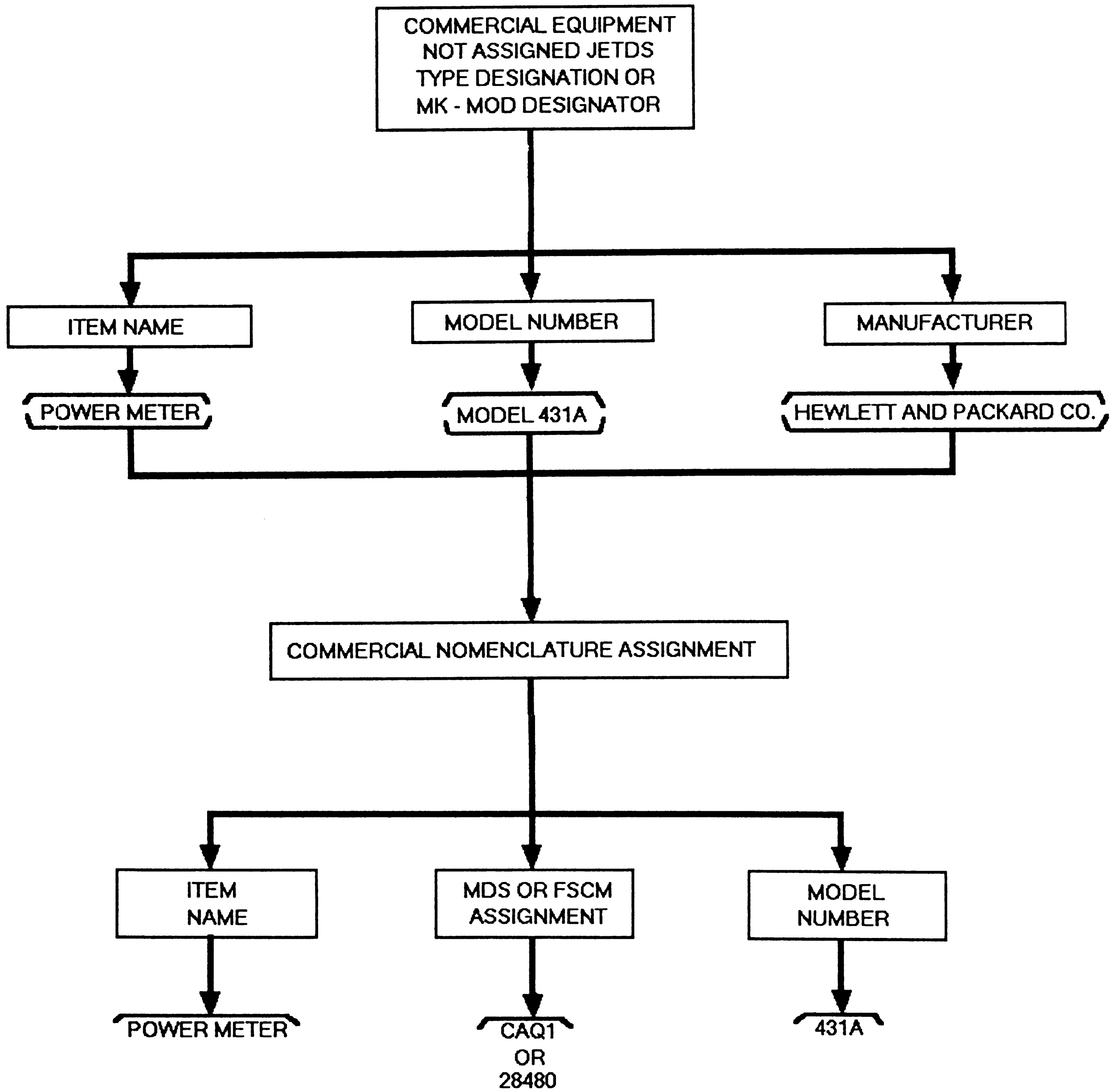

Figure 6-12.–Commercial nomenclature assignment.

Government Entity (CAGE), will be addressed in the chapters relating to supply.) Figure 6-12 shows the basic structure of the Commercial Nomenclature System.

MAINTENANCE

The mission of the electronics division is to support the mission of the ship by maintaining all assigned electronic equipment at the specified standards of performance. This is done by performing all preventive maintenance actions on schedule and by taking immediate steps to perform corrective maintenance to eliminate deficiencies that may arise. You, as the EMO, should keep both your department head and your commanding officer informed of the current status of all assigned electronic equipment. You should also advise them, at least 36 hours before getting underway, of any equipment that is not operating at the required level of performance.

LEVELS OF EQUIPMENT MAINTENANCE

Three levels of equipment maintenance are performed within the Navy. They are organizational level maintenance, intermediate level maintenance, and depot level maintenance. Since both intermediate and depot level maintenance are beyond the capability of ship's force, we will only define them in this chapter. We will discuss them in more detail in chapter 8.

Organizational Level Maintenance

Organizational level maintenance is the first level of maintenance and consists of preventive and corrective maintenance performed on a ship by the ship's force. This work is a blend of equipment operation, condition monitoring, planned maintenance actions, and repair. It ranges from simple equipment lubrication to component changeout and, in some cases, complete rework in place.

Each ship must be as self-sufficient as possible. The Planned Maintenance System, described in the *Maintenance and Material Management (3-M) Manual*, OPNAVINST 4790.4B, defines the minimum preventive maintenance program to be carried out on board the individual ship. Each ship's command must ensure that maintenance is planned, scheduled, and done effectively.

Intermediate Level Maintenance

Intermediate level maintenance is usually done by IMA personnel on tenders, repair ships, aircraft carriers, fleet support bases, and Shore Intermediate Maintenance Activities (SIMAs). It normally consists of calibration; repair or replacement of damaged or unserviceable parts, components, or assemblies; emergency manufacture of nonavailable parts; and providing technical assistance to using organizations.

Depot Level Maintenance

Depot level maintenance requires skills and facilities beyond those of organizational and intermediate levels. Depot level work can include the manufacturing of parts, installation of modifications, testing, and reclamation as required. This type of work is normally done at naval shipyards, private shipyards, naval ship repair facilities, or other shorebased facilities during scheduled periods of maintenance, called availabilities, and regular overhauls.

PREVENTIVE MAINTENANCE

Preventive maintenance is the systematic performance of actions necessary to reduce or eliminate failures and to prolong the useful life of the equipment. All preventive maintenance actions are grouped into four basic categories: routine maintenance, routine inspections, testing, and adjusting. Preventive maintenance actions are directed through the preventive maintenance system (PMS).

The preventive maintenance system is a part of the Maintenance and Material Management (3-M) Systems. The importance of the PMS system cannot be overemphasized, as it prescribes the minimum maintenance requirements to be performed on equipment. As the EMO, you must understand both the scheduling and the administrative procedures of the PMS system. The four basic categories of PMS are discussed below.

Routine Maintenance

Routine maintenance is the performance of special procedures for inspecting, cleaning, and lubricating equipment. The term "special procedures" is used because approved and standard methods are used whenever such maintenance actions are performed. For example, certain methods have been approved for cleaning and lubricating ball bearings. Whenever a ball bearing requires lubrication, it must first be cleaned using approved methods and solvents, and then it must be lubricated with the proper lubricant. Included with the lubricating instructions are lubrication charts that specify approved lubricants and their general usage.

Routine Inspections

Routine inspections include such actions as checking equipment ground straps for loose connections; checking for broken or frayed straps; checking tightness of screws, bolts, and nuts; checking oil reservoirs for the proper quantity of oil; checking front panel indicators and illumination for burned-out bulbs; and the like. Such inspections require direct analysis and judgment, and may lead on to corrective maintenance.

Testing

Testing of electronic systems involves the use of calibrated instruments to obtain electrical, mechanical, or chemical measurements from the equipment's circuits and other devices, for comparison with established standards. By observing the responses and indications of the test instruments, and by comparing the results with established standards, the technicians can determine if the circuits or devices are functioning as they should.

The difference between a test and an inspection is that a test involves the use of an instrument to determine a condition not perceivable by the human senses or which could be hazardous to your health. With the information provided by the instrument, the technician can then make an examination and analysis. On the other hand, an inspection requires direct examination by human senses, normally sight.

Adjusting

Adjusting of electronic equipment is a broad term that encompasses all of the following phases:

1. Adjustments to rearrange or change a function or characteristic
2. Circuit alignment that adjusts one or more sections of a circuit or system so their functions are properly synchronized
3. Circuit calibration by which circuits or instruments of a given accuracy standard are checked against standards of higher accuracy and then aligned or adjusted accordingly

CORRECTIVE MAINTENANCE

Corrective maintenance is the performance of the actions required to restore an inoperative piece of equipment, or one operating at reduced capability, to a fully operative condition. Corrective maintenance actions may be routine or they may be the actions needed to repair an equipment after a casualty. Every corrective maintenance action, regardless of the situation, involves performing a sequence of basic operations. We will provide a brief discussion of the steps involved in corrective maintenance so that you, as EMO, may be more knowledgeable in the repair of malfunctioning equipment. Familiarity with the actions the technicians undertake to place the equipment online is important. These actions, listed below, are discussed in the subsections which follow.

- Troubleshooting
- Maintenance Action Documentation

Troubleshooting

Troubleshooting involves identifying and analyzing system troubles. It is a logical six-step procedure as follows:

1. Symptom recognition
2. Symptom elaboration
3. Listing of probable faulty functions
4. Localizing the faulty function
5. Localizing the trouble to the circuit
6. Failure analysis

SYMPTOM RECOGNITION.–Before a technician can repair an equipment, he or she must first recognize that a problem exists. All electronic equipment is designed to do a specific job or group of jobs. This demands a certain type of performance at all times. Deviations from performance specifications are always indicated by some kind of symptom. For this reason the recognition of trouble symptoms is the first step in troubleshooting an equipment.

A trouble symptom is a sign or indicator of some disorder or malfunction. Symptom recognition is the act of identifying such a sign when it appears.

Very often, a competent equipment operator can see or sense an equipment malfunction that can be corrected without the aid of the technician. However, operators are not qualified technicians and are responsible for reporting a malfunction or a symptom of probable malfunction to the appropriate technician.

Not all pieces of equipment produce symptoms that are easily recognized; some problems are discovered only during preventive maintenance. Each technician must be able to recognize both apparent and not so apparent symptoms.

SYMPTOM ELABORATION.–Symptom elaboration is the process of obtaining a more detailed description of the trouble symptom. Recognizing that the fluorescent screen of a cathode-ray tube is not lighted is not sufficient for deciding exactly what could be causing the trouble. This symptom could mean that the cathode-ray tube is burned out, that there is some disorder in the internal circuitry associated with the tube, that the intensity control is turned down too low, or even that the equipment is not turned on. Think of the time the technician might waste by tearing into the equipment and beginning testing procedures when all that is necessary is to is flip the "on-off" switch to on, adjust the intensity control, or plug in the main power cord.

After the technician has recognized the equipment trouble, he or she should use all the available aids designed into the equipment to further elaborate on the symptom. The use of front panel controls and other built-in indicating and testing aids will provide better identification of the symptom. The equipment operation sections of technical manuals may serve as guides. Breaking out the test equipment and equipment diagrams and proceeding headlong into testing

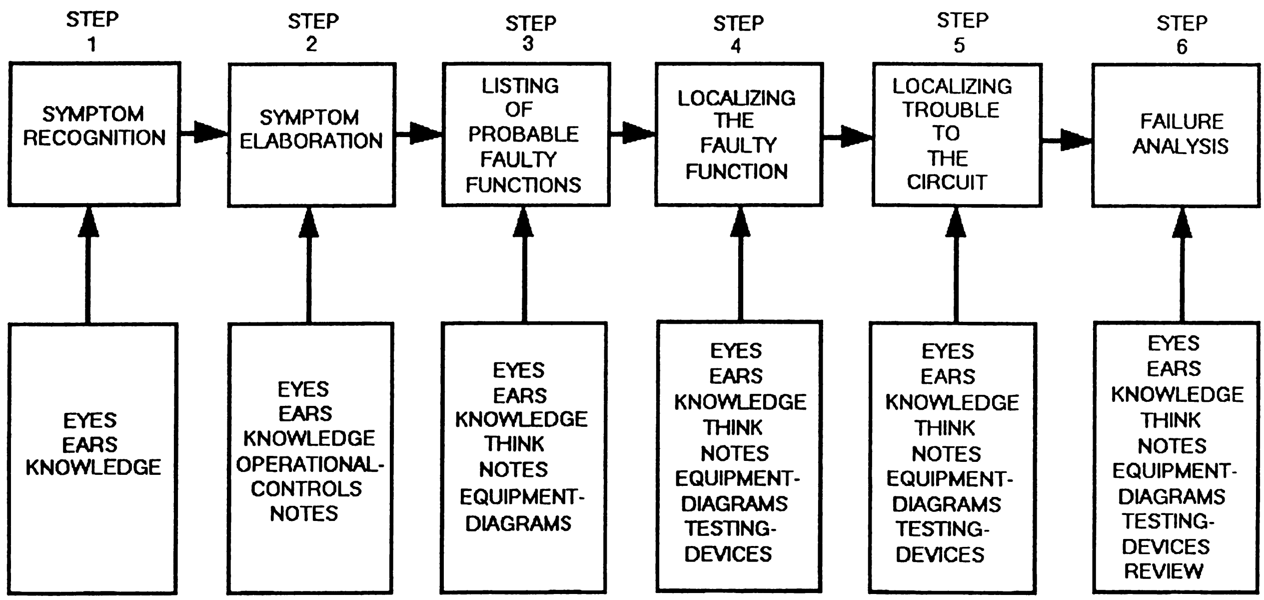

Figure 6-13.–The six-step procedure.

procedures on just the original recognition of a trouble symptom is not a wise approach. A technician who fails to completely define a trouble symptom first may be quickly and easily led astray. The result might very well be a loss of time, unnecessary expenditure of energy, or perhaps even a total dead-end. This is the "I need more information" step in our systematic approach.

LISTING OF PROBABLE FAULTY FUNCTIONS.–The next step in troubleshooting is to formulate a number of logical ideas of what may be wrong. The ideas should be based on a knowledge of how the equipment operates, a full identification of the symptom, and information contained in technical manuals. (The overall equipment functional descriptions with associated block diagrams are especially helpful.)

LOCALIZING THE FAULTY FUNCTION.–Once the malfunction is identified, its basic source must be localized to a function. Localizing the malfunction is normally done by using the servicing block diagrams in technical manuals. The potential sources of the problem should be checked by following the signal flow, according to the block diagrams, through the equipment in an order that will require the least time. Each potential source should be checked in a logical manner until the faulty function or basic cause of the symptom is found.

LOCALIZING THE TROUBLE TO THE CIRCUIT.–Once the malfunction is localized to a function, it may be necessary to identify which circuit, or group of circuits is at fault. Again, the servicing block diagrams for the equipment are used, along with schematics and other installed test equipment information. If the trouble is not immediately apparent, other test methods are then necessary to further isolate the fault. Some of these are waveform analysis, voltage checks, resistance checks, tube testing, semiconductor testing, and module testing. This process continues until the specific cause is located. Examples of specific causes are defective components, improper wiring and soldering of components and terminations, loose connectors and shielding, covers left off circuits and equipment cabinets, circuits not in proper electrical alignment, and dirty air filters.

FAILURE ANALYSIS.–After the faulty component, misalignment, or other problems, have been located, but prior to making the repair, the technician should review the procedures followed up to this point to determine exactly why the fault affected the equipment in the manner it did. This review is usually necessary to make certain that the fault discovered is actually the cause of the malfunction, and not just the result of the malfunction. For example, a defective transistor may have caused the loss of a certain function, but insufficient cooling may be what caused the transistor to fail.

The six-step troubleshooting procedure is summarized in figure 6-13.

Documenting Actions

Although not directly connected with troubleshooting procedures, documentation is the final step in completing a maintenance action. The following paragraphs briefly describe documentation.

Documentation is the record of maintenance actions and is the keystone of the Maintenance Data System (MDS), another portion of the 3-M system. Documentation is provided by shipboard personnel for all shipboard maintenance actions, including computer software problems. This documentation describes what was done or needs to be done, why it was done or needs to be done, who did it or who needs to do it, and what resources were used or are needed. This is done by preparing an OPNAV 4790/2K as described in OPNAVINST 4790.4B, the 3-M manual. The purpose of this documentation is to give equipment, personnel, logistics, and funding managers feedback to aid them in correcting common problems and making better decisions concerning future equipment. Maintenance action documentation is probably the most neglected area of maintenance and one which needs constant attention.

Regardless of how effective the preventive maintenance program on your ship is, electronic equipment will continue to malfunction and be degraded by battle, foul weather, accidents, and so on. Most equipment malfunctions and minor damage can be repaired by the ship's force, but the more severe casualties may require repair at the intermediate or depot level.

EQUIPMENT OVERHAUL

Work at organizational, intermediate, and depot levels is always specified as one of five classes (A, B, C, D, or E), based on the type of work to be performed. The class designation system enables both maintenance personnel and their supervisors to know the extent of work requested for a particular item. The following is a brief explanation of the five classes.

Class A Overhaul

A class A overhaul is designed to bring a system, subsystem, or component up to the most recent design and technical specifications. During a class A overhaul, all applicable manufacturer's and technical manual performance standards and specifications are met, all technical documentation is brought up to date, and the overhauled item is tested for compliance with government-specified criteria. Class A overhauls may be made to components or subsystems of ship weapons, machinery, electrical, hull, or electronic systems, or to an entire system. These overhauls may include ship alterations (SHIPALTs), ordnance alterations (ORDALTs), and field changes.

Class B Overhaul

A Class B overhaul is designed to bring a system, subsystem, or component back to its original design and technical specifications. Other modifications, including ORDALTs and SHIPALTs are not made unless they are specifically requested by the customers. Maintenance and calibration routines are performed, as appropriate, and each item is tested for compliance with government specified performance criteria.

Class C Overhaul

A Class C overhaul involves repair work specified on a work request, or work required to correct particular deficiencies or malfunctions identified on a work request, for a system, subsystem, or component. The repairing activity must show that the work requested has been done or that the deficiencies or malfunctions have been corrected. However, the repairing activity is not responsible for ensuring that components associated with the repaired item function properly or that the entire system functions properly.

Class D Overhaul

A Class D overhaul includes work associated with the "open, inspect and report" type of work request in which the customer is not sure what is wrong with the item. The repairing activity will report findings, recommendations, and cost estimates to the customer for authorization prior to beginning any repair work. Minor repairs and adjustments may, at the request of the customer, be made without additional authorization.

Class E Overhaul

A Class E overhaul involves work required to make specific modifications to a designated system, subsystem, or component. The repairing activity must show that the modifications were successful and that the item meets operational standards, but only to the extent required by the modification orders. However, the repairing activity may, at the request of the customer, conduct system tests to prove that the system will work properly with the modified item reinstalled. Repairs, if any, are minor.

ALTERATIONS TO SHIPS AND EQUIPMENT

An alteration is any modification to the hull, machinery, equipment, or fittings that involves a change in the design, materials, number, location, or relationship of the component parts of an assembly. Alterations may be made by themselves or in conjunction with repairs. Requests for alterations may originate from the fleet, from the Naval Sea Systems Command (COMNAVSEASYSCOM or NAVSEA), or from the Chief of Naval Operations (CNO). As the EMO, you will be responsible for understanding the various types of alterations, and what actions will be required to get them done.

Before you allow the installation of any alteration, make sure a complete equipment operational check is conducted. Serious complications could result if an alteration is installed in equipment that is not fully operational.

Alterations to naval ships, whether they are designated (SHIPALTs) or (ORDALTs), special project alterations (SPALTs), or as any other systems command controlled alteration or modification (except electronic equipment field changes) are categorized as one of the three types described in the following paragraphs.

Military Alteration

A military alteration changes or improves the operational or military characteristics of a ship.

Technical Alteration

A technical alteration does not affect the operational or military characteristics of a ship. In general, technical alterations concern matters of safety of personnel and equipment, or equipment performance.

Alteration-Equivalent-to-Repair

An alteration-equivalent-to-repair (AER) is an alteration that has one or more of the following characteristics:

- The use of different materials that have been approved similar use and which are available from standard stock.

- The replacement of obsolete, worn-out or damaged parts, assemblies, or equipment requiring renewal by those of later and more efficient design previously approved by the systems command concerned.

- The strengthening of parts that require repair or replacement to improve the reliability of the parts and the unit, provided no other change in design is involved.

- Minor modifications involving no significant changes in design or functioning of equipment, but considered essential to eliminate the recurrence of unsatisfactory conditions.

Authority for the Approval and Authorization of Alterations

The word **approve** used in connection with an alteration indicates that the controlling agency agrees with the proposed change. Publication of an approved alteration constitutes authority to expend design resources to plan for the alteration, but does not constitute authority to procure material or to actually make the alteration. The word **authorize** is used to signify permission to proceed with the installation and the granting of funds for a specific ship during a particular availability.

Alterations affecting the military characteristics of a ship (military alterations) may be approved only by the Chief of Naval Operations, who will determine when the alterations are to be made.

Alterations not affecting the military characteristics of a ship (technical alterations) may be approved and authorized by agencies at lower levels, without prior CNO approval.

Alterations-equivalent-to-repairs may be approved and authorized by fleet or type commanders to the extent of the authority delegated to them by the systems commands concerned.

Unauthorized Modifications

OPNAVINST 4720.93 states, "Changes, alterations, and arrangement variations from the approved class plans on ships under construction, in overhaul, or in operation are prohibited. Specifically, no alterations shall be made unless previously approved and authorized in writing by competent authority."

Emergency Alterations

Alterations made for emergency purposes, where advance authorization is impossible, must be reported to NAVSEA and to other appropriate authorities at the earliest practical time.

When circumstances warrant emergency alterations, adequate consideration should be given to the safety of personnel and equipment and to the basic equipment performance requirements. Requests for the approval of alterations to the ship or ship's equipment or systems must be forwarded to NAVSEA via the applicable type commander (with an information copy to the type commander of the opposite fleet). The two type commanders will then forward to NAVSEA their recommendations concerning the proposed (or emergency) alteration and a list of ships affected.

Ship Alterations (SHIPALTS)

A ship alteration (SHIPALT) is an alteration that involves material under the technical control of NAVSEA. Alterations that affect shipborne systems and equipment under the technical control of other systems commands (e.g., ORDALTs, air alterations, and SPALTs) are not SHIPALTs, but may require concurrent SHIPALTs to modify ship equipment associated with the other equipment to be modified. SHIPALTs are assigned categories (or "Titles") as follows:

1. Title D alterations are alterations-equivalent-to-repairs. Title D SHIPALTs are approved by NAVSEA, authorized by type commanders, and funded under Operation and Maintenance of the Navy (O&MN) program as operating expenses.

2. Title F alterations can be done by forces afloat and do not require special program material or centrally procured material. Special program material is material that is procured specifically to support approved SHIPALTs and is provided to the installing activity on a nonreimbursable basis. Title F SHIPALTS are authorized and funded by type commanders, with no industrial assistance required.

3. Title K is assigned to all other types of SHIPALTs authorized by NAVSEA. Program and installation cost is funded by the CNO under the O&MN account.

FLEET MODERNIZATION PROGRAM (FMP)

Each year the Navy re-evaluates its missions and the threat faced by Navy forces. Analysis of the results leads to a statement of Required Operational Capabilities (ROC) in the Projected Operational Environment (POE) for each class of ships. The ROC and POE then serve as the basis for determining necessary modifications and modernization of existing ships.

Attaining the operational capabilities required for every ship to best carry out its assigned missions is the primary goal that drives the Fleet Modernization Program. Other goals include increasing fleet readiness by improving standardization for all ships of a class; improving safety, repair, habitability, reliability, and maintainability; and completing the highest priority alterations in the most timely manner.

Several terms used in discussing the FMP are as follows:

1. Military Improvement. A military improvement changes or improves a ship's operational or military characteristics. The decision to incorporate a proposed military improvement rests solely with the CNO.

2. Military Improvement Plan (MIP). A Military Improvement Plan (MIP) lists all military alterations for a particular class of ship and is arranged in priority order by the Ship Acquisition and Improvement Panel–Working Group (SAIP–WG). Each MIP is approved by the CNO.

3. Technical Improvement. A technical improvement results in a change to improve the safety of personnel and equipment or to provide increased reliability, maintainability and efficiency of installed equipment. A technical alteration does not affect the operational or military characteristics of a ship.

4. Technical Improvement Plan (TIP). A Technical Improvement Plan (TIP), approved by CHNAVMAT, lists in priority order all technical improvements for a particular class of ship.

5. Amalgamated Military Technical (AMT) Improvement Plan. The AMT consists of all active, approved Title K alterations and ORDALTs. The AMT portion of the FMP is planned and funded by the CNO and implemented by COMNAVSEASYSCOM. The CNO retains exclusive control over all changes to the AMT plan for the current and future fiscal years.

6. TYCOM Alteration Matrix (TAM). The TAM consists of all active, approved Title D and F SHIPALTs. The TAM portion of the FMP is planned and funded by type commanders. TYCOMs retain exclusive control over changes to the programming of all depot level Title D and F SHIPALTs in execution and programming fiscal outyears.

PROGRAM PHASES

The FMP process consists of four phases:

Evaluation of proposed improvements

Alteration development

Program formulation

Program execution

Evaluation of Proposed Improvements Phase

Based on the capability to be added to the class of ships, an improvement is proposed and documented as a Proposed Military Improvement (PMI) or Proposed Technical Improvement (PTI). The PMI is submitted to OPNAV for approval and the PTI is submitted to the appropriate NAVSEA Ship's Logistics Manager (SLM) for approval. The submittal of the PMI or PTI is the first event in the FMP process.

Alteration Development Phase

This phase transforms an approved PMI or PTI into alterations that can be made by depot, intermediate, and organizational maintenance activities during ship availabilities. The second phase may occur simultaneously with the early portion of the alteration execution phase.

Program Formulation Phase

This phase serves as the basis for actually programming alterations for installation on a particular ship. This is the time when budgets and overhaul schedules are reviewed to schedule the installation of the alteration. Alterations are considered "programmed" when they are scheduled for installation in a specific availability.

Program Execution Phase

This is the last phase, when the alteration is installed. The TYCOM and NAVSEA will issue authorization letters to installing activities. The installing activities begin the necessary planning and procurement actions required to install the authorized alterations. This phase is considered terminated when the alteration is reported as complete.

FMP PROGRAMMING AND MANAGEMENT PROCEDURES

All depot level Title K, D, and F ship alterations are planned and programmed in the same manner. Nondepot level Title D and F alterations and TYCOM issued alterations (TIAs) are planned separately for individual ships and assigned IMAs.

AMT/TAM Depot Level Alteration Programming and Management Procedures

When the annual FMP conferences are completed, the CNO and TYCOMs program depot level alterations for regular overhauls (ROHs), Selective Restrictive Availabilities (SRAs), and Phased Maintenance Availabilities (PMAs) that will occur in the Program Objectives Memorandum (POM) fiscal year. The POM year is 3 fiscal years after the current fiscal year. Alterations are selected from the ATM and TAM in priority sequence based on the projected funding levels for specific ship availabilities and are then assigned a fiscal year for installation in the FMPMIS. FMPMIS programming becomes the budgetary basis for the POM Year Plan and also initiates long-lead time material acquisition actions, design development, and other planning actions necessary for each alteration. Alterations are programmed for ships if the alteration data is listed as active in FMPMIS.

TAM Non-Depot Level Ship Alteration

Ship Alteration Management. Title D and F ship alterations within the capability of ship's force or an IMA will be installed by ship's force or an IMA. Whoever is scheduled to install the alteration should:

1. Obtain the appropriate copy of the SHIPALT design drawing from the Class Planning Yard.
2. Review the drawing to determine the skills and resources required.
3. Review the drawing Bill of Material (BOM) and order the needed material.
4. Send an OPNAV 4790/CK (see "REPORTING CHANGES TO EQUIPMENT CONFIGURATION" below) and a TIA or SHIPALT completion form to the TYCOM upon completion of the alteration.

If a title D or F SHIPALT or a TIA is beyond the capability of a ship's force, the ship should submit an IMA work package for the alteration.

No further authorization is required by the IMA or ship's force (SF) to do any active Title D or F SHIPALTs. The overall management of all nondepot level SHIPALTs for a ship is an individual ship responsibility. Funding for IMA and SF alterations are allotted from normal Operations Target funding (OPTAR) if ship's force performs the alteration or from IMA support funding if the alteration is installed by the IMA.

FLEET MODERNIZATION PROGRAM MANAGEMENT INFORMATION SYSTEM (FMPMIS)

FMPMIS is the central data management system used by the Navy to manage the Fleet Modernization Program. The system is used by the CNO, COMNAVSEASYSCOM, and type commanders to budget and plan for alterations. FMPMIS is also used by material and systems command activities, and industrial activities for material acquisition, design tasking, and workload planning. COMNAVSEASYSCOM has forwarded to each administrative group, squadron and IMA, an access code to the FMPMIS central computer. Many previous hard copy SAMIS reports are now available as FMPMIS teleprocessed reports. Each group, squadron, and IMA is expected to maintain the equipment/software to operate this communication link, which not only permits access to FMPMIS data, but allows communications between groups, squadrons, IMAs, and TYCOM maintenances.

On board ship, your point of contact concerning FMPMIS is the chief engineer who will have responsibility for alterations and the FMP. Additionally, the *Fleet Modernization Program Manual*, NAVSEA SL720-AA-MAN-010, gives in-depth descriptions of the FMP. FMPMIS Reports are detailed in the 3-M Manual, OPNAVINST 4790.4B, chapter 11.

ELECTRONIC EQUIPMENT FIELD CHANGES

Alterations to electronic equipment are issued as field changes according to the general specification for field changes and field change kits. A field change is any modification or alteration made to an electronic equipment after its delivery to the government.

Field changes are developed to improve performance, operational characteristics, maintenance, reliability, and safety features of equipment. They may require minor wiring or mechanical changes to an item of equipment and consist only of instructions for making the change, or they may be more extensive, requiring circuit changes and the removal or substitution of parts. The nature of each field change is indicated by a type and classification designation, operational category, and an installation priority.

TYPES OF FIELD CHANGES

Field Changes are designated as **Type I, Type II, Type III**, or **Type IV**. The type designator indicates the general contents of the change kit (publications package only, publications package and parts, and so on.) The publications package consists of the Electronic Field Change Bulletin, changes to technical manuals, reference standards books, and other NAVSEA/NAVELEX-supplied equipment manuals. Not included in the package are Planned Maintenance System (PMS) documentation, Allowance Parts List (APL) documentation, or other documentation not controlled by NAVSEA or NAVELEX. Corrections and revisions to these documents, as a result of field changes, are issued by the activities that have control over them. Type definitions are described in the following paragraphs.

Type I

A Type I field change requires parts, all of which are included in the change kit. The kit consists of a publications package, all parts, materials, and special tools required to change to one piece of equipment and to revise the equipment's nameplates, publications, and charts.

Type II

A Type II field change requires parts, none of which are included with the field change. The Type II field change may be either a kit consisting of only the publications package, or instructions that are published in the Electronics Information Bulletin (EIB) or other official instruction or letter. When the change is published in the EIB, complete instructions for making the field change and for correcting related publications are included. The parts, tools, and test equipment required to make a Type II field change are either standard shipboard items (e.g., wire, terminal lugs, soldering irons) or readily available from stock supplies (e.g., repair parts stocked for the equipment).

Type III

A Type III field change requires parts, of which some, but not all, are included in the kit. The kit consists of materials, and special tools required to make the field change to one piece of equipment and to revise the equipment's nameplates, publications, and charts. The parts, tools, and test equipment not included in the kit are either standard shipboard items (e.g., wire, terminal lugs, soldering irons), or readily available from stock supplies (e.g., onboard repair parts stocked for the equipment).

Type IV

A Type IV field change does not require parts or use of special tools. This type of field change may be either a kit consisting of only the publications package, or instructions published in the EIB or other official instruction or letter. When the change is published in the EIB, complete instructions for making the field change and for correcting related publications are included.

CLASSES OF FIELD CHANGES

There are three class designations (**A, B, and C**) for field changes, one of which is assigned to each field change. The class designator indicates who is responsible for funding the change and who is responsible for installing it.

Class A

Class A field changes are approved for installation by forces afloat or station personnel. No installation funding is required.

Class B

Class B field changes to shipboard equipment are approved for installation by naval shipyards, tenders, or repair facilities under the conditions stated in the field change bulletin, when authorized by type commanders. Fleet installation funding is required. Class B field changes to equipment at training activities are approved for installation and funded by the appropriate systems command. EXCEPT FOR CLASS B FIELD CHANGES PRESENTLY UNDER PROCUREMENT, IN THE SUPPLY SYSTEM, OR IN THE FLEET INSTALLATION PLANNING STAGE, THIS TYPE OF FIELD CHANGE WILL NO LONGER BE ISSUED.

Class C

Class C field changes normally require industrial assistance for installation and require the appropriate systems command installation funding.

OPERATIONAL CATEGORIES OF FIELD CHANGES

Two operational categories describe the effect the changes will have on the operating characteristics of the equipment. These categories are operational and nonoperational.

An operational change affects the military characteristics of the equipment (i.e., a range increase for radar equipment, an addition of the electronic countermeasures function of specific equipment.)

A nonoperational change does not effect the military characteristics of the equipment. This kind of change pertains to equipment maintenance and reliability improvements, safety of personnel and equipment, and effectiveness of equipment performance.

ACCOMPLISHMENT PRIORITIES OF FIELD CHANGES

An accomplishment priority (**Emergency, Urgent,** or **Routine**) is assigned to each field change to indicate the urgency of accomplishment.

Emergency

The emergency priority is assigned to field changes for either of the following reasons:

1. To make a change in operational characteristics, which if not done without delay might seriously compromise the national security.

2. To correct a hazardous condition that might result in fatal or serious injury to personnel, or extensive damage to, or destruction of equipment.

Urgent

The urgent priority is assigned to changes for the following reasons:

1. To make a change in operational characteristics, which if not done expeditiously might seriously compromise the mission effectiveness of the deployed equipment.

2. To correct a potentially hazardous condition that might result in serious injury to personnel or damage to equipment. A potentially hazardous condition compromises safety and embodies risk, but within reasonable limits, permits continued use of the affected equipment, provided the operator has been informed of the hazard and given appropriate precautions.

Routine

The routine priority is assigned to proposed changes where either "emergency" or "urgent" does not apply.

APPROVAL OF CHANGES

Field changes to electronic equipment are developed to improve the equipment's performance and operational characteristics and maintenance, reliability, and safety features. Therefore, field changes are approved only after the effort and cost involved have been determined to be warranted by the improved results. Approval of field changes is given by the systems command that has control over the equipment to be modified. The controlling systems commands for shipboard electronic equipment are NAVSEA and NAVELEX.

AUTHORITY FOR MAKING CHANGES

An approved field change implies authority for making the change, but only on the systems and equipment specified by the approving activity (the controlling systems command). The applicability of field changes to specified installations, systems, and equipment is presented in each Electronic Field Change Bulletin and distributed in advance by publication in the EIB or, in special cases, by letter or message from the controlling systems command or project office.

Installation of approved and applicable field changes is mandatory when they are available, and the changes must be made at the earliest opportunity according to the assigned accomplishment priorities assigned.

RECORDING THE COMPLETION OF FIELD CHANGES

The final procedure in the installation of a field change is an important one, and must be performed even if it was not included in the field change bulletin. This procedure includes the following two steps:

1. Stamping the field change number accomplishment plate attached to the equipment or unit to which the field change bulletin applies. The plate should belong to the equipment or unit whose type designation matches, exactly, the type designation (e.g., AN/SPS-10D) of the field change bulletin (e.g., 4-AN/SPS-10D). If the equipment or unit does not have a plate, put one on. They can be requisitioned from the supply system.

2. Making a complete report by submitting an OPNAV 4790/CK as required by the 3-M manual.

REPORTING CHANGES TO EQUIPMENT CONFIGURATION

One of the major objectives of the Maintenance Data System (MDS) is to provide the capability for reporting configuration changes. The importance of configuration change reporting cannot be overemphasized. Whenever any system, equipment, component, or unit within the ship is installed, removed, modified, or relocated, the change must be reported. This action will ensure proper accounting of configuration changes, and will help provide improved supply and maintenance support (i.e., technical manuals, PMS coverage, COSAL, etc.) to the fleet. The Ship Configuration and Logistics Support Information System (SCLSIS) is the designated system for maintaining the configuration status reported by the fleet. SCLSIS data is maintained in a central file: the Weapons Systems File (WSF) at SPCC, Mechanicsburg, Pa. Supply and maintenance support managers depend on this central file to provide adequate support to the fleet.

RESPONSIBILITIES

The responsibility of identifying and reporting configuration changes rests at all levels of the command. The ship or activity is responsible for reporting all maintenance actions resulting in configuration changes, whether they are made by ship's force, an Intermediate Maintenance Activity (IMA), an Alteration Installation Team (AIT) or other off-ship activity, with the exception of changes installed during an overhauling or yard availability. The ship is responsible for obtaining the forms from the installing activity. Maintenance actions that result in configuration changes and which are done by an activity other than ship's force (i.e., AIT, IMA) are reported by that activity on a 4790/CK provided to the ship.

A configuration change is either: (1) the completion of any action prescribed by an alteration directive (i.e., SHIPALT, or equipment alteration), or (2) the installation, removal, or modification of any system, equipment, component or unit. The replacement of repair parts (e.g., nuts, bolts, wires, o rings, gaskets, resistors, capacitors, etc.) with like parts does not constitute a configuration change.

Configuration status information data is maintained in the same manner as data in the 3-M central data bank. The difference between the information in these two data banks is that the information in the 3-M data bank is maintained by Job Control Number (at the job level),

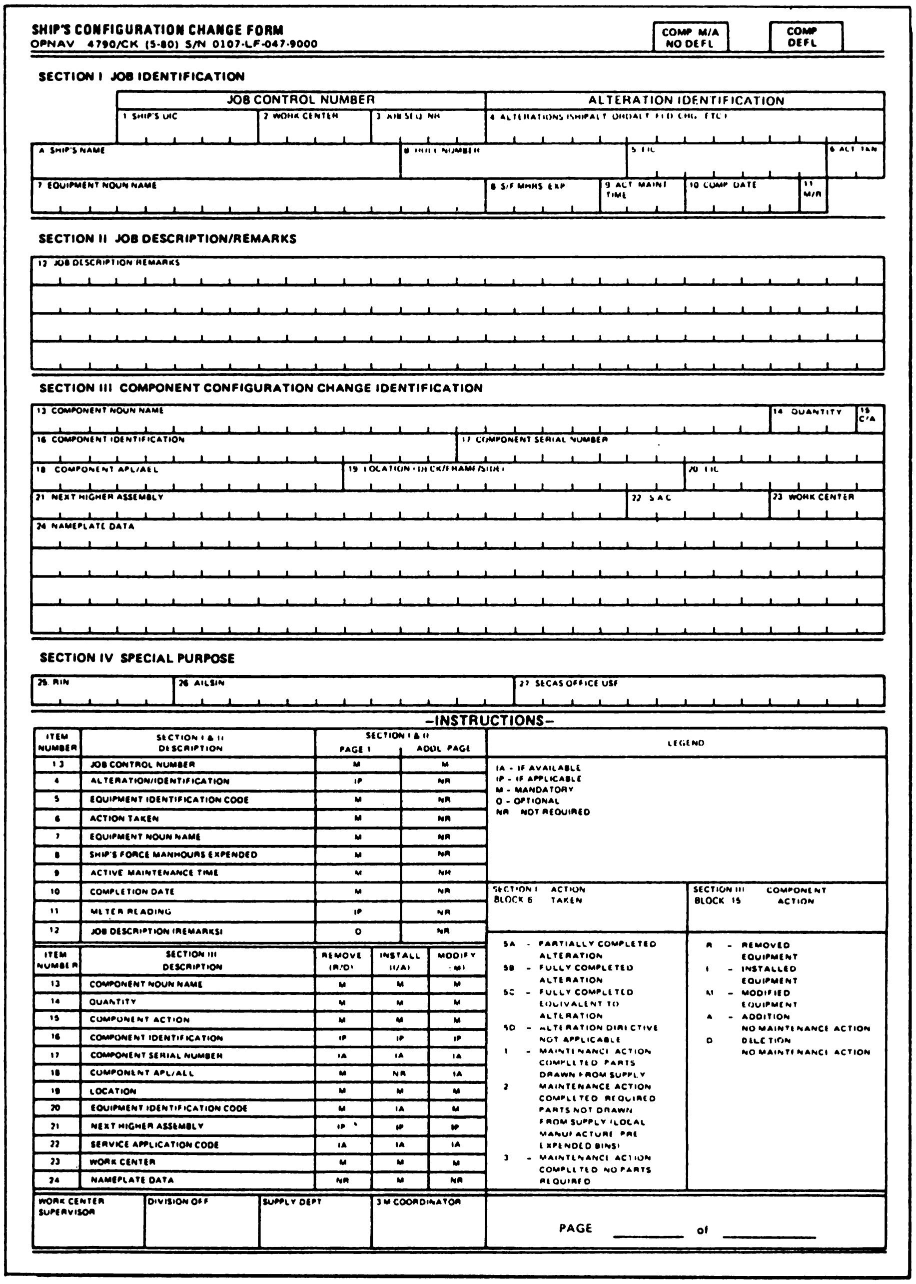

Figure 6-14.–Ship's Configuration Change Form, OPNAV 4790/CK.

and the information in the configuration data bank is maintained for each ship at the configuration item level. The information provided to the WSF via the OPNAV Form 4790/CK is used to generate COSAL update information for each ship, and updates of PMS, technical manuals, and other logistics support documentation. The quality of information recorded in the configuration data base directly determines the quality of support to the fleet. The OPNAV 4790/CK is the only means operating ships have to report, update, or correct configuration status.

It is very important to recognize that reporting of configuration changes by the ship is absolutely essential to ensure that spare parts and logistics support documentation are available to support maintenance actions. If configuration changes are not reported as described in chapter 9 of the 3-M Manual, parts may not be available when they are needed. Whenever you submit a 4790/CK, be sure to send a copy to your supply officer.

REPORTING

The Ship's Configuration Change Form, OPNAV 4790/CK (fig. 6-14), is used to report configuration changes at the individual equipment level; whereas the

OPNAV Form 4790/2K is used to report maintenance actions at the job level. You will continue to use the OPNAV Form 4790/2K to document all deferred maintenance actions (including deferred configuration changes) and to report the completion of maintenance actions (closing deferrals and completed maintenance actions) that do not result in a configuration change. When you use the OPNAV FORM 4790/CK to report a configuration change, you do not need to document the completion of the maintenance action on an OPNAV Form 4790/2K. You may use the 4790/CK as either a closing deferral for reporting the completion of a previously deferred maintenance action, if the action results in a configuration change, or as a completed maintenance action (no prior deferral) reporting a configuration change. Do not use the OPNAV Form 4790/2K to report completion of any maintenance action that results in a configuration change.

Never use the OPNAV FORM 4790/CK when the completion of a maintenance action results in a configuration change. For the purposes of reporting configuration changes, all deletions, removals, turn-ins, modifications, additions and replacements of equipment are included in the term "maintenance action," whether or not corrective maintenance of an actual equipment failure takes place. A configuration change occurs whenever the completion of a maintenance action results in any of the following:

- Addition or installation of any new equipment.
- Deletion, removal, or turn-in of any installed equipment.
- Replacement or exchange of any equipment. A replacement or exchange is reported as the removal of an installed item and installation of a new item.
- Modification of any installed equipment. A modification occurs when a maintenance action alters the design or operating characteristics of the equipment, or when a maintenance action in which nonstandard replacement parts (not identified on the APL or in the technical manual) are used.
- Relocation of any equipment.
- Compliance with any alteration directive, i.e., field change, or ORDALT.

You should also use the 4790/CK to correct any erroneous data in the support establishment's configuration records.

On the OPNAV Form 4790/CK, fill in Section I (JOB IDENTIFICATION) and Section II (JOB DESCRIPTION/REMARKS) on the first page to identify the maintenance action at the job level. Fill in Section III (COMPONENT CONFIGURATION CHANGE IDENTIFICATION) using the first page and as many continuation pages as necessary to identify what was done as part of the maintenance action described in Sections I and II. Most of Section IV (SPECIAL PURPOSE) is not filled in aboard ship. Instructions are included on the form to assist you in properly completing it. At the bottom of the page are blocks for recording the initials of shipboard personnel who reviewed the completed form. Space is also provided for you to identify the number of pages of information you provide for each maintenance action. For example, if a configuration change occurs to four different pieces of equipment as a result of a single maintenance action, you should have Sections I, II, and III completed on page 1 of the form to describe the maintenance action and identify the configuration change to one piece of equipment. Have three continuation forms (pages 2, 3, and 4) completed to describe the configuration change to the other three pieces. Pages 2, 3, and 4 need only the JCN recorded in Blocks 1 through 3, the completion of Section III, and the appropriate page numbers entered at the bottom of the page. Specific procedures for filling out and submitting the 4790/CK are provided in chapter 9 of the 3-M manual.

PREPARATION FOR SEA

Readying a ship for sea, including its initial voyage after an overhaul, involves meticulous planning, persistent work, and determined follow-up to make certain that necessary actions or material are not omitted. As EMO you must see that the division is in order and that allowances of equipment, tools, and repair parts are on board and properly stowed. The reason for this is obvious, as negligence can make your ship a liability during a crucial action. You must impress upon the technicians and operators the importance of reporting to proper authority all defects, regardless of their apparent insignificance. When you report the division ready for sea or for getting underway, the commanding officer assumes that each piece of equipment can meet its operational requirements.

INSPECTIONS

Type commanders must ensure that the ships under their command are informed of and kept up to prescribed standards of maintenance and readiness. These standards are found in various directives from fleet and type commanders, technical commands, and the Chief of Naval Operations (CNO). These directives may be in the form of regulations, letters, directives, or manuals. Most of these directives get fleetwide dissemination, but the material is so voluminous that it is not readily available for reference. Consequently, type commanders issue type instructions and type letters in which pertinent material is quoted or summarized, thus reducing the general instructions to specific instructions peculiar to the ship type.

Not only must type commanders issue standards for their ships; they must also enforce those standards by means of inspections. The number and kinds of inspections are specified in Navy regulations and CNO directives. There are three types of inspections: **Administrative, Operational Readiness,** and **Material.** Most of these inspections are based upon the operating cycles of the ships; that is, the periods between regularly scheduled shipyard overhauls, but some are based upon the competitive cycle for unit awards.

Inspections of ships and aircraft squadrons are under the control of the fleet commanders who delegate this responsibility to the type commanders. The commanders of task forces, squadrons, or groups conduct or direct inspections recommended by the type commanders and submit formal reports. When requested, fleet training commands assist the type commanders in conducting inspections.

The grade a ship receives on an inspection is based upon the readiness of onboard personnel and material to carry out the ship's missions.

ADMINISTRATIVE INSPECTION

An administrative inspection is an inspection of all the administrative methods and procedures normally used by a ship to determine whether or not the ship is being administered according to prescribed directives and regulations.

OPERATIONAL READINESS INSPECTION

An operational readiness inspection (ORI) requires a ship to prove its readiness and ability to perform the operations that might be required of it during war.

As with administrative inspections, the conduct of an ORI is the responsibility of the type commander, who normally requests the assistance of the fleet training command. The inspection generally includes a battle problem prepared, conducted, and observed as specified by the CNO in the publication *Preparation, Conduct and Analysis of a Battle Problem*, FXP3-2. In addition, other operational exercises are prescribed by the type commander, including gunnery, damage control, engineering, CIC, communications, and seamanship.

MATERIAL INSPECTION

The purpose of a material inspection is to determine the actual material condition of a ship and its equipment. It attempts to assess the extent to which the ship can realistically perform its intended mission. It may also recommend repairs, alterations, or changes to enhance the ship's material readiness. Material readiness implies that the ship has established routines for ship's force inspections, tests, and preventive maintenance; that there is effective use of facilities for repair and preservation; and that outstanding items of work have been correctly determined as within the capacity of the ship's force, repair ships/tenders, or naval shipyards, respectively.

A few other inspections that you will experience are briefly described below. There are many others, and you must consult TYCOM instructions to determine the inspections that apply to your ship.

Board of Inspection and Survey (INSURV) Inspection

Approximately every 3 years, a material inspection is conducted by the Board of Inspection and Survey (INSURV) to determine the material readiness of a ship's equipment and systems, and to establish work requests covering deficiencies. (See OPNAVINST 4730.5.) Whenever practical the INSURV inspection is held in advance of the regular overhaul. INSURV inspections are scheduled as Underway Material Inspections (UMI) and provide a realistic way to assess total ship readiness. This is probably the most thorough inspection that you will ever experience.

Pre-Overhaul Test and Inspection (POT&I)

A POT&I is conducted before a ship arrives for overhaul. This inspection is authorized by the type commander and includes the determination of the condition of the equipment and systems. It also includes the preparation of a list of repairs required to ensure effective electrical and mechanical operation at the completion of overhaul.

Post-Overhaul Inspection

Post-overhaul inspections are made to furnish the commanding officer of a ship a report on the condition, capabilities, and limitations of the electronic equipment and systems. This inspection is normally conducted as a part of post repair sea trials.

3-M Inspection

This is a surprise inspection that determines how well the 3-M program is administered and the material condition of equipment. It is conducted, normally by the TYCOM, according to requirements of the 3-M Manual and counts toward competition for the Battle 'E' Award.

SUMMARY

In this chapter we have briefly discussed the EMO's material responsibilities. We started out by describing the six equipment nomenclature systems that you must understand to effectively communicate with your technicians and others in the chain of command. In the area of maintenance, we defined preventive and corrective maintenance and overviewed some of the basic administrative procedures. Detailed information for administration of the 3-M program is in the 3-M manual. Remember, the job isn't finished until the paperwork is done.

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CHAPTER 7

SUPPLY PROCEDURES

OVERVIEW

Supply procedures and understanding the supply system are mandatory aspects for the EMO. To get equipment repaired, you must have spare parts in hand. This chapter will give the EMO instructions and examples in filling out the basic supply paperwork.

OUTLINE

Types of material

Federal Supply Classification System

Coordinated Shipboard Allowance List

NAVSUP publications

Issues from supply storerooms

Automated procedures

Financial control of shipboard budgets

INTRODUCTION

As an EMO, you will probably find replacement of electronic parts the most important part of your job. To succeed, you must have a good understanding of the supply system as well as a good rapport with the supply officer. How effectively you maintain electronic equipment is directly related to the flow of spare parts.

Problems in supply support are frequently listed among the major causes of delayed equipment repair. Fortunately, the problems usually have simple and effective solutions. If you understand the role of an afloat supply department and your place in the supply process, you will not only eliminate the headaches but will also simplify the technical repair aspect of your job. In this chapter we will familiarize you with the workings of the supply department aboard your ship. We want to help you take full advantage of the possibilities offered by the naval supply system so you can carry out your responsibilities more effectively.

TYPES OF MATERIALS

The Navy divides its material into four categories: equipment, equipage, repair parts, and consumables and services.

EQUIPMENT

Equipment is any functional unit of hull-, mechanical-, electrical-, ordnance-, or electronic-type material that is operated either singly or as a component of a system or subsystem. It is identified by a component identification number (CID), a numerical control code (NCC), an allowance parts list (APL), or other similar designation. Examples of equipment are the ship's radar, communications transceivers, and a satellite antenna.

EQUIPAGE

Equipage is items that require management control because of one or more of the following factors: high unit cost, vulnerable to pilferage, essential to the ship's mission, or a combination of these factors. Equipage does not include installed mechanical, electrical, ordnance, or electronic equipments, components, or systems. Equipage items generally have such specific uses aboard ships that an allowed quantity of each item can be determined for each ship. All equipage that has an allowed quantity is identified on the ship's Allowance Equipment List (AEL). Examples of AEL items include projection screens, pennants, furniture, and fuel hoses.

Some items on the AEL require special management control because they are either essential for the

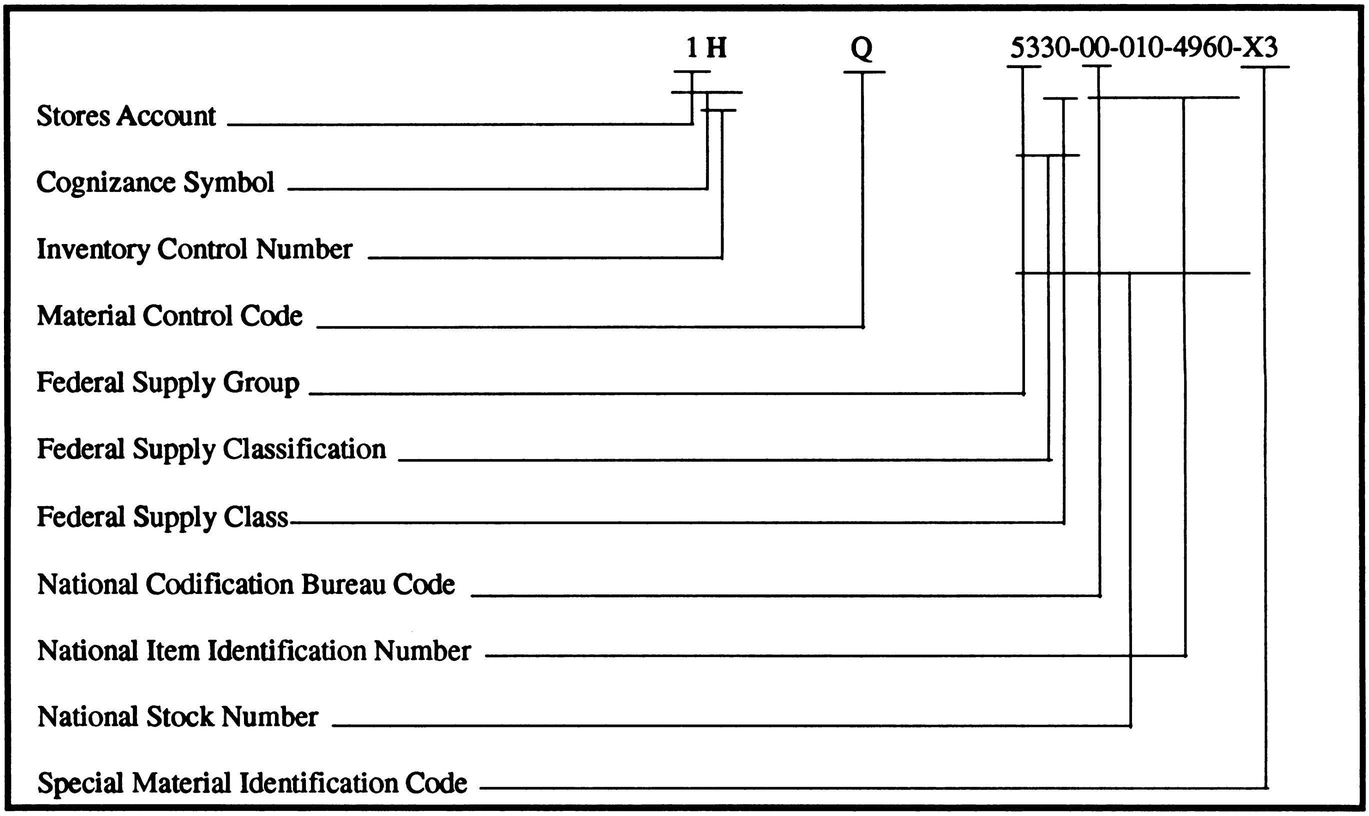


Figure 7-1.–Breakdown of National Stock Number (NSN).

protection of life or relatively valuable and easily converted to personal use (life jackets, binoculars, and so forth). These items, called *controlled equipage*, require special inventory control.

REPAIR PARTS

A repair part is any item, including modules and consumable-type materials, that is put in place of an identical or similar item in a piece of equipment to correct a malfunction. Repair parts may be listed in an APL, a Stock-Number Sequence List (SNSL), an Integrated Stock List (ISL), a Naval Ship System Command drawing, or a manufacturer's handbook.

CONSUMABLES AND SERVICES

Consumables are administrative and housekeeping items, common tools, paints, cognizance symbol 1I forms, or any other items not specifically defined as equipage or repair parts. Materials such as general-purpose hardware, metals, lumber, and lubricating oil are considered to be consumables when they are procured. However, when they are used for maintenance actions, they are treated as repair parts. Services are nonmaterial consumables: i.e., equipment rental, commercial telephone, pilotage, and tug hire. For accounting purposes, both services and equipage not designated as controlled equipage are reported as consumables.

You may wonder why there is so much concern about defining types of material. Typically, type commanders allocate funds by categories: X dollars for repair parts; Y dollars for controlled equipage; and Z dollars for consumables. In most commands, you will be budgeted funds only for consumables. The supply department (under the commanding officer's control) will reserve funds to pay for all repair parts and controlled equipage. You must, therefore, ensure that APL and equipment identification code (EIC) numbers be included on the request document for every APL item used in a repair action. This will prevent them from being charged against the funds of your department.

MATERIAL CLASSIFICATION

Since the ordering of parts and services requires you to deal with the supply system, you must learn some basics about the numerical language used to communicate your requirements. The Navy and other agencies of the federal government have adopted one standardized system of classification and identification for the materials they use–the Federal Supply Classification (FSC) System. In the FSC System, most material used by the Navy is assigned a national stock number (NSN). Given a correct stock number, supply personnel can usually locate detailed information on any item of standard stock.

NATIONAL STOCK NUMBERS (NSN)

An NSN (fig. 7-1) is a 13-digit number that consists of a four-digit Federal Supply Classification (FSC group and class) and a nine-digit National Item Identification Number (NIIN). Figure 7-1 illustrates all of the elements of the NSN in their proper sequence.

COGNIZANCE SYMBOL

A two-part cognizance symbol is used with the NSN to provide supply information. Currently, there are 94 of these symbols in use. Most of the transactions aboard ship are covered by symbols 1H, 7G, 7H, 9G, and 9N. The first part of the symbol is a single number that denotes the stores account in which the material is carried in the supply system. Briefly, the numerical part of the symbol indicates the following:

- 1, 3, 5, or 7–Material held in the Navy stock account (NSA). When this material is issued, it must be paid for by the requisitioner.
- 9–Material purchased by the defense stock fund and held in NSA. When this material is issued, it must be paid for by the requisitioner.
- 2, 4, 6, or 8–Material held in the appropriations purchases account or nonstores account. This material is issued without charge to the requisitioner. (Notice that the requisitioner pays for all odd-numbered cog items but not for even-numbered cog items.)

The second part of the cognizance symbol is a single-letter code that designates the inventory control point and the inventory control manager of the material.

FEDERAL SUPPLY GROUPS AND CLASSES

The Federal Supply Classification (FSC) System divides all material into numbered groups and classes that indicate the general nature of the material. Each item of supply is assigned to only one FSC. An example of an FSC is 5905, in which group (59) is Electrical and Electronic Equipment Components, and the class (05) is Resistors. A complete list of FSC group and class designations is provided in Defense Logistics Agency (DLA) Publication H-2.

NATIONAL ITEM IDENTIFICATION NUMBER (NIIN)

The NIIN is a nine-digit number that identifies each item in the supply system used by the Department of Defense. The NIIN relates to identification data that makes an item of supply different from any other item. Although the NIIN is part of the NSN, it is used independently to identify an item. Except for identification lists, most federal supply catalogs are arranged in NIIN order.

The NIIN is the basis of all your dealings with supply sources. You should ensure accuracy in all your communications with supply. You must ensure accuracy in writing and transmitting NIINs. If you make an error in transcribing the cognizance symbol or the group and class of an item, it will probably be detected and corrected by someone in the supply chain. If, on the other hand, you err in transmitting the NIIN to supply, you may end up with a piece of anchor chain instead of an electrical resistor.

The NIIN consists of a two-digit National Codification Bureau (NCB) code and seven digits that identify each NSN in the Federal Supply System.

NATIONAL CODIFICATION BUREAU (NCB) CODES

There are two NCB codes assigned for the United States. NCB Code "00" identifies all FSNs (11-digit Federal Stock Numbers–FSNs–were used prior to NSNs) assigned prior to 31 March 1975. In the example below, note that although the last seven digits of the NIIN are identical, the items are different. One has an NCB code of "00" and the other has an NCB Code of "01." Errors in the use of "00" and "01" can result in rejected requisitions or receipt of the wrong material.

COG	FSC	NIIN	NOMENCLATURE	PRICE
9N	5915	-00-005-8825	FILTER	$ 182.97
2R	1650	-01-005-8825	CYLINDER	$2,120.00

SPECIAL MATERIAL IDENTIFICATION CODE (SMIC)

An SMIC is a two-position alpha or alphanumeric code that is assigned by the Commander, Naval Supply Systems Command, to certain NSN items that require the following controls:

1. Source of quality control
2. Technical design or configuration control
3. Special controls for procurement, receipt, inspection, test, storage, or issue

SMIC codes are listed and defined in SPCCINST 4441.170A, Appendix C. When an SMIC is assigned to an NSN item, the SMIC will be suffixed to the NSN in all supply documents and records.

NAVY ITEM CONTROL NUMBERS

Items of material that are not included in the Federal Catalog System, but which are stocked or monitored in the Navy supply system, are identified by Navy Item Control Numbers (NICNs). NICNs are 13-character item identification numbers that Inventory Control Points (ICPs) and other Navy item managers use to control certain non-NSN items. An NICN consists of four numbers in the first four positions; followed by a two-position alpha code (NICN code) that identifies the type of NICN, and seven digits or alphanumerics. The NICN codes that are currently authorized for use in supply records and transaction documents are as follows:

NICN	Applications	Examples
LD	Directives Ordering Number	1234-LD-123-4567
LE	Poseidon items common to Trident	1220-LE-F00-4016
LF	Cog I stock number for forms	0108-LF-504-2201
LK	Aircraft change kit numbers	1234-LK-UA1-2345
LP	Cogs 01 and OP stock numbers for publications	0530-LP-485-0000
LS	SSP alteration kit numbers	1234-LS-123-4567
LX	Local control numbers assigned by ASO field activities to certain items under their inventory control (see ASO Pub. NAC-10)	1560-LX-NP1-2345
LL	All other control numbers assigned by the following: An ICP or other Navy item manager or any other activity	4930-LL-CAO-0001 4820-LL-HHO-7571 7520-LL-000-1234

Use care when you deal with NICNs that contain LL in the fifth and sixth positions. In these NICNs, the alphanumerics in positions 7 through 13 may have a special meaning. For example, a C used as the seventh character indicates that the NICN is not authorized for use on DD Forms 1348. As another example, the combination of numbers 0000123 (vice 000-D123) indicates a local control number. For a complete explanation, refer to NAVSUP P-485.

TEMPORARY NAVY ITEM CONTROL NUMBER (T-NICN)

NICNs with "LL" in the fifth and sixth positions and any letter except "C" in the seventh position are assigned by the Ship's Parts Control Center (SPCC) (Mechanicsburg, Pa.) selected non-NSN items pending assignment of NSNs by the Defense Logistics Service Center (DLSC), Battle Creek, Michigan. The use of T-NICNs enables item managers to set up and maintain automated file records, to obtain stocks of the items, and to maximize the automated processing of requisitions.

PERMANENT NAVY ITEM CONTROL NUMBER (P-NICN)

A P-NICN formally known as a Unique Control Number (UCN) or Permanent NICN, is assigned by ICPs and other Navy item managers to identify and monitor certain non-NSN items that are not expected to generate sufficient demand to be assigned NSNs. A P-NICN is a 13-character alphanumeric designation with "LL" in the fifth and sixth positions and a "C" in the seventh position (LL-CAO-0001). Any item assigned a P-NICN must be requisitioned by FSCM and part number on a DD Form 1348-6.

LOCAL ITEM CONTROL NUMBER

Technically, any item identification number assigned by an activity for its own use is an NICN. However, to distinguish between NICNs that are authorized for use in supply transaction documents and those that are not, the term "Local Item Control Number" is used to indicate the type of identification number that is not authorized. Local item control numbers (formally called local stock numbers) may be assigned to shipboard stocked consumable items that are not identified by an NSN, a NATO stack number, or another type of NICN. A local item control number consists of 13 characters. The first four are numerics that correspond to the FSC of similar NSN items. The fifth and sixth are "LL," and the remaining seven are all numerics. For example:

7520 - LL - 0000123

Appropriate FCS

Designation for a locally assigned identification number

Serially assigned identification number

Locally assigned item control numbers are authorized for local use only (i.e., for shipboard stock records, locator records, bin tags, issue documents, and so on). They are not authorized in requisitions since they would be meaningless to the supply source. If replenishment of a locally numbered item is required, it must be requisitioned by DD Form 1348-6 according to NAVSUP P-485.

COORDINATED SHIPBOARD ALLOWANCE LIST

The chief publications your department will use aboard ship in identifying material are the Coordinated Shipboard Allowance List (COSAL); the manufacturers' publications, such as technical manuals and catalogs; and the technical bureau or systems command publications.

Most identification publications have notes or introductions that explain how to use them. These publications can be rather complex. Should you or anyone in your department have trouble in deciphering the various codes or reference numbers, contact the personnel assigned to the supply department. They will be glad to assist. Having a clear understanding of how to use the different identification publications will make your interaction with the supply department a lot easier.

ALLOWANCE LISTS

Allowance lists identify and specify the number of items of equipage and equipment, spare parts, consumables, and so on, which are authorized on board a particular ship. However, except for equipage and equipment, you cannot expect to find in the supply department storerooms every item in the quantity specified on the lists. When funds are available at the TYCOM level, you will generally find the authorized quantities of spare parts in the storage bins. When funds are not available, you will probably find less than the allowed quantities. In any event, you cannot have more than the allowed quantity of repair parts on board unless you have the approval of the type commander or can support the need for the excess by usage data. Consumables allowance lists represent best guesses of the kinds and quantities of consumables that each ship type needs to support its operational requirements. Typically, a ship will emerge from an outfitting with these quantities on board, but will adjust its stock levels of consumables according to usage data, with occasional adjustment to reflect abnormalities in its operating schedule.

Your primary use of allowance lists will be to identify the NSN of a part that you need, such as an transistor for an AN/SPS-49 RADAR. The allowance list you will use most frequently is the COSAL, which pertains to hull, mechanical, electrical, ordnance, and electronic (HMEO&E) equipment. Its use is detailed in the following paragraphs. Other COSALs have a similar format. If you have a firm grasp of the HMEO&E COSAL and read the introductory sections of the other COSALs, you should have no difficulty in using them.

HMEO&E COSAL

The HMEO&E COSAL is prepared by the Ship's Parts Control Center (SPCC), the Navy Fleet Material Support Office, and the Naval Publications and Forms Center. It lists the operating equipments, repair parts, and equipage installed aboard ships. Each ship in the Navy has its own COSAL, which is tailored specifically to the equipment and equipage installed on that particular ship. The COSAL lists the repair parts necessary to support each equipment and equipage item. It specifics which and how many of these repair parts must be carried aboard ship. The COSAL also contains valuable technical information, such as the nameplate data of the equipment and a cross-reference of the manufacturers' part numbers to the national stock numbers.

The proper use of the COSAL is important to personnel in all departments aboard ship. Before attempting to use the COSAL, you should study its introduction, which contains general instructions for its use and maintenance. As with any other technical publication, you must understand its format to benefit fully from the data it contains.

EQUIPMENT/COMPONENT/EQUIPAGE IDENTIFICATION NUMBERS							
004920311	016550004	017610015	019210394	030240015	060250010	070970008	070970028
013040001	016720064C	017710005	019310008	030250021	060250052	070970009	070970029
016021435	016720065C	017770023	019310048	030270015	060250078	070970010	070970030
016021438	016720066	017770031	019310076	030270016	060950222	070970011	070970031
016021439	016720067	017830025	019310077	030270018	060950223	070970012	070970032C
016021441	017030386	017840018	019310078	030270019	060950224C	070970013	070970033C
016021443C	017030400	017940018	019430001	032010008	061430250C	070970014	070970034C
016021446	017030406	017970005	019430002	032180051	061430251	070970015	070970035C
016032249	017030407	018180005C	019470002	032370002	070270011C	070970016	070970036
016032250	017030408	018550002	019670002C	040200010	070470023	070970017	070970037C
016110685	017030409	018630009	019780021	043020292	070470024	070970018	070970038C
016180414	017030411	018720001	019990011	043020295	070470025	070970019	070970039C
016180422	017030412	018880162	023110001	052050007	070840060	070970020C	070970040
016180423	017030414	019160630	023110002	052050008	070970001	070970021	070970041C
016200401	017200007	019160631	030080592	052050009	070970002	070970022	070970042C
016200402	017200008	019160636	030130989	052050011	070970003	070970023	074000321
016200403	017200009	019160637	030131021	052209000	070970004	070970024	074000586C
016200446C		019160640	030131070	059950001	070970005	070970025C	074000587C
016210215	017410030	019210183	030240012C	059960001	070970006	070970026C	074000588C
016550004	017440021	019210393	030240013C	059970001	070970007	070970027C	074000589C

DD 901		01-15-9_	SUMMARY OF ALLOWANCE PARTS/EQUIPAGE LISTS	H 1
SHIP TYPE & HULL NO.		DATE		PAGE

Figure 7-2.–Summary of Allowance Parts/Equipage Lists.

The HMEO&E COSAL publication is divided into the parts and sections listed below.

Part I

- Summary of Allowance Part/Equipage List (SOAPL)
- Section A–Nomenclature Sequence to APL
- Section B–Service Application to APL
- Section C–APL/AEL to EIC to AILSIN
- Section D–EIC to APL/AEL
- Section E–AILSIN to APL/AEL

Part II

- Section A–Allowance Parts List (APL)
- Section B–Electronics Allowance Parts List
- Section C–Allowance Equipage List (AEL)

Part III

- Section A–Storeroom Item (SRI) Stock Number Sequence List (SNSL)
- Integrated Stock List (ISL)–(For Overhaul Ships)
- Section B–Operating Space Items (OSIs) Stock Number Sequence List (SNSL)
- Section CF–SNSL Maintenance Assistance Modules
- Section CR–SNSL Ready-Service Spares
- Old to New Stock Number Cross-Reference List
- Section D–Alternate Number Cross-Reference to Stock Number List
- Section E–Generally used, consumable, nonequipment-related items; for initial outfitting of a ship's operating spaces and storerooms.

Part I

Part I contains the Summary of Allowance Part/Equipage List (SOAPL) and five indexes that cross reference parts data in several different ways.

EQPT/ COMP. MEC	EQUIPMENT/COMPONENT/EQUIPAGE NOMENCLATURE/CHARACTERISTICS	IDENTIFICATION NUMBER	QUAN-TITY	COL. NO.	NOTES	#ALLOW. SUPT. CODE	SERVICE APPLICATION/INFORMATION
V	PUMP CTFGL 320GPM 60PSI 3500RPM MCC VI 1	016150611	2			SPAA	AIR CONDITIONING-CHILLED WATER PUMP
V	PUMP CTFGL 365GPM PSI 1750RPM MD VI 1	017810016	1			SPAA	FOOD SERVICE-GENERAL-DISHWASHER SCULLERY
V	PUMP CTFGL 400GPM 1425PSI 7300RPM TD VI 1	016031604	3			SPAA	FEEDWATER SYSTEM-MAIN FEED PUMP
V	PUMP CTFGL 430GPM 65PSI 1150RPM MD VI 1	016020863	3			SPAA	FEEDWATER SYSTEM-MAIN FEED BOOSTER PUMP
V	PUMP CTFGL 900GPM 125PSI 3500RPM MD VI 1		1			SPAA	FIRE FIGHTING-FIRE PUMP
V	PUMP DSCG HND 1.00X1.00 5.00GPM 50SPM 22PSI	016170095	1			SPAA	FUEL OIL SYSTEM-CONTAMINATED OIL TANK
V	PUMP PLUMBERS FORCE	2-470004001		1		SOAA	PUMPING X DRAINAGE-PLUMBING
V	PUMP PRESS TESTING BOILER AIR UPER	2-510004003		1		MSOAA	BOILER SYSTEM
V	PUMP PRTL SBMROL 5 HP 440V AC 180GPM 50FT HEAD	017710005	7			SPAA	DAMAGE CONTROL-PUMPS

SHIP TYPE & HULL NO.		DATE	*ALLOWANCE SUPPORT CODE	PART	SECTION	PAGE
DD 0001		11-15-9_	1st. digit ------ Technical Bureau/Cognizance 2d. & 3d. digits ---- Program-Support Activity 4th. & 5th. digits --- Logistic-Support Status	I	A	H 88

Figure 7-3.–COSAL Index, Section A.

SERVICE APPLICATION/INFORMATION	EQPT./ COMP. MEC	EQUIPMENT/COMPONENT/EQUIPAGE NOMENCLATURE CHARACTERISTICS	IDENTIFICATION NUMBER	QUAN-TITY	COL. NO.	NOTES	#ALLOW. SUPT. CODE
FEEDWATER SYSTEM-MAIN FEED BUOSTER PUMP OCACY	V	SWITCH PRESS 10 TO 180 LBS	610010394	2			SPAA
FLEDWATER SYSTEM-MAIN FEED PUMP OAOTE	V	BEARING ASSY THR PV SGHT DBL 4.375	370010291	3			SPAA
	V	PUMP CTFGL 400GPM 1425PSI 7300RPM TD VLT	016031604	3			SPAA
	V	PUMP RTY PWR 10.00GPM 60PSI 1750RPM	016200295	3			SPAA
	V	VALVE GLB .25IPS 1500PSI SWLDG STL	882051964	6			SPAA
FEEDWATER SYSTEM-MAIN FEED PUMP LUBE OIL OALJN	V	MUTOR AC 440V 1 HP 1735RPM	174752430	3			SPAA
							SPAA
	V		882241450	1			
FEEDWATER SYSTEM-PIPING-AUXILIARY GLAND LEAKOFF OASUF	V	VALVE ANL .50IPS 600PSI SWLDG STL	882001189	3			SPAA
	V	VALVE ANL STP .50 STL	88200	4			SPAA

SHIP TYPE & HULL NO.		DATE	*ALLOWANCE SUPPORT CODES	PART	SECTION	PAGE
DD 0001		12-15-9_	1st. digit ------ Technical Bureau/Cognizance 2d. & 3d. digits ---- Program-Support Activity 4th. & 5th. digits --- Logistic-Support Status	I	B	H 43

Figure 7-4.–COSAL Index, Section B.

SUMMARY OF ALLOWANCE PARTS/ EQUIPAGE LIST (SOAPL).–This section is a numerical sequence listing, by identification number, of allowance parts lists (APLs), allowance equipage lists (AELs), and allowance component lists (ACLs) in part II of the COSAL. (See figure 7-2.)

SECTION A–NOMENCLATURE TO APL.–This section is arranged alphabetically by equipment name. It also contains number identification and basic APL, AEL, and ACL information. (See figure 7-3.)

SECTION B–SERVICE APPLICATION TO APL.–This section contains the same information as section A. However, the information is arranged in sequence by service application. Service application is the major shipboard function in which the equipment/component/equipage operates or performs a service. (See figure 7-4.)

EQUIPMENT/COMPONENT NOMENCLATURE/CHARACTERISTICS:
PUMP CTFGL 400GPM 1425PSI 7300RPM TD VLT
TECHNICAL DOCUMENT NUMBER: MANUAL 0S47-107-8010; PLAN
IDENTIFICATION NO. 016031604 | DATE 11-15-9- | PAGE 1

CHARACTERISTICS
MFR-WORTHINGTON MARINE AND INDUSTRIAL PRODUCTS INC A SUB
NAVCOM PLAN-
MFR DWG-RW140700
MFR ID-3UWS8
PATTERN NO-174
EQUIP SPEC-MILP17881
NSN-
LAPL-01-001
CAPACITY-400GPM
TOTAL DYNAMIC HEAD-1425PSI
SPEED-7300 RPM
POWER RATING-509BHP
IMPELLER DIA-7.750 IN
TYPE-4 STG
MOUNTING-HORIZONTAL
ROTATION-CW
TYPE DRIVE-TD
ENGSC-A
FSCM-93232
0744

PART MES | SOURCE | MAINT | RECOVERY | NOTES | QTY. IN ONE EQPT./COMP. | U/I | ALLOWANCE | ON BOARD ALLOWANCE TABLE — NUMBER OF EQUIPMENTS/COMPONENTS: 1 | 2 | 3 | 4 | 5 8 | 9 20 | 21 50

BEARING ASSY THR PV SGMT 370010291 8 1 SEE SNSL FOR ALLOW
*SERVICE APPL--FEEDWATER SYSTEM-MAIN FEED PUMP
21674PO2 07482 VALVE, CHECK OHL 2HE4820-01-016-5989C21PB2LL A 1AYZ
C26243PC4 93232 PACKING-PREFMD 2.300 ID 9Z 5330-00-599-7953 1PC2ZZ 2EA
O-RING CPLG SE HUB

RY143425 93232 ROTOR ASSY-COMPL 2HE4320-00-433-0950 1PA4LL 1AYD
RY143425PC102 93232 STAGE PIECE-US 9C 4320-00-933-0953 1PA2ZZ 3EA
RY143425PC103 93232 RING-CSG US 1ST STG 9C 4320-00-933-0954 1PA2ZZ 1EA
RY143425PC11 93232 GLAND-SHFT SLV 9Z 3120-00-684-2903 1PA2ZZ 1EA
RY143425PC13 See Next Page 93232 SLEEVE-SHAFT 9Z 3120-00-318-7238 1PA2ZZ 2EA
RY143425PC14 93232 SLEEVE 9C 4320-00-933-0958 1PA2ZZ 2EA

REFERENCE SYMBOL NUMBER | ITEM NAME | STOCK NUMBER | PART MES | SOURCE | MAINT | RECOVERY | NOTES | QTY. IN ONE EQPT./COMP. | U/I | 1 | 2 | 3 | 4 | 5 8 | 9 20 | 21 50
DD 0001 (SHIP TYPE & HULL NO.) | H 18 (PAGE) | PART II ALLOWANCE PARTS LIST (APL) SECTION A | 016031604 (IDENTIFICATION NO.) | 11-15-8- (DATE) | 1 (PAGE)

Figure 7-5.–Allowance Parts List.

SECTIONS C, D, AND E.–These sections contain information similar to that found in sections A and B and are used primarily by maintenance personnel.

Part II

Part II contains three sections: the allowance parts list (APL), the electronics allowance parts list, and the allowance equipage list (AEL).

SECTION A–ALLOWANCE PARTS LISTS.–This section of the COSAL contains Allowance Parts Lists. An APL is a technical document that lists the repair parts authorized to be kept on board a ship for a particular piece of equipment. Separate APLs are prepared for each different piece of equipment on board a ship and for each major component in a piece of equipment. (See figure 7-5.)

SECTION B–ELECTRONICS ALLOWANCE PARTS LIST.–This list identifies electronic repair parts that may have to be replaced during a maintenance procedure. It is organized numerically by part numbers taken from the equipment's technical manual or drawings. Each part is cross referenced to a supply ordering code. (See figure 7-6.)

SECTION C–ALLOWANCE EQUIPAGE LISTS.–This section contains the Allowance Equipage Lists (AELs). An AEL is a technical document prepared for various categories of equipage associated with mechanical, electrical, electronic, and ordnance systems. When an AEL is written for a system, it identifies the items required to operate the system and the repair parts required to maintain it. The AEL lists specific information for each item, such as name, NSN, unit of issue, quantity needed, and quantity allowed on board.

The AELs are arranged in this section numerically by AEL identification number (AEL ID No.). An AEL ID number identifies a specific group of material collectively known as equipage. The first digit of the

COSAL INTRODUCTION APPENDIX (A)

REFERENCE DESIGNATOR	NOTES	FIIN/ACN/FSCM-REF	SMR	APPL	ADDM
1A 10	1	622-1236-306	X-REF	0	
1A 10A 1		787-6448-203	X-REF	0	
1A 10A 1A 1		609-2721-001	X-REF	0	
1A 10A 1A 1A 1		609-2715-001	X-REF	0	
1A 10A 2		[522-4873-007	X-REF]	0	
1A 10A 2A 1		775-2108-003	X-REF	0	
1A 10A 2A 1 FIG 19		779-2621-001	X-REF	0	
1A 10A 2A 1 FIG 21		778-3766-002	X-REF	0	
1A 10A 2A 1 FIG 23		775-2143-001	X-REF	0	
1A 10A 2A 1 FIG 24		779-2612-001	X-REF	0	
1A 10A 2A 1 FIG 25		791-1879-001	X-REF	0	
1A 10A 2A 2		778-3455-002	X-REF	0	
1A 10A 2A 2 FIG 9		778-3405-001	X-REF	0	
1A 10A 2A 2 FIG 10		775-2275-001	X-REF	0	
1A 10A 2A 2 FIG 11		778-3443-001	X-REF	0	
1A 10A 2A 2 FIG 12		778-3451-001	X-REF	0	
1A 10A 2A 2 FIG 13		775-2098-001	X-REF	0	
1A 10A 2A 2 FIG 14		775-2137-001	X-REF	0	
1A 10A 2A 2 FIG 15		775-2140-001	X-REF	0	
1A 10A 3		792-6305-101	X-REF	0	
1A 10A 3A 1		779-3261-010	X-REF	0	
1A 10A 3A 1A 1		778-1125-001	X-REF	0	
1A 10A 3A 1A 4		775-3352-001	X-REF	0	
1A 10A 3A 1A 5		778-1122-010	X-REF	0	
1A 10A 3A 1A 7		778-1126-001	X-REF	0	
1A 10A 3A 1A 8		777-3268-001	X-REF	0	
1A 10A 3A 1A 9		778-1127-001	X-REF	0	
1A 10A 3A 1TB1		777-2978-010	X-REF	0	
1A 11		607-4564-001	X-REF	0	
1A 7A 1	1	13499 784-6100-001	PA2ZF	0	
1A 7A 3		784-6001-003	X-REF	0	
1A 7A 3A 39		619-1227-001	X-REF	0	
1A 7A 3A 40		619-2165-000	X-REF	0	
1A 9A 1	1	13499 787-6542-004	PA2ZF	0	
1A 9A 1A 1		791-1964-001	X-REF	0	
1A 9A 3		13499 787-6344-102	X-2ZF	0	
1A 9A 3A 1		789-2325-002	X-REF	0	
1A 9A 3A 1A 1		789-2323-001	X-REF	0	
1A 9A 4		13499 522-4841-103	X-2ZF	0	
1A 9A 4A 1		778-2735-001	X-REF	0	
1A 9A 4A 1A 1		778-2759-001	X-REF	0	
1A 9A 4A 2		13499 778-2736-001	X-2ZF	0	
1A 9A 4A 2A 2		778-2760-001	X-REF	0	
1A 9A 5	1	13499 522-4781-101	X-2ZF	0	
1A 9A 5A 1		777-4152-002	X-REF	0	

REFERENCE DESIGNATOR	NOTES	FIIN/ACN/FSCM-REF	SMR	APPL	ADDM
1A 9A 5A 1 P 1		777-4481-001	X-REF	0	
1A 9A 5A 2		777-4158-001	X-REF	0	
1A 9A 6		13499 772-5296-102	X-2ZF	0	
1A 9A 6A 3		791-2957-001	X-REF	0	
1A 9A 6A 3 F 1		791-2907-003	X-REF	0	
1A 9A 6A 3 F 2		791-2907-003	X-REF	0	
1A 9A 6A 3 F 3		791-2907-003	X-REF	0	
1ZZM79-2621-001 FIG 19- 14		13499 546-6798-002	XB4ZZ	1	
1ZZ522-4781-101		13499 522-4781-101	XB444	1	
1ZZ522-4781-101 A 3		13499 778-2712-002	PB4DD	1	
1ZZ522-4781-101 A 5		13499 778-2766-001	PB4DD	1	
1ZZ522-4781-101 A 6		13499 778-2660-002	PB4DD	1	
1ZZ522-4781-101 A 7		13499 778-2711-001	PB4DD	1	
1ZZ522-4781-101 A 9		13499 778-2767-001	PB4DD	1	
1ZZ522-4781-101 A 12		13499 778-2639-001	PB4DD	1	
1ZZ522-4781-101 M 1		13499 458-0964-000	XB4ZZ	1	
1ZZ522-4841-103		13499 522-4841-103	XB444	1	
1ZZ522-4841-103 A 1		13499 778-2735-001	XB4ZZ	1	
1ZZ522-4841-103 A 3		13499 778-2729-001	PB4DD	1	
1ZZ522-4841-103 A 4		13499 778-2730-001	PB4DD	1	
1ZZ522-4841-103 A 5		13499 778-2719-001	PB4DD	1	
1ZZ522-4841-103 A 6		13499 778-2733-001	PB4DD	1	
1ZZ522-4841-103 A 7		13499 778-2734-001	PB4DD	1	
1ZZ522-4841-103 A 8		13499 778-2719-001	PB4DD	1	
1ZZ522-4841-103 A 9		13499 778-2709-001	PA4DD	1	
1ZZ522-4841-103 M 1		13499 458-0964-000	XB4ZZ	1	
[1ZZ522-4873-007]		13499 522-4873-007	XB444	1	
1ZZ522-4873-007 A 3		13499 775-0939-001	PB4DD	1	
1ZZ522-4873-007 A 4	1	13499 775-0949-001	PB4DD	1	
1ZZ522-4873-007 A 5		13499 793-9416-001	PB4DD	1	
1ZZ522-4873-007 A 6		13499 778-2691-001	PA4DD	1	
1ZZ522-4873-007 A 7		13499 793-9171-001	PB4DD	1	
1ZZ522-4873-007 A 8		13499 778-2693-001	PA4DD	1	
1ZZ522-4873-007 A 9		13499 775-0948-003	PB4DD	1	
1ZZ522-4873-007 A 10		13499 778-2692-001	PA4DD	1	
1ZZ522-4873-007 A 11	1	13499 775-0946-003	PB4DD	1	

NOTE:
X-REF – The abbreviation X-REF appearing in this APL under the column headed SMR is intended to provide a Cross Reference from the Reference Designator at this point to an assembly breakdown located elsewhere in the APL. This method has been employed when redundant usage of an assembly part number in the equipment would require an assembly breakdown for each appearance. The assembly breakdown appears one time only, in sequence, further in the APL under the part number indicated.

	NOMENCLATURE	IDENTIFICATION NO.	DATE	PAGE
	AN/USC-30, DATA COMMUNICATIONS SYSTEM	58592640	12-1-9_	1

Figure 7-6.–Circuit Symbol Number Lists.

AEL ID number (followed by a dash) indicates the type of equipage, as shown below:

0 – Ordnance equipage

1 – Space/system related equipage

2 – Miscellaneous equipage

3 – Automotive, construction, and materials handling equipage

4 – Flag allowance equipage

5 – Special project office equipage

6 – NRP (Nuclear Reactor Plant) equipage

7 – Portable electronic equipage

8 – Trident equipage

9 – Nuclear equipage

AELs developed for portable electronics differ in several ways from other AELs. They contain only one section and are identified with distinctive nomenclatures and numbers. The following ranges of AEL numbers are used:

Communication Equipment	7-000000001 thru 7-000009999
Infrared Equipment	7-000010000 thru 7-000019999
Radiac, Conventional	7-000020000 thru 7-000029999
Radiac, Nuclear	7-000030000 thru 7-000039999
Sonar Equipment	7-000040000 thru 7-000049999
Electrical Test Equipment	7-000060000 thru 7-000069999
Noise Monitoring Equipment	7-000070000 thru 7-000079999
Electronic Tools	7-000080000 thru 7-000089999
Miscellaneous	7-11 Series
Electronic Test Equipment	7-670050000 thru 7-670059999

The nomenclatures of the 7- AELs are preceded by the Sub-Category (SCAT) Code. If no SCAT has been assigned by NAVSEALOGCEN, a "9999" is used. This is especially important in the case of Portable Electrical/Electronic Test Equipment (PEETE) because the Ships Portable Electrical/Electronics Test Equipment Requirements List (SPETERL) is in SCAT sequence. Allowances of PEETE are determined in terms of SCAT codes rather than specific equipment models.

Accessories furnished with the equipment are shown with a descriptive name and the part number that appears in the technical manual. Technical manual numbers are also shown. This is especially important since all accessories and technical manuals must be turned in when an equipment is turned in.

Commercial equipment AELs are identified by the CAGE/FSCM and model number. The three or four letter Manufacturer's Designating Symbol is shown in the characteristics as an alternate nomenclature for reference purposes. The nomenclature of the equipment itself and its APL appears in the COSAL Index exactly as it was reported through the SCLSIS system and as reflected in the Weapon Systems File (WSF). See figure 7-7 for Portable Electronics Equipage.

Sections A and C also contain some of the documents that follow:

- Bald APL/AEL–This list consists of one or more pages of parts for which logistics support was not available at the time the COSAL was prepared. When logistics support becomes available, the APL/AEL will be produced and forwarded to the ship.

- Allowance Components List (ACL)–An ACL identifies the component and equipment APLs that *could* apply to a given equipment or system. Such a list may identify more than one APL for a certain item. However, an ACL that appears in a COSAL will identify *only* the APLs that apply to the particular installation covered by the COSAL. This type of listing allows you to identify all of the APLs that apply to equipment or systems for which you are responsible.

- Miscellaneous Repair Parts APL–This APL identifies items that may be needed during equipment maintenance or repairs but that are not included on equipment or system APLs. Examples are fuses, light bulbs, toggle switches, and lighting fixtures.

Part III

Part III contains an integrated stock list (ISL), a ship value list, an old-to-new cross reference list, and seven assorted sections that pertain to parts, modules, consumables, stock numbers, and forms and publications.

ALLOWANCE EQUIPAGE LIST (AEL)

EQUIPMENT/COMPONENT NOMENCLATURE/CHARACTERISTICS	TECHNICAL DOCUMENT NUMBER	MANUAL / PLAN	IDENTIFICATION NO.	DATE	PAGE
4245 AEL AN/PSM-4E			7-670050115	11-15-9	1

CHARACTERISTICS

APL NUMBER/RIC 56731Q15
ALLW SUPPORT CODE AA
PRIORITY 23
WEIGHT 5.5 LB
CUBE 0.12 CF L 7.47 W 5.94 H 4.72 INCHES
CALIBRATION REQUIRED - YES
COLUMN SELECTED BASED ON EQUIPMENTS ON BOARD.
TOTAL SHIPBOARD ALLOWANCE REQUIREMENTS FOR
TEST EQUIPMENT ASSIGNED TO THIS SCAT CODE
ARE PRINTED IN THE SPETERL, SHIPS PORTABLE
ELECTRICAL/ELECTRONIC TEST EQUIPMENT
REQUIRMENTS LIST, FOR EACH INDIVIDUAL SHIP
ALTERNATE NOMENCLATURE NONE
MODEL NONE.
ITEMS TO BE TRANSFERRED WITH TEST EQUIPMENT.
INSTRUCTION MANUALS

MULTIMETER	ME-48E/U	1EA
COVER	CW-326/PSM-4A	1EA
LEAD, RED	CX-2353/PSM-4A	
LEAD, BLACK	CX-2354/PSM-4A	1EA
LEAD, HIGH VOLT	CX-2335/PSM-4A	1EA

Item	Name	Stock Number	SEC CODE / SOURCE	MAINT	RECY	NOTES	CUST	U/I	QTY	COL. 1	COL. 2	COL. 3	COL. 4	COL. 5	COL. 6	COL. 7	COL. 8
AN/PSM-4E	MULTIMETER	4GD6625-00-379-0206TE	UPE24G		1			EA	1	1	2	3	4	5	6	7	8

END

NOTE: APLs and AELs for portable electronics equipage are listed in COSAL Part I, Indices A and B as follows:

Index Section A Nomenclature sequence

APLs by equipment designator, i.e., AN/PSM-4E   AELs in SCAT code sequence, i.e., 4245 AN/PSM-4E

Index Section B Service Application sequence

APLs under the service/equipment application

APLs and AELs for portable electronics equipment/equipage included in a ship's COSAL are based upon configuration and not allowances; therefore, configuration changes in PEETE must be reported in accordance with Chapter 5. Allowances for PEETE are contained in the ship's SPETERL. For detailed information on the SPETERL and its relationship to validations and the COSAL see Chapter 7B.

REFERENCE SYMBOL NO		ITEM NAME	STOCK NUMBER	SEC CODE	SOURCE	MAINT	RECY	NOTES	CUST	U/I QTY	1	2	3	4	5	6	7	8
DD 901	E 36	PART II ALLOWANCE EQUIPAGE LIST (AEL) SECTION C									7-670050115				11-15-77		1	
SHIP TYPE & HULL NO	PAGE										IDENTIFICATION NO				DATE		PAGE	

Figure 7-7.–Electronics AEL.

	STOCK NUMBER.	ITEM NAME.	EQUIPMENT/ COMPONENT/ EQUIPAGE ID NO.	U/I.	ALLOW-ANCE QUAN-TITY	NOTES	TOTAL SHIP'S POPULA-TION PER ID NO.	MIL. ESS. CODE	* SUPPLY MGMT SL	SLA	TSS	SMC	SC	CUSTODY	UNIT PRICE	DERIV	UNIT CUBE
	1HM0099-LL-H22-3950	PLATE, INFORMATION	006230024	EA	8	E	8	21	0	00			U	R		P	
	1HM0099-LL-H22-3951	PLATE, INFORMATION	006230024	EA	8	E	8	21	0	00			U	R		P	
	9Z 5305-00-201-3806	SCREW, CAP, HEXAGON, H	00009290	EA	1		2	21	0	00			U	R		I	
A.	9Z 5305-00-207-8253	SCREW, CAP, HEXAGON, H	00009290	EA	5		2	21	0	00			U	R		D	
	9Z 5305-00-253-5615	SCREW-DR STL .116X1-4	00009290	HD	1		1	21	0	00			U	R		I	
	1HM3120-00-404-3679CF	BUSHING, SLEEVE	00009290	EA	1		2	21	0	00	C		U	R		I	
	9Z 5310-00-515-7449	WASHER, FLAT	00009290	HD	1		1	21	0	00			U	R		I	
	9Z 5305-00-576-5417	CAPSCREW	00009290	EA	3		2	21	0	00			U	R		D	050
	9Z 5310-00-595-5669	WASHER, FLAT	00009290	EA	1		2	21	0	00			U	R		I	
	9Z 3120-00-723-2905	WASHER, THR	00009290	EA	1		2	21	0	00			U	R		I	050
	9Z 5365-00-808-7913	RING RETAININ	00009290	EA	1		4	21	0	00			U	R		I	
	1HM4940-01-111-8154	WAND, SPRAY GUN	950355612	EA	1		2	21	0	00			U	R		I	
B.	1HM0099-LL-H22-3949	PLATE FUMES, WARNING	006230024	EA	8		8	21	0	00			U	R		P	
C.	9C 4230-01-291-5275	PARTS KIT, RECIPROCA	019570044	EA	2		2	21	0	00	A		U	R		I	

A. REPRESENTS NEW OR REVISED APL TRANSACTIONS B. REPRESENTS PEN & INK CHANGE TRANSACTIONS C. REPRESENTS 4790CK TRANSACTIONS

SHIP TYPE & HULL NO.		DATE	* SUPPLY MANAGEMENT CODES	PART	SECTION	PAGE
CVN 69		06/27/9_	SC - Security Class,n SL - Shelf Life SLA - Shelf-life Action SMC - Special mat'l Content TSS - Type of Storage Space	II	A	1

Figure 7-8.–COSAL Stock Number Sequence List (SNSL).

STOCK NUMBER	ITEM NAME	EQUIPMENT/ COMPONENT/ EQUIPAGE ID NO.	U/I	ALLOWANCE QUANTITY	NOTES	TOTAL SHIP'S POPULATION PERID NO	MIL. ESS. CODE	*SUPPLY MGMT SL	SLA	TSS	SMC	SC	CUSTODY	UNIT PRICE	DERIV	UNIT CUBE
9Q 5210-00-229-3060	CALIPER-INS 8 IN	1-911154100	EA	1	1	1		0	00			U	E		N	
9Q 5210-00-229-3062	CALIPER-INS 4 IN	1-911154100	EA	1	1	1		0	00			U	E		N	
9G 9350-00-229-4175	BRICK-RFRY SP1	021450070	EA	45	X	200		0	00			U	R		N	
9Q 5130-00-230-2311	CHISEL-PWR HMR SCL	2-920015001	EA	6	1	6		0	00			U	E		N	
9Q 5120-00-230-6364	HANDLE-SKT WR BRC1-2DR	0-005030002 0-006220001	EA	1 1	1 1	1 1		0	00			U	E		N	050
9Q 5120-00-230-6380	WRENCH-TORQ	0-006300355	EA	1	1	1		0	00			U	E		N	
9Q 5120-00-230-6385	HANDLE-SKT WR RCHT 1-2DR	0-006220001 0-006320317 1-910284001 2-750004002 2-920015101	EA	1 1 2 2 1	1 1 1 1 1	1 1 2 2 1		0	00			U	E		N	050
9C 4720-00-230-6481	HOSE-RUB	2-470004001	FT	12	1	12		0	00			U	R		N	
9C 4720-00-230-6548	HOSE-RUB PNEUM 1-2IN BRD	2-380020013	FT	9	1	9		0	00			U	R		N	
9C 4730-00-231-2402	CAPXPIPE	2-830029025	EA	2	1	2		0	00			U	R		N	
9G 9150-00-231-6689	LUBRICATING OIL	0-006470180	QT	3	1	3		7	T7	G	G	U	C		N	100
9N 5935-00-231-8124	CONNECTOR-PG ELECL	870040006	EA	1	X	1		0	00			U	R		N	
9Z 4020-00-231-9007	ROPE-MNLA 1 1-4IN CRCM	2-820379008 2-820379009	CL	AR AR	1 1	1 1		0	00			U	E		N	

SHIP TYPE & HULL NO.		DATE	*SUPPLY MANAGEMENT CODES	PART	SECTION	PAGE
DD 0001		11-15-9-	SC – Security Class'n SLA – Shelf-life Action SL – Shelf Life SMC – Special-mat'l Content TSS – Type of Storage Space	III	B	74

Figure 7-9.–SNSL of Operating Space Items.

SECTION A–STOREROOM ITEMS.–This section identifies items kept in the storeroom and is arranged in ascending order by National Item Identification Number (NIIN). It also contains other information, such as item name, allowance quantity, shelf-life code, security classification code, and unit price. This list is known as the Stock Number Sequence List (SNSL) for storeroom items. (See figure 7-8.)

SECTION B–OPERATING SPACE ITEMS (OSI).–This section lists items that are used to make repairs in operating spaces. (See figure 7-9.)

SECTION CF–MAINTENANCE ASSISTANCE MODULES.–This section lists quick-change units, such as modules and circuit boards, that might appear in section A (storeroom items) if usage warrants backup support. The items are arranged in ascending NIIN order.

SECTION CR–READY SERVICE SPARES.–This section lists small parts that can be changed easily, such as cable assemblies, connectors, covers, light bulbs, fuses, and so on.

OLD-TO-NEW STOCK NUMBER CROSS REFERENCE LIST.–This cross-reference list has all the stock number updates. It is arranged in old number sequence and is tailored to the specific ship for which the COSAL is developed.

SECTION D–ALTERNATE NUMBER CROSS REFERENCE TO NIIN/NICN.–This section is arranged by alternate number (manufacturer's number), and allows you to cross reference a manufacturer's part number to an NIIN or NICN.

SECTION E–GENERAL USE CONSUMABLES LIST.–The general use consumables list (GUCL) identifies nonequipment-related consumables recommended for supporting a ship's routine maintenance and administrative operations. It is usually published for new construction, reactivation, or major conversion ships.

For a thorough understanding of the COSAL, refer to the *COSAL Use and Maintenance Manual*, SPCCINST 4441.170A, chapter 3. As you become more familiar with the COSAL, you will find it much easier to use.

ALLOWANCE CHANGE REQUEST
NAVSUP 1220-2 (12-76) S/N 0108-LF-501-2206

Instructions on Reverse | Please Type or Print

1. FROM: CO, USS JOHN PAUL JONES (DDG-32)
FPO San Francisco, CA 96601

TO: O-in-C, Mechanicsburg Division (SEC 6830)
Naval Ship Engineering Center, Mechanicsburg, PA 17055

VIA: Commander Naval Surface Forces, U. S. Pacific Fleet
San Diego, CA 92155

2. Date/Serial Number
6/3/9_ DDG32/ØØ5

3. APL/XXXXXX Number 48Ø11ØØ93

4. Status of Requested/Allowed Item
[X] XXXXXXXXQuantity Increase [X] Item on Board
or or
[ ] Item Deletion [ ] Item Not on Board

5. National Stock Number (NSN) or FSCM & Part Number	6. Equipment/Component (E/C) or Item Nomenclature	7. Unit of Issue	8. Unit Price	9. Present Qty. Allowed	10. New Total Qty.	11. Extended Value of Change
9C/294Ø-ØØ-287-1931	FILTER, FEED PRESSURE	EA	6.66	4	8	26.64

12. Justification (Mandatory)
Four feed pressure filters are installed in each of the ship's two emergency diesel generators. Since these generators are run simultaneously, all eight filters usually are required to be replaced at the same time. Therefore, an allowance of eight filters is necessary to permit onhand availability of what is considered to be the "minimum replacement unit".

13. Copy To: COMNAVSURFPAC

14. Signature: R. S. Sears
R.S. SEARS, LT, SC, USN
By direction

15. First Endorsement [ ] Approval Recommended [ ] Disapproved [ ] Other

Figure 7-10.–NAVSUP 1220-2 (Allowance Change Request).

CHANGES TO THE COSAL

When new equipment is installed or when changes are made to equipment already on board, your ship should receive new APLs to replace obsolete ones. Make sure that new equipment or alterations to existing equipment are supported by a new APL in the COSAL, and that the supply department either has the required repair parts on board or on order. The importance of doing this cannot be overemphasized. Few things will cause as much grief for both you and the supply officer as having equipment listed improperly in the COSAL. You can prevent this type of embarrassment by ensuring that the supply department is aware that new APLs are required for the COSAL. Many times, alterations to existing equipment will require new repair parts support. Be sure the supply officer is made aware of the alterations so he can provide whatever additional support is required.

Normally, the supply department submits the appropriate documentation to change the COSAL. However, you will probably know better than supply which of your equipment is supported by COSAL. Therefore, supply personnel will probably need to confer with you or your personnel to determine the complete and accurate technical data for the equipment before they request the COSAL change.

Three different forms are used to change or update the ship's COSAL: (1) Allowance Change Request (ACR), NAVSUP 1220-2; (2) Ship Configuration Change Form, OPNAV 4790/CK; and (3) Fleet COSAL Feedback Report (FCFBR), Form 1371.

Allowance Change Request (ACR) (NAVSUP 1220-2)

Revisions of published allowance lists may be required for many reasons. The more common reasons are as follows:

1. Material failure rates are significantly greater or less than initially estimated
2. New operating areas or conditions require different levels of support

FLEET COSAL FEEDBACK REPORT
NAVSUP FORM 1371 (4-80)

Please *Print* or *Type* all Information

DATE: 12/15/9

FROM:
EM01S. L. JONES
USS NEVERSAIL DD0001
FPO, SFRAN, CALIF. 96601

TO: NAVSEALOGSUPENGACT Code 70, Box 2020, Mechanicsburg, PA 17055

APL/AEL NO.	APL DATE
011456882	9/15/9

COMPLETE NAMEPLATE DATA IF APL/AEL NUMBER IS UNKNOWN

FULLY DESCRIBE THE APL/COSAL TECHNICAL PROBLEM, QUESTION, SUGGESTION, ETC. (*Attach continuation sheet if needed*)

Thrust collar nut is maintenance significant and is not listed on the above APL. FSCM 93233. MFRS Part Number R-1348-5 listed in technical manual 0947-LP-106-9000.

	DATE
SUBMITTED BY: NAME, RATE, WORK CENTER S. L. JONES, EM01	12/15/9
REVIEWED BY: WORK CENTER SUPERVISOR B. L. FRASK, EM03	12/17/9
REVIEWED BY: SUPPLY SUPPORT CENTER SUPERVISOR SKC BRONSON, SS01	12/18/9

SSC ASSIGNED TRANSMITTAL NO.
(03318/001) (*Retain copy for follow-up file*)

REVIEWING ACTIVITY RESPONSE

Figure 7-11.–Sample Fleet COSAL Feedback Report.

3. Mission assignments require additional equipments, equipage, or repair parts
4. Development of technological improvements in equipments or systems and repair parts that can provide the ship with additional capabilities

The ship is responsible for recognizing and requesting all necessary changes to allowance lists that have not been previously directed or authorized by the appropriate type commander, allowance list maintenance activity, hardware systems command, or other appropriate authority. However, before the ship submits an ACR, someone in ship's company should review the microfiche APLs and AELs in the technical library of the nearest tender, repair ship, NSY, or NSC (when practical) to determine whether or not the desired change is already reflected in a newer APL or AEL. The responsibility for initiating ACRs rests with the commanding officer. HOWEVER, the supply officer is usually expected to prepare the ACRs for repair parts (including repairables) and to assist in preparing ACRs for equipments and equipage. ACRs will be prepared and distributed according to NAVSUP P-485 as appropriate (see figure 7-10).

If the ACR is for a Depot Level Repairable (DLR), it must be sent via message, as specified in NAVSUP P-485.

Configuration Change Form (OPNAV 4790/CK)

The Configuration Change Form is submitted when a new piece of equipment is installed or an existing piece of equipment is modified. This is to ensure that the proper file is updated in the system and that you will get the necessary allowance support from the supply system. This form was described in chapter 6.

Fleet COSAL Feedback Report (NAVSUP Form 1371)

The Fleet COSAL Feedback Report is used to call attention to, and seek correction of, any technical discrepancies found on APL or AELs. This form is NOT used to report equipment configuration changes or to request changes in the ship's carried allowance of repair parts or equipage. (See figure 7-11.)

INTEGRATED LOGISTICS OVERHAUL/INTEGRATED LOGISTICS REVIEW (ILO/ILR)

An ILO/ILR is conducted concurrently with a maintenance overhaul or availability. The primary purpose of the ILO/ILR is to ensure that the ship actually has the mission-related equipment and repair parts it needs at the End of Overhaul or End of Availability (EOH/EOA).

An integrated logistics review (ILR) is an abbreviated ILO. The ILR pertains to ships that are covered by the short availability maintenance program (i.e., ships that do not have regular or complex overhaul), the Phase Maintenance Program (PMP), and progressive maintenance availabilities. If resources are available, an ILR may be conducted on ships in the ROH/COH system during interim maintenance availabilities. The five basic elements of an ILO or ILR are as follows:

1. Configuration and COSAL Analysis
2. Repair Parts Analysis
3. Technical Manual Analysis
4. Planned Maintenance System Analysis
5. Integrated Logistic Support (ILS) Maintenance Training

Some major elements of these material support functions include the following:

1. Ensuring the equipment indices of the allowance lists (nonautomated ships) and the SNAP II database (automated ships) are accurate.

2. Off-loading and identifying all stocks of technical repair parts and equipment related items, allowance lists, and bin or rebin items, as appropriate.

3. Conducting an accurate physical inventory of all the repair parts.

4. Inspecting material to ensure its readiness for issue and repacking and represerving allowed material for shipboard stowage, as required.

5. Recording demand data on nonallowed parts and determining if those items have an application to installed equipment.

6. Adjusting shipboard stowage space to make maximum use of existing storage facilities.

7. Taking appropriate action to ensure repair parts support for equipment changes made during the maintenance overhaul.

8. Establishing stock records that will accurately reflect quantities allowed, on hand, and stowage location of material.

9. Developing and publishing a post-overhaul Integrated Stock List (ISL) of all repair parts applicable to the nonautomated ship.

10. Computing and publishing lists of excesses and deficiencies required to achieve EOH/EOA configuration quantity objectives, providing preprinted requisitions, and turning in cards to accomplish the supply actions.

11. Restowing all allowed repair parts upon completion of the ILO to ensure maximum accessibility and turning in excess material ashore for credit, disposal, or redistribution.

12. Training ship's personnel in using ILO aids and COSAL maintenance, and updating ship's configuration to assure material readiness and logistic support after the overhaul.

The functions mentioned above will be performed by an ILO team consisting of ship's force personnel. You should assign to the team the technician who is the most aware of the equipment changes that are being made in the work center. The technicians must work closely with one another as well as with the ILO Team to ensure that all configuration changes are documented accurately and in a timely manner.

NAVSUP PUBLICATIONS

The submission of a requisition for supplies sets in motion a long chain of events involving the movement of materials, maintenance of stock records, and procurement actions. Therefore, whoever submits a requisition *must* provide accurate data to help ensure that the supply system can quickly provide exactly what is needed. Managers involved in supply transactions must also have sources of data to help them do their jobs efficiently. The *Management List-Navy (ML-N)* and several related publications are designed to provide this data. These publications are used primarily by the supply department in communicating with its sources of supply, but because you will have an occasional use for them, a short description of them follows.

MANAGEMENT LIST-NAVY (ML-N)

The ML-N is the basic publication for NSN management data. It is published quarterly by the Defense Logistics Services Center (DLSC) on 48X microfiche.

The ML-N is arranged in NIIN sequence and lists only items of interest to the Navy. It includes basic management data necessary for preparing requisitions, such as stock numbers, unit of issue, unit price, shelf-life codes, and deleted and superseded NIINs, with appropriate phrase codes to indicate disposition action. The ML-N also provides other data of importance to you; namely whether an item is a mandatory turn-in item, whether it is OPTAR funded and, if so, the net cost (with turn-in) or unit cost (without turn-in). For further information concerning the ML-N, refer to the *Introduction to Federal Supply Catalogs*, NAVSUP P-4000.

RELATED PUBLICATIONS

The ML-N provides most of the required management data related to a stock number. Other essential information is included in related publications that you should use with the ML-N. These publications are described in the paragraphs below.

Master Cross-Reference List (MCRL)

The MCRL, published on microfiche, provides cross-reference information from reference numbers to NSNs (Part I), and from NSN to reference numbers (Part II), to assist you in identifying items in the supply system.

The MCRL is a consolidated publication. It includes items of supply that are used by all services; therefore, many NSNs will be identified in the MCRL that are not listed in the ML-N.

Master Repairable Item List (MRIL)

The MRIL is a catalog of Navy-managed repairable items. The primary purpose of the MRIL is to provide fleet activities with the information and data required for disposing of not-ready-for-issue (NRFI) repairables. This includes information on who can repair each item, how to ship it, and in some cases, how to dispose of the item locally.

Afloat Shopping Guide (ASG)

The ASG is designed to assist fleet personnel in finding an NSN for items of supply that normally do not have a part number or reference number. The ASG also helps personnel find substitutions for general hardware items through the use of illustrations, specifications, and narrative descriptions. Sections of the ASG are republished when enough changes have accumulated. These catalogs are published in sections by FSC group and class and items are listed in ascending NIIN order.

NAVSUP P-2002

The *Navy Stock List of Publications and Forms*, NAVSUP P-2002, commonly referred to as the "I Cog Catalog," is published quarterly on microfiche and consists of three sections.

SECTION I contains an alphanumeric listing of form numbers, publication numbers, hull-specific publication numbers, electronic model numbers, and standard subject identification code for Cog 1I Forms.

SECTION II contains an alphabetical listing of publications and forms by title/nomenclature.

SECTION III contains a numerical listing of publications and forms by stock number, followed by NAVAIRSYSCOM technical directives (by type and directive number).

Publications and forms are sequenced together. Section I and section III both provide information such as "canceled," or superseding item, "superseded by," and "replaced by."

List of Items Requiring Special Handling (LIRSH)

The LIRSH is a quarterly publication that identifies supply items in the following categories that require special handling: repairables, shelf-life items, certain controlled inventory items, and hazardous items.

Hazardous Material Information System (HMIS)

This publication provides information to help minimize on-the-job risk due to hazardous materials. There is a wide range of data in the system related to safety, health, packaging, labeling, transportation, and disposal of hazardous materials. HMIS also provides labeling and packing requirements; shipment, storage, and handling safety precautions; and other pertinent information about the items listed. The listing is divided into three sections as follows:

1. Trade Name to Product Identity Cross Reference
2. Part Number Cross Reference (PN XREF)
3. Specification Number Reference (SPEC XREF)

The HMIS (DOD 6050.5L and LR) superseded the Consolidated Hazardous Item List (CHIL). It is issued in a basic edition dated in November and in quarterly cumulative updates dated the following February, May, and August.

Commercial and Government Entity (CAGE) Cataloging Handbook H4/H8

Formerly the *Federal Supply Code for Manufacturers (FSCM),* the *CAGE Cataloging Handbook H4/H8* contains the names and addresses and 5-digit CAGE code of manufacturers who have previously produced or are currently producing items used by the Federal Government. The H4/H8 is published in two parts:

Part A–Name to Code Cataloging Handbook H4/H8–lists manufacturers in alphabetical order by name address and 5-digit CAGE code each.

Part B–Code to Name Cataloging Handbook H4/H8–lists manufacturers in numerical order by cage code. Part B also provides each manufacturer's name and address.

The CAGE code is used with the part number, item, symbol, or trade name assigned by the manufacturer to his product. Be sure to use care when you select a CAGE code because some major manufacturers have more than one code assigned. Codes are often assigned to separate divisions or affiliates as well as to the parent company.

OTHER SOURCES OF IDENTIFICATION DATA

Suppose you do not have a stock number for an item, and cannot locate it in the allowance lists. Your chief sources of information for identifying the item then become other identification data relating to the item itself, and identification publications in which available data is recorded and used.

If you can find other identification data, such as reference numbers for the item, your supply department may be able to locate the correct NSN. A reference number may be a part, type, catalog or drawing number, or a specification or nomenclature designation that has been given to the item by the manufacturer, contractor, or a governmental agency. Some of the sources available are listed below.

Commercial Catalogs and Instruction Books

Commercial catalogs and instruction books or pamphlets issued by the manufacturer contain information that you can use to prepare procurement documents for nonstandard material. You can also use them as a supplement to Navy publications to provide a quick and accurate method of identifying commercial equipment, repair parts, and accessories.

Serial Number

Certain technical material may be serially numbered, either by direction of the responsible bureau or systems command or by the manufacturer. These serial numbers are used in maintaining records on the material and appear on all vouchers, records, custody cards, and survey reports.

Nameplates

Nameplates attached to items, particularly portable and installed equipment, can contain a considerable amount of identification data, such as the manufacturer's name, and the equipment make or model number, serial number, size, and voltage.

Drawing Numbers

Certain technical materials are identified by a drawing or sketch number assigned by the controlling bureau or systems command or by the manufacturer. When you requisition nonstandard items, be sure to include any available drawing number with the data you provide on the NON-NSN Requisition (Manual) (DD Form 1348-6). Having the drawing number will help supply personnel positively identify what you need.

Markings

Various items of electronic equipment are identified by a Joint Electronics Type Designation (JETD) (e.g., AN/UYK-5[V]) and a Navy type or model number, as well as a stock number and serial number. In addition, major units of electronic equipment are identified by Mark and Modification numbers.

Contractors' Service Bulletins

Contractors' service bulletins include contractors' recommendations for modifications to specific equipment. They cover a wide range and usually contain part numbers, nomenclature, and names of manufacturers.

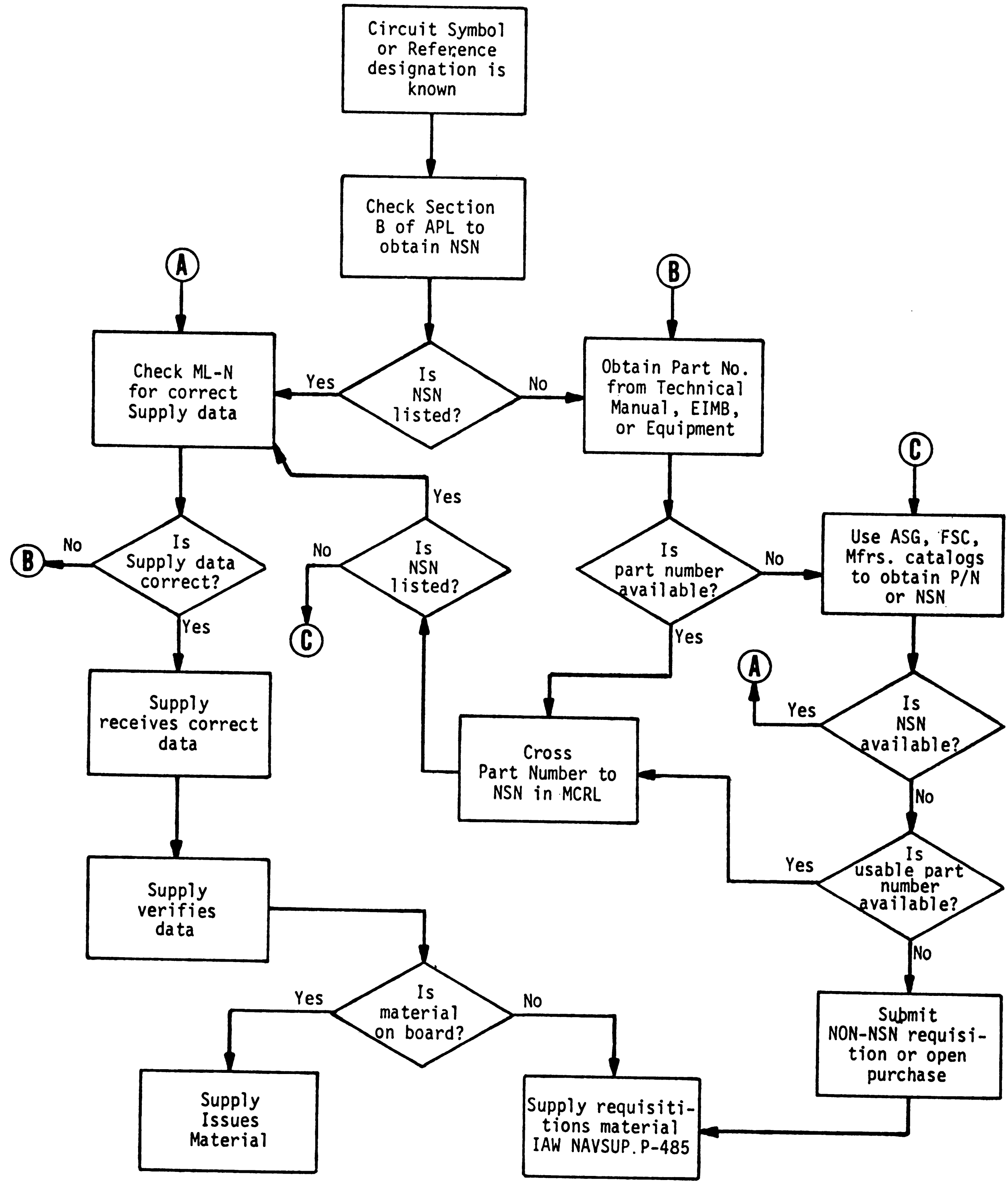


Figure 7-12.–Material Identification Chart.

Naval Ship's Technical Manuals (NSTMs)

NSTMs are published by NAVSEA and contain information and instructions for the operation, care, and repair of systems.

Before you can obtain necessary material, someone must determine its current NSN. In most cases, this requires using supply catalogs. There are three basic ways to enter (search) the catalogs to obtain the current NSN (see figure 7-12):

1. Entry with an NSN (which may or may not be current)
2. Entry with a reference number (manufacturer's part number, Navy drawing number, or other reference number)
3. Entry with a noun name or physical characteristics description

ENTRY WITH AN NSN

In actual practice, a requisition containing a National Stock Number (which may or may not be current), as obtained by the customer, is submitted to the supply department.

The department should have several personnel well trained in using the catalogs to identify a material's NSN. Usually, only the more complicated identification problems require storekeeper or supply officer assistance.

Only the NIIN portion is used to enter the ML-N, which is arranged in NIIN sequence without regard to Cog symbol and Federal Supply Class. In the vast majority of cases, the ML-N section will provide the required management data.

ENTRY WITH A REFERENCE NUMBER

A reference number is generally considered to be any number, other than a current NSN, that can be used to identify an item or to assist in identification of its current NSN. Reference numbers therefore include old NSNs, electron tube-type numbers, and electronic equipment circuit symbol numbers. There are, however, two additional important types of reference numbers that can be converted to National Stock Number by using the Master Cross-Reference List (MCRL): (1) manufacturers' part numbers and (2) Navy drawing and piece numbers.

Manufacturers' part numbers are numbers assigned to parts by the manufacturers who designed and built the equipment. They are assigned manufacturers for their own use in cataloging and identifying their own material. Some use part number formulation systems in which their plan or drawing and piece numbers form all or a portion of their part numbers.

Navy drawing and piece numbers are assigned by Navy technical commands to identify items in equipment built or designed by those commands. Some items may have both manufacturer's part numbers and Navy drawing and piece numbers assigned, in various reference publications.

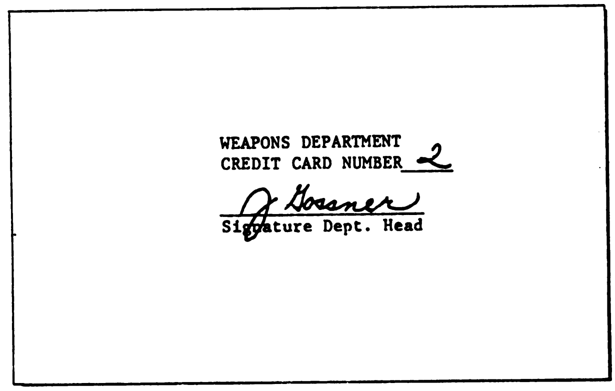


Figure 7-13.–Credit card.

When one of your technicians first attempts to determine a material's NSN, he or she may well have to look for the manufacturer's part number or a Navy drawing and piece number. There are several possible places where these numbers may be located:

- The part number may be stamped on the item to be replaced
- Navy drawing and piece numbers are given on ship's available on the ship
- Part numbers are available in equipment technical manuals furnished by the manufacturer
- Any of these numbers may be found in a logbook kept for frequently used electronic parts

Supply officers are not normally a good source for technical manuals, since they have very few in their custody. A large number of technical manuals are, however, kept and used by the ship's technicians to maintain the complex equipment installed in the ship. In addition to using these manuals to maintain their equipment, technicians also use them as a basic source of information for identifying repair parts.

To obtain a current NSN when you know a reference number, enter the Master Cross-Reference List (MCRL) with the reference number to determine the NIIN. When the NIIN is listed, check to ensure that the Federal Supply Code for Manufacturers coincides with that of the manufacturer of the part.

ENTRY WITH NOUN NAME OR PHYSICAL DESCRIPTION

The majority of the items in the Navy supply system do not have a physical description because they are difficult, if not impossible to describe briefly.

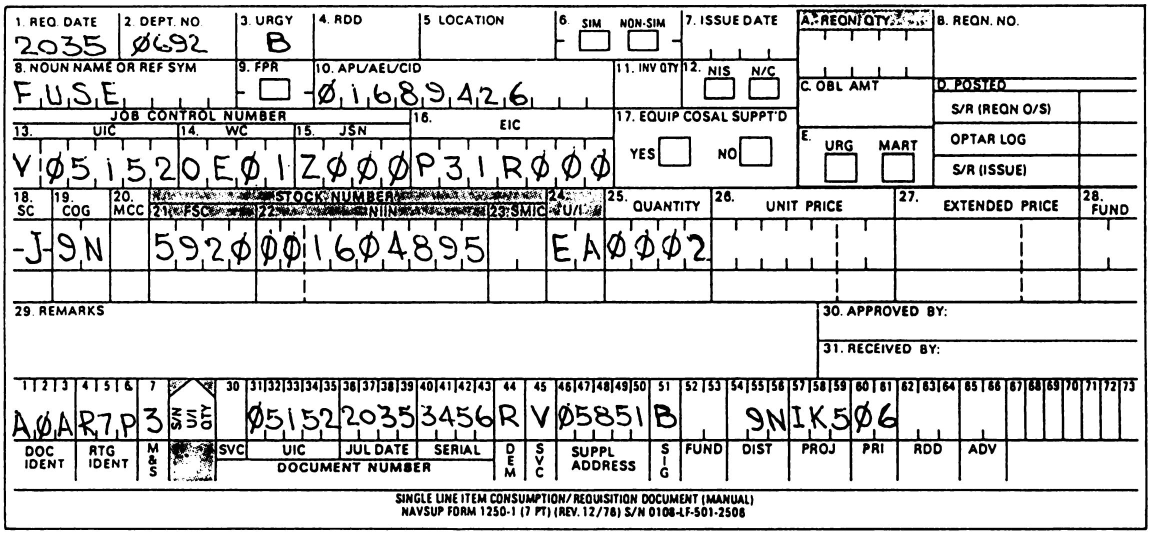


Figure 7-14.-NAVSUP Form 1250-1.

There are, however, large numbers of items that can and should be described by physical characteristics. Examples of these are common-use, nontechnical items such as paint, hand tools, nuts, and bolts. Examples of technical items that have physical descriptions are fuses, resistors, and electron tubes.

This method of entry uses descriptions similar to those provided in mail order catalogs. In addition to a noun name, the item description may include descriptions of physical, chemical, mechanical, and electrical properties.

ISSUES FROM SUPPLY STOREROOMS

Routine issues of repair parts and consumable items from supply department storerooms are made ONLY to authorized individuals. These issues are based on requests made in writing by the respective department head. You may authorize individuals to draw material either by sending the supply officer a list of those authorized, or through the use of a "credit card" system. A credit card is a locally developed form similar to the one shown in figure 7-13; these credit cards are controlled by the department head. The necessity of limiting the number of people authorized to draw material is obvious–you want to ensure that repair parts and hand tools issued from supply storerooms are used to repair equipment aboard ship, not to outfit someone's personal tool kit.

You will find that you can keep a tighter grip on your budget if you keep the number of "authorized signatures" (or, alternately, those with access to your credit card) to a minimum. As an additional control, the supply department may require the person to whom material is issued from stock to sign in block 31 of the NAVSUP 1250s. You will get copies of these 1250s with your departmental budget report (discussed later), and you will be able to trace material that "gets lost" between supply and its intended use.

NAVSUP Form 1250-1

The NAVSUP Form 1250-1 is the most commonly used form for requisitioning items through the naval supply system and is the only form that we will discuss in detail. To get full support from the supply system, you must ensure that it is completed correctly.

Figure 7-14 shows a NAVSUP 1250-1 and depicts all information that a customer must include. The remainder of the form is filled in by the supply department and will not be discussed here. Information that your department provides is explained in the following text:

Data Block	Data Block Caption	Explanation
1	Req. Date	Julian date on which the issue request is submitted.
2	Dept. No.	Internal control number for specific identification of the issue request, when desired.

Data Block	Data Block Caption	Explanation
3	Urgy	Urgency of need designator A, B, or C, as appropriate. This is discussed in detail later in this chapter.
4	RDD	Julian date when delivery of the material is required. (Entered only when the requested item is not in stock or not carried, and the priority authorized to be assigned in a requisition will not provide for timely delivery of material.)
8	Noun Name or Ref. Sym.	Noun name of the requested item, or the reference symbol number for an electronic or ordnance item (required.)
9	FPR	Checked when the requested item is a replacement for a failed part.
10	APL/AEL/CID	The allowance parts list, allowance equipage list, or other allowance list for the equipment or component in which the requested item is to be used; or (if an allowance list has not yet been developed), the component identification (CID) number, if available.
	Job Control Number	A 13-character number used to identify a maintenance action; it consists of the combined data entries in data blocks 13, 14, and 15.
13	UIC	Ship's unit identification code, prefixed by the service designator code R, V, or N, as applicable.
14	WC	Work center code that identifies the work center that will use the material.

Data Block	Data Block Caption	Explanation
15	JSN	Job sequence number that, with the UIC and WC codes, identifies a specific or nonspecific maintenance action.
16	EIC	Equipment identification code, which identifies the system, subsystem, or equipment in which the requested item is to be used.
21-23	Stock Number	NSN, including SMIC if applicable.
24	U/I	Unit of issue.
25	Quantity	Quantity required. (Limit the quantity of each maintenance-related item requested for issue to that actually required for a specific maintenance action.)
29	Remarks	Additional information pertinent to the requested item, when required for identification or management purposes.
30	Approved by	Signature of the department head or a designated representative when appropriate.

For more information on NAVSUP Form 1250-1, refer to *Afloat Supply Procedures*, NAVSUP P-485.

NOT-CARRIED (NC) TRANSACTIONS

You may often have a requirement for material that is not authorized to be stocked in supply department storerooms (because it neither appears on an allowance list nor is supported by adequate usage). Do not order not-carried material unless you have an immediate or definite need for it. Do not try to circumvent the Navy's financial control scheme by holding in one of your storerooms material that is not authorized to be held in supply storerooms. If you require a part that has a high usage, the supply department will be authorized to stock the material based on your usage.

Occasionally, you may feel that you are justified in requesting that a not-carried repair part be ordered for stock. When you do, you may request that the supply officer prepare a requisition. You may also request that the COSAL preparation and maintenance activity revise the applicable allowance parts list to include this part in your allowance. If they concur with your justification, the allowance will be revised and the supply officer can stock the repair part.

NOT-IN-STOCK (NIS) TRANSACTIONS

Sometimes your request for an item may result in a not-in-stock transaction. An NIS transaction occurs when the supply storerooms do not have material in sufficient quantity (or maybe have none at all) to satisfy your request for an item they are authorized to carry. Such a situation does not necessarily mean a breakdown in supply support procedures. How could this happen? Suppose that the AN SPS-10 radar has suddenly started blowing fuses. If the allowance for these fuses is two and you have had no usage over the last 3 years, you may not have a replacement on board for a third blowout within a short period. In a different situation, suppose one of your technicians is a good buddy of the electronics storeroom SK. One night a tube, for which the storeroom allowance is one, blew. Rather than "go to all the trouble" of completing a NAVSUP 1250-1, the technician went to the buddy, the SK, who made the issue without having the proper paper work. The SK had every good intention of posting it to the stock record card the next morning, but forgot; so a replacement for the storeroom stock was never ordered from the supply center. Two years later you have a requirement. The card shows an on-hand quantity of one, but it isn't in the storeroom. The "easy" issue of 2 years ago has caught up with you and will result in excessive down time for the equipment. DO NOT allow your personnel to "go around" the supply system. The supply department will always support you better if you and your personnel use the system properly.

SELECTED ITEM MANAGEMENT SYSTEM (SIM)

During Ship's Operating Cycle, which is the period between overhauls, and before a new COSAL is issued, the Selected Item Management System (SIM) adjusts local inventory levels upward. On nonautomated ships, SIM focuses management attention on the small percentage of items most in demand. An item qualifies as SIM if it is requested two or more distinct times in a 6-month period. Allowed items qualifying as SIM are carried in quantities above allowance based upon past demands. Previously nonallowed items designated SIM can now be stocked.

You must realize that improper documentation and stockpiling of material adversely affects SIM effectiveness. Suppose a technician needs one transistor to repair a radar and the transistor is not a carried item. The technician orders two, one to make the repair, the other to have on hand to repair another radar in 2 months. By requesting the two transistors on one document, the technician documents a frequency of demand of one in 6 months. This does not meet the criteria for SIM, (i.e., a demand of two or more within a 6-month period), so the item remains not carried. Once established as SIM, an item must experience a demand frequency of one in 6 months to remain a SIM item. NAVSUP P-485, Chapter 6, provides detailed procedures for the SIM program.

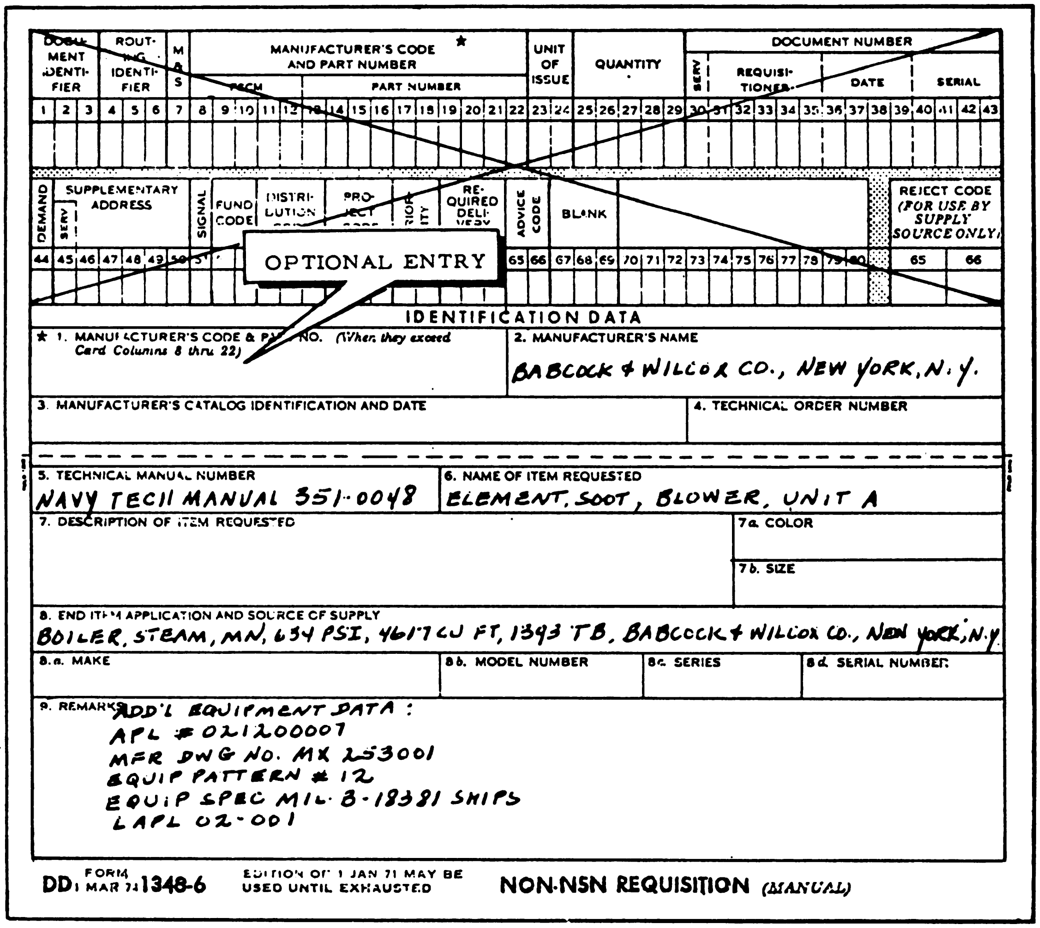
A nonallowed, not-carried item with a frequency of demand of two in a 12-month period qualifies for stocking on board as a NON-SIM item in a quantity of one each, or in a minimum replacement quantity.

PRE-EXPENDED BIN (PEB) MATERIAL

PEBs consist of low cost, frequently used, maintenance related items stored in departmental workcenters for easy accessibility. PEB material must be authorized in writing by the department head and supply officer according to the requirements of NAVSUP P-485. You will be allowed to maintain PEBs provided that there are no abuses of the system and that usage chits are submitted to validate their need. Some of the requirements are as follows:

1. The items must be authorized by the supply officer.
2. All items must be maintenance related SIM items as described above.
3. There must be a demand frequency of 3 per month in the workcenter.
4. Quantities are limited to one month's usage.
5. Unit cost is limited to $50 or less unless authorized by the TYCOM.
6. Repairables (DLR/MTR) and pilferable items cannot be pre-expended.

To keep PEBs, you *must* manage them properly. Be sure to adhere strictly to the procedures outlined in NAVSUP P-485.



DOCUMENT IDENTIFIER | ROUTING IDENTIFIER | M&S | MANUFACTURER'S CODE AND PART NUMBER ★ | UNIT OF ISSUE | QUANTITY | DOCUMENT NUMBER: SERV, REQUISITIONER, DATE, SERIAL

DEMAND | SUPPLEMENTARY ADDRESS | SIGNAL | FUND CODE | DISTRIBUTION | PROJECT | PRIORITY | REQUIRED DELIVERY | ADVICE CODE | BLANK | REJECT CODE (FOR USE BY SUPPLY SOURCE ONLY)

OPTIONAL ENTRY

IDENTIFICATION DATA

★ 1. MANUFACTURER'S CODE & PART NO. (When they exceed Card Columns 8 thru 22)

2. MANUFACTURER'S NAME: BABCOCK & WILCOX CO., NEW YORK, N.Y.

3. MANUFACTURER'S CATALOG IDENTIFICATION AND DATE

4. TECHNICAL ORDER NUMBER

5. TECHNICAL MANUAL NUMBER: NAVY TECH MANUAL 351-0048

6. NAME OF ITEM REQUESTED: ELEMENT, SOOT, BLOWER, UNIT A

7. DESCRIPTION OF ITEM REQUESTED

7a. COLOR

7b. SIZE

8. END ITEM APPLICATION AND SOURCE OF SUPPLY: BOILER, STEAM, MN, 634 PSI, 46177 CU FT, 1393 TB, BABCOCK & WILCOX CO., NEW YORK, N.Y.

8a. MAKE

8b. MODEL NUMBER

8c. SERIES

8d. SERIAL NUMBER

9. REMARKS: ADD'L EQUIPMENT DATA:
APL # 021200007
MFR DWG NO. MX 253001
EQUIP PATTERN # 12
EQUIP SPEC MIL-B-18381 SHIPS
LAPL 02-001

DD FORM 1 MAR 74 1348-6 EDITION OF 1 JAN 71 MAY BE USED UNTIL EXHAUSTED

NON-NSN REQUISITION (MANUAL)

Figure 7-15.–DD Form 1348-6.

NON-NSN REQUISITION

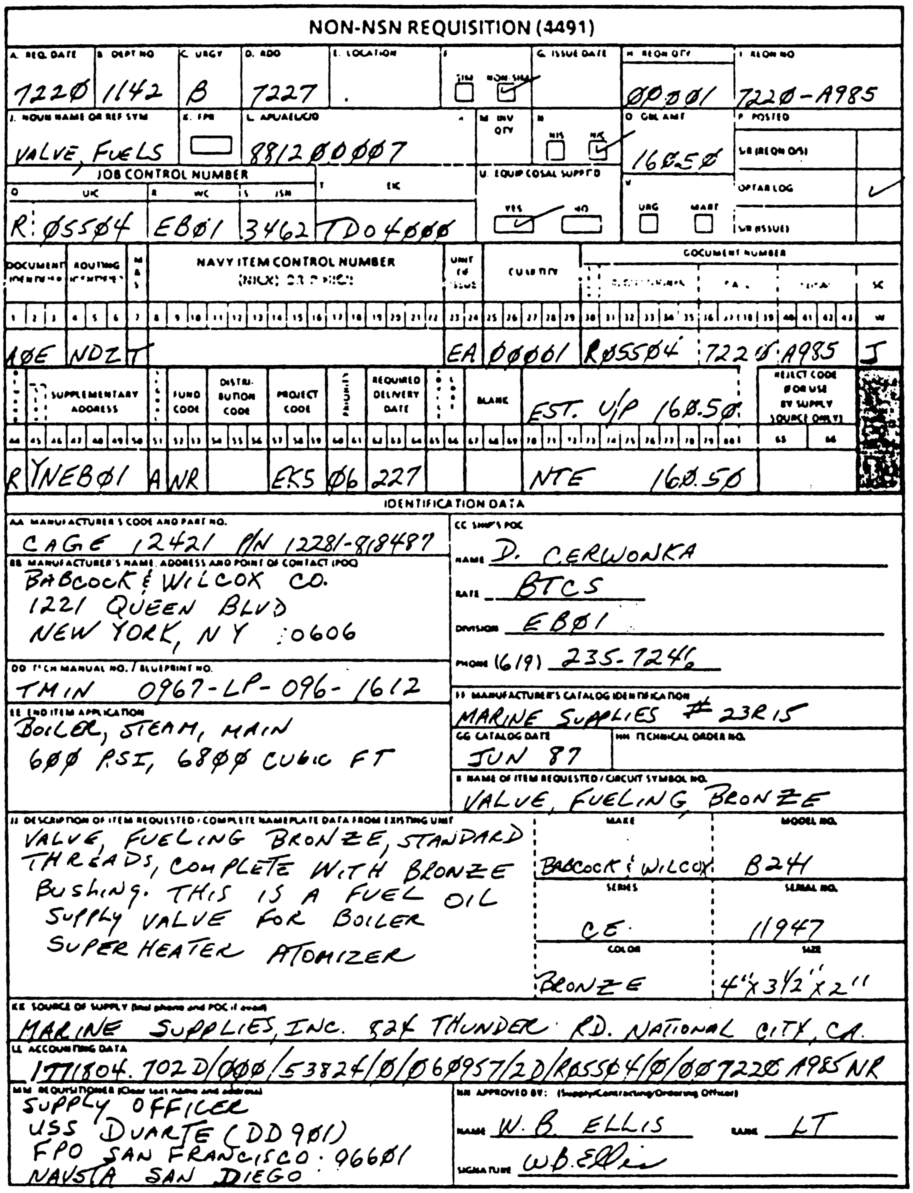
DD FORM 1348-6

To this point, we have discussed how to use the NAVSUP Form 1250-1 when you have an NSN. You complete it in the same manner when you cannot find the NSN, except that you leave blocks 3 through 5 blank. In addition, you must complete a NON-NSN Requisition, DD Form 1348-6, and attach it to the NAVSUP 1250-1. You use the DD 1348-6 (fig. 7-15) to give supply technical data about an item that you need when you can find no NSN to convey the technical requirements. Therefore, if you have an NSN, you don't need to use a DD 1348-6. Whenever you order an item through supply, remember that the more complete your technical description, the greater your chances are of getting the material in a timely manner.

NAVSUP 1250-2

The NAVSUP Form 1250-2 is a dual-purpose document, used by afloat activities to requisition NON-NSN/part numbered items from Navy supply sources and to record and report demand and usage data. The form is a combination of the DD Form 1348-6 and the NAVSUP Form 1250-1. Use of the form allows afloat supply personnel to requisition and report the demand and usage on a single document instead of having to complete a separate NAVSUP Form 1250-1 and a DD Form 1348-6 for each item. Unlike the DD Form 1348-6, which is a DOD form, the NAVSUP Form 1250-2 may only be used by afloat activities and only at Navy supply activities. It is not approved for use outside the Navy supply system.

Data blocks "A" through "V" of the NAVSUP Form 1250-2 (see figure 7-16) should be completed the same way as data blocks 1-17 and data blocks A-E of the NAVSUP 1250-1. Card Columns (CCs) 1-80 and the Identification Data blocks "AA" through "NN" are duplicated from the DD Form 1348-6 and should be completed the same way.


NON-NSN REQUISITION (4491)

A. REQ. DATE 7220Ø | B. DEPT NO 1142 | C. URGY B | D. ADD 7227 | H. REQN QTY ØØØØ1 | I. REQN NO 7220-A985

J. NOUN NAME OR REF SYM VALVE, FUELS | L. APL/AEL/CID 8812ØØØØ7 | O. CRL AMT 160.5Ø

JOB CONTROL NUMBER R: Ø55Ø4 EBØ1 3462 TDO4ØØØ

NAVY ITEM CONTROL NUMBER

AØE NDZ T | EA ØØØ01 RØ55Ø4 7220 A985 J

R YNEBØ1 A NR EKS Ø6 227 | EST. U/P 160.5Ø | NTE 160.50

IDENTIFICATION DATA

AA MANUFACTURER'S CODE AND PART NO. CAGE 12421 P/N 1228I-818487

BB MANUFACTURER'S NAME, ADDRESS AND POINT OF CONTACT (POC) BABCOCK & WILCOX CO. 1221 QUEEN BLVD NEW YORK, NY 10606

CC SHIP'S POC NAME D. CERWONKA RATE BTCS DIVISION EBØ1 PHONE (619) 235-7246

DD TECH MANUAL NO./BLUEPRINT NO. TMIN 0967-LP-096-1612

EE END ITEM APPLICATION BOILER, STEAM, MAIN 6ØØ PSI, 68ØØ CUBIC FT

FF MANUFACTURER'S CATALOG IDENTIFICATION MARINE SUPPLIES # 23R15

GG CATALOG DATE JUN 87 | HH TECHNICAL ORDER NO.

II NAME OF ITEM REQUESTED/CIRCUIT SYMBOL NO. VALVE, FUELING BRONZE

JJ DESCRIPTION OF ITEM REQUESTED/COMPLETE NAMEPLATE DATA FROM EXISTING UNIT: VALVE, FUELING BRONZE, STANDARD THREADS, COMPLETE WITH BRONZE BUSHING. THIS IS A FUEL OIL SUPPLY VALVE FOR BOILER SUPER HEATER ATOMIZER

MAKE BABCOCK & WILCOX | MODEL NO. B24 | SERIES CE | SERIAL NO. 11947 | COLOR BRONZE | SIZE 4"x3 1/2"x2"

KK SOURCE OF SUPPLY (Incl phone and POC if avail) MARINE SUPPLIES, INC. 824 THUNDER RD. NATIONAL CITY, CA.

LL ACCOUNTING DATA 1771804.702D/ØØØ/53824/Ø/Ø6Ø957/2D/RØ55Ø4/Ø/ØØ7220A985NR

MM REQUISITIONER (Clear text name and address) SUPPLY OFFICER USS DUARTE (DD 901) FPO SAN FRANCISCO 96601 NAVSTA SAN DIEGO

NN APPROVED BY: (Supply/Contracting/Ordering Officer) NAME W. B. ELLIS RANK LT SIGNATURE W.B. Ellis

Figure 7-16.–NAVSUP Form 1250-2.

AUTOMATED PROCEDURES

The Shipboard Nontactical Automated Data Processing Program (SNAP) is the Navy's plan to automate records aboard ships. A major portion of the SNAP program is for Supply and Financial Management (SFM); however this is used with the 3-M portion of the system. Currently, there are two types of SNAP systems in the fleet: SNAP I and SNAP II.

SNAP I

The SNAP I software systems were designed to provide on-line, real-time, automated support of management functions associated with supply, finance, personnel administration, aviation and surface maintenance, retail operations, food services, and other similar activities. SNAP I ships and activities include ADs, AFSs, T-AF5s, ARs, ASs, CVs, CVNs, LHAs, LPHs, and selected Shore Intermediate Maintenance Activities (SIMAs).

SNAP II

The SNAP II system consists of seven subsystems that perform a variety of shipboard functions. As the EMO, you will work primarily with the Supply Financial Management (SFM) subsystem. The SFM subsystem is used to perform afloat supply and financial management functions. However, the SFM interacts with four other SNAP II subsystems when performing certain supply or financial management tasks and performs similar functions of another subsystem. These subsystems are related to the SFM subsystem as follows:

1. System Management Subsystem (SMS)–The SMS is the control subsystem of SNAP II. It provides informational support for SNAP II system use and maintenance, processes messages between users, and controls user access to other subsystems. The SMS is also used to update databases and to upgrade the SNAP II system software. This subsystem supports the SFM by providing the ability to print out or delete prepared supply and financial management reports and files, generate supply message paper tape, and control access to the SFM.

2. Maintenance Data Subsystem (MDS)–The MDS supports the ship's maintenance functions. Some of these functions are identifying equipment, recording completion and deferral of maintenance actions, ordering of parts, and providing data and records for the current ships maintenance project (CSMP). The MDS subsystem is used to access the SFM when maintenance requirement paperwork is prepared. In addition, the MDS interfaces with the SFM in the area of automated support of the ship's COSAL. Fleet COSAL Feedback Reports (FCFBRs) and 4790/CKs are processed through this subsystem.

3. Integrated Logistics Management (ILM) Subsystem–The ILM provides managers with automated assistance during Integrated Logistic Overhauls (ILOs) when they need to refine shipboard inventories of repair parts, to update related stock records and to identify material deficiencies and excesses. This subsystem interfaces with SFM in the area of inventory management.

4. Mobile Logistic Support (MLS) Subsystem–The MLS provides support to Combat Logistics Force (CLF) ships for managing loadout, issuing, invoicing, financial and statistical reporting, reordering, and all other supply functions for CLF operations under special accounting class procedures. This subsystem provides supply and financial functions similar to the SFM but is operated separately.

The SMS subsystem was developed from the guidelines set down by NAVSUP 485. The procedures are basically manual, but are now done on a computer. Instead of sending someone to supply to look up information on requisitions, all you have to do is look it up on the computer. On a ship with the Shipboard Nontactical ADP Program (SNAP II), there will be manuals, called SNAP II Desktop Guides, which will tell you how to look up information and how to order material you need to fulfill your mission.

All battleships, oilers, destroyers, cruisers, frigates, amphibious ships, and submarines will eventually be automated with SNAP II or some similar program on a microcomputer.

UNIFORM MATERIAL MOVEMENT AND ISSUE PRIORITY SYSTEM (UMMIPS)

UMMIPS is used during peace and war to ensure that material is provided to requesting activities according to the military importance and urgency of each need, and according to other command and management considerations. Criteria for issuing the material are structured to provide a distinct advantage to deployed forces.

In satisfying competing material requirements, it is necessary to identify the relative importance of demands not only for material but also for other logistic system resources, such as transportation, warehousing, and paperwork processing. Urgent operational requirements must be given priority over requisitions for housekeeping and administrative supplies, or similar requirements. The UMMIPS is designed to recognize and give preferential treatment to material needs that adversely affect a command's ability to carry out its assigned mission.

UMMIPS uses a series of 2-digit codes called priority designators to indicate the level of importance of each requisition and material movement. This allows competing demands to be rank ordered by importance. The priority designator is derived from a matrix combining the requisitioner's Force/Activity Designator (FAD) and the Urgency of Need Designator (UND). The FAD is a Roman numeral (I through V) assigned by the Secretary of Defense, the Joint Chiefs of Staff (JCS), or by a DOD component. It indicates how essential the mission of a unit, organization, installation, project, or program is with respect to national objectives. The UND (alphabetic character) is determined by the requisitioning activity according to OPNAVINST 4614.1F. See figure 7-17.

For detailed information on UMMIPS, refer to OPNAVINST 4614.1F and NAVSUP P-485.

TABLE RELATING F/AD AND UNDs TO PRIORITY DESIGNATORS					
URGENCY OF NEED DESIGNATOR	F/AD				
	I	II	III	IV	V
	PRIORITY DESIGNATOR				
A. (UNABLE TO PERFORM)	01	02	03	07	08
B. (PERFORMANCE IMPAIRED)	04	05	06	09	10
C. (ROUTINE)	11	12	13	14	15

Figure 7-17.–UMMIPS F/AD, UND, and PD relationships.

ANTICIPATED NOT OPERATIONALLY READY (SUPPLY) (ANORS) /NOT OPERATIONALLY READY, SUPPLY (NORS) REQUISITIONS

ANORS requisitions are submitted for requirements that could create a work stoppage; i.e., a tech rep needs parts before troubleshooting can continue. NORS requisitions are submitted for casualty report (CASREP) materials. Both of these requisitions receive special handling in the supply system. The requested material is shipped with the highest priority designator authorized. NORS requisitions are identified by the letter "W" in the first position of the serial number and generally carry a required delivery date of "999." Detailed procedures concerning ANORS/NORS requisitions are contained in NAVSUP P-485.

MILSTRIP REQUISITION

Military Standard Requisition and Issue Procedure (MILSTRIP) is a standardized system of material procurement using codes designed for electronic data processing machines. It is used for ordering all material (except those items excluded in NAVSUP P-485) from the supply system, other military installations, the Defense Logistics Agency, and the General Services Administration.

MILSTRIP requisitioning is based on the use of a coded, single line item document for each supply transaction. Depending on the situation, each of your MILSTRIP requisitions will be submitted on one of the following documents:

- DOD Single Line Item Requisition System Document (Manual) (DD Form 1348)
- DOD Single Line Item Requisition System Document (Mechanical) (DD Form 1348m)
- Non-NSN Requisition (4491) (NAVSUP Form 1250-2)
- Single Line Item Consumption/Requisition Document (NAVSUP Form 1250-1)
- DOD Single Line Item Requisition System Document (Mechanical-Long Form) (DD Form 1348-6)

REQUISITION STATUS AND FOLLOW-UP

The supply activity that processes your requisition must keep you informed of its status, regardless of its priority. When the supply activity has the requested material in stock and is able to process your requisition within the proper time limit, you will receive no status on the requisition unless it has a high priority. However, when the supply activity does not have the requested material, and either passes the requisition to another activity or back-orders the material, it will inform you (the requisitioner) of the change. Such a change will give your request an exception status; other examples of exception status are a change in the unit of issue, a federal stock number change, substitution, or a partial filling of the requisition.

On high priority requisitions, naval supply activities furnish notice of shipment, including date, mode of transportation, and bill of lading number. This type of status is known as shipment status. Status data is normally provided on a DD 1348, but it may also be furnished by naval messages on high priority requisitions.

The supply officer maintains each status card with its requisition so requesting departments can find out what is happening to material they ordered. Normally, the supply department will not provide you with status on routine requisitions if they expect to receive the material by the planned date (as described in UMMIPS).

If the material will be delayed, you will be supplied exception status along with your weekly budget report. On high priority requisitions, you will be continually informed of all supply or shipment status, usually as a part of the 8 o'clock reports.

One of the reasons the supply officer maintains a file of outstanding requisitions with status cards, is so supply can initiate appropriate follow-up action on overdue requisitions. This file is checked periodically, and MILSTRIP follow-ups are sent out on outstanding requisitions. Follow-up action is normally initiated on a DD 1348 (manual); for high priority requisitions, message follow-ups may be used. If you are concerned about the delay in receipt of material, have your technicians inquire at the supply support center about the delay.

Occasionally, a change in your local situation or a supply system delay will increase your concern about the receipt material you ordered under a routine UND. The new circumstances may justify the use of a higher priority UND. If so, have your supply officer either upgrade the priority of your initial requisition or submit a new requisition with the higher PD. Do not trust the communications system to relay this message to your supply officer; see him personally. Some new paperwork may be required, but if it's important enough for a priority upgrade, it's important enough to justify a personal visit.

BEARER REQUISITIONS

For certain critical items needed immediately, a representative of your department or the supply department may carry a bearer requisition to the supplying activity ashore, walk it through each processing step, and personally pick up the material. However, do not get into the habit of using the bearer requisition to solve problems created by failing to use routine ordering procedures in a timely manner. The supply officer may not allow walk-throughs if you abuse the privilege.

IN-EXCESS REQUISITIONS

Sometimes you may need to request a quantity of material that will bring the total quantity on board above the allowed limit. For such a case, you will need to submit an in-excess requisition. In-excess requisitions are required for all the following material:

- Equipage not on the ship's allowance list
- Equipage on the allowance list requested in greater quantities than allowed
- Nonstandard consumable supplies
- Repair parts not listed with allowed quantities on ship's allowance lists, for which a requirement can be justified

Note that the approval (by your type commander) of an in-excess requisition does not constitute a change of, or addition to, an allowance list. Also, additional approval is required before in-excess articles can be replaced.

To order in-excess material, use an Allowance Change Request Form, NAVSUP 1220-2.

EXPENDITURES

Material is considered expended when it is issued from the supply storerooms, when it is transferred to another ship or station, and when it is surveyed. We have already discussed issue procedures and now will cover transfers and surveys.

TRANSFERS

A transfer generally occurs when another ship or station requests material that your ship has on hand. All transfers must be approved by the commanding officer, supply officer, and the department head who has control of the material. Frequently, the commanding officer will delegate to department heads the authority to approve transfers. This means that you only have to concern yourself with two approvals. The paperwork involved in a transfer is prepared by the supply department.

The most common type of transfer involves emergency requirements for repair parts while the ship is deployed. If another ship, deployed with you, requires a repair part that your ship has in its supply storeroom, the supply officer will usually transfer this part after consulting with you and the commanding officer. Hopefully, your ship will not need this same repair part before supply can procure a replacement. You should agree to the transfer of this repair part to the requesting ship for two reasons. First, this transfer action allows another ship to get vital equipment back into an operating condition with the least cost to the Navy. Second, there will be times when your ship will need parts. If it has the reputation of transferring repair parts to other ships in dire need, the chances of your urgent request for a repair part being answered are much greater.

SURVEYS

A survey is an investigation of the circumstances surrounding the loss, damaging, or unauthorized destruction of Navy property. A survey must be initiated for all Navy property except incoming shipments, in which case, a Report of Discrepancy (ROD) (Standard Form 364) must be submitted. Information for completing this form is contained in NAVSUP P-485. The completed survey form is used to determine responsibility for lost, damaged, or destroyed property and to fix the actual loss to the government. To make a true determination, the facts surrounding the loss or damage must be thoroughly researched in a timely manner. The research should not be limited to verifying statements of interested parties, but should be broad enough to ensure that the interests of the government as well as the rights of the individual(s) or Navy activities concerned are fully protected. A review of the factual information of the survey is required to prove or refute the statements of interested persons and to place the responsibility for the lost or damaged property where it belongs.

SURVEY FORMS

The form used to record and report circumstances, findings, and recommendations associated with a survey is the Report of Survey, DD Form 200. (See figures 7-18 and 7-19.)

The DD Form 200 will be initiated by the opening official or the commanding officer. When circumstances warrant, such as when there is an indication of criminal action or gross negligence, the commanding officer will appoint a surveying officer or survey board.

Research action is not required when the commanding officer believes that negligence was not involved in the loss, damage, or destruction of the government property. Additionally, research action is not required when, for reasons known to the commanding officer, negligence, or responsibility cannot be determined, and research would constitute an unnecessary administrative burden. Research action is not normally required when an individual accepts responsibility for the loss, damage, or destruction. Under the following circumstances, and at the discretion of the commanding officer, investigative reports required by other appropriate DOD component regulations may be used instead of research procedures prescribed in NAVSUP P-485:

- The total property damage does not exceed $2,500
- There is no possible claim against the government

SURVEY PROCEDURES

Immediately upon discovery of loss, damage, or destruction of government property, the department head or division officer must determine if there is evidence of negligence, willful misconduct, or deliberate unauthorized use. When preliminary research fails to show positive evidence of negligence, willful misconduct, or unauthorized use, the accountable or responsible officer initiates a Report of Survey, DD Form 200. If value of the loss does not exceed $500 and the responsible officer consents to reimburse the government, no Report of Survey is required.

Additional research is usually required for unresolved discrepancies related to any of the following situations:

1. Sensitive items: drugs, precious metals, narcotics, alcohol–when any discrepancy occurs, regardless of the dollar value
2. Classified items regardless of dollar value
3. Pilferable items–when the discrepancy is $500 or more
4. Any discrepancy when there is an indication or suspicion of fraud, theft, or negligence
5. Mandatory turn-in repairables, including items that have been invoiced and shipped but not received
6. Arms, ammunition, and explosives, regardless of dollar value
7. Bulk petroleum–loss exceeding stated allowances

SURVEY BOARD

A survey board may be appointed by the commanding officer specifically to conduct investigations on reports of survey. The survey board provides greater surveillance over the loss or damage investigations and supervises processing actions. One member of the board (usually the senior member) will be designated to serve as the appointing authority. Letters and orders are issued to establish the board and name the persons detailed to it. Survey Board

REPORT OF SURVEY

(*) MLSR REPORT 1988/0052

PRIVACY ACT STATEMENT

Personal information from the individual is solicited. As required by the Privacy Act of 1974, we advise:

AUTHORITY: 16 U.S.C. 136; 10 U.S.C. 1071; DoD Instruction 7200 10.

PRINCIPAL PURPOSE: To officially report the facts and circumstances supporting the assessment of pecuniary charges for the loss, damage, or destruction of DoD-controlled property.

ROUTINE USES: To initiate investigations of losses/gains of DoD-controlled property and record the findings and actions taken.

DISCLOSURE IS VOLUNTARY: Refusal to explain the circumstances under which the property was lost, damaged, or destroyed may be considered with other factors in determining if an individual will be held pecuniarily liable.

1. TYPE REPORT (X one)
   - X a. REPORT OF SURVEY
   - b. GOVERNMENT PROPERTY LOSS/DESTROYED

2. SURVEY NUMBER: R52192-0265-8130

3. DATE LOSS/GAIN DISCOVERED (YYMMDD): 90 09 22

4. NATIONAL STOCK NO.	5. ITEM DESCRIPTION	6. QUANTITY	7. UNIT COST	8. TOTAL COST
7G 5955-00-478-6339	OSCILLATOR, CRYSTAL	1 EA	$422.00	$422.00

9. CIRCUMSTANCES UNDER WHICH PROPERTY WAS (X one) (Attach additional pages, as necessary) [X] LOST [ ] GAINED [ ] DAMAGED [ ] DESTROYED

During the ships' PRE-OVERSEAS MOVEMENT (POM) period, the S-1 Division of the Supply Department was conducting a validity inventory of H-Storeroom, which is the storage area for all DLR items on J.D. 0263. During the inventory, the Oscillator could not be located in the recorded location reflected on the stock record card (H0023). A complete search of surrounding locations was conducted and the item could not be found. Further research indicated that the item had been rec'd on J.D. 0113, and posted to the stock record by SK2 Gleason, (Stock Record Storekeeper), on J.D. 0114. The stock record revealed no prior transactions (i.e., receipts/issue's) had been posted since that time. Additionally, a spot inventory of the Oscillator was last conducted by SK3 Benson, (H-storeroom Storekeeper) on J.D. 0142 with the item being onboard. The item is believed to have been issued without record during the upkeep period J.D. 0170-0195. Extensive work was done on the applicable equipment during that period, but the maintenance man has been transferred and the work center can't confirm usage of the part.

10. ACTIONS TAKEN TO CORRECT CIRCUMSTANCES REPORTED IN BLOCK 9 AND PREVENT FUTURE OCCURRENCES (Attach additional pages, as necessary)

Re-emphasize the importance of proper receipt, storage, and issue of DLR items in accordance with current directives and instructions. Also stress the importance of personal accountability for items lost, damaged, or destroyed has a result of improper storage and/or inventory procedures. Material will be expended from stock records and recorded.

11. INDIVIDUAL COMPLETING BLOCKS 9 AND 10

a. TYPED NAME (Last, First, Middle Initial)	b. SIGNATURE	c. DATE SIGNED	d. AUTOVON NUMBER
Carson, Lawrence, L., SKC	L. L. Carson	90 SEP 09	235-1687

12. RESPONSIBLE OFFICER

a. ORGANIZATIONAL ADDRESS (Unit Designation, Office Symbol, Base, State, Zip Code)	b. TYPED NAME (Last, First, Middle Initial)	c. AUTOVON NUMBER
R52192 USS JOHN PAUL JONES (DDG-32) FPO San Francisco 96601	Williams, B.A., ENS, SC, USN	235-1882
	d. SIGNATURE: B.A. Williams	e. DATE SIGNED: 90 SEP 09

13. ACCOUNTABLE OFFICER

a. NUMBER OF DOCUMENTS USED TO ADJUST PROPERTY RECORD: 2

b. ORGANIZATIONAL ADDRESS (Unit Designation, Office Symbol, Base, State, Zip Code)	c. TYPED NAME (Last, First, Middle Initial)	d. AUTOVON NUMBER
R52192 USS JOHN PAUL JONES (DDG-32) FPO San Francisco, 96601	Hunter, M.L., LT, SC, USN	235-1836
	e. SIGNATURE: M. L. Hunter	f. DATE SIGNED: 90 SEP 10

DD Form 200, OCT 84
S/N 0102-LF-000-2001

Replaces DD Form 200, 83 MAY; AF Form 198, JAN 83; DD Form 2090, SEP 77; and DA Form 4697, SEP 81, which are obsolete.

Figure 7-18.–Report of Survey, DD Form 200.

14 FINDINGS AND RECOMMENDATION OF SURVEY OFFICER

a. FINDINGS AND RECOMMENDATIONS *(Attach additional pages, as necessary)*

The lack of inproper custody controls led to the loss of the Oscillator. Not all S-1 Division personnel have been trained on the proper procedures relating to receipt/storage/issue of DLR items. In addition, a formal training plan had not been developed by the LCPO/LPO, and approved by the Division Officer for th proper security procedures for Depot Level Repairable items.

The Stock Records Storekeeper is toincorporate a DLR checklist to be supervised by the leading Petty Officer (LPO) conducting receipt, storage, and issue of DLR items into division training programs. Furthermore, the Storeroom Storekeeper will ensure that DLR items rec'd are accounted for daily, and once a month as operational commitments permit, a complete inventory of H-Storeroom will be conducted in addition to the annual inventory requirements for those such items. Also personnel accountability should be stressed both to the storeroom storekeepers and to all S-1 Division personnel who may be entrusted with such material.

It is therefore recommended that SK2 Gleason and SK2 Benson be relieved of financial liability.

b. DOLLAR AMOUNT OF LOSS/GAIN	c. RECOMMENDED PECUNIARY CHARGE	d. LOSS/GAIN TO GOVERNMENT

15. SURVEY OFFICER

a. ORGANIZATIONAL ADDRESS *(Unit Designation, Office Symbol, Base, State, Zip Code)*	b. TYPED NAME *(Last, First, Middle Initial)*	c. AUTOVON NUMBER
R52192 USS JOHN PAUL JONES (DDG-32) FPO San Francisco 96601	Harris, J.T. , LCDR, USN	235-1110
	d. DATE REPORT SUBMITTED TO APPOINTING OFFICIAL	e. DATE APPOINTED
	f. SIGNATURE J.T. Harris	g. DATE SIGNED 90 SEP 12

16. INDIVIDUAL CHARGED

a. I HAVE EXAMINED THE FINDINGS AND RECOMMENDATIONS OF THE SURVEY OFFICER AND *(X one)*

	(1) SUBMIT THE ATTACHED STATEMENT OF OBJECTION
	(2) DO NOT INTEND TO MAKE SUCH A STATEMENT.

b. I AM AWARE OF MY RIGHT TO (1) LEGAL ADVICE AND (2) APPEAL IF PECUNIARY CHARGES ARE ASSESSED. ENLISTED PERSONNEL HAVE THE RIGHT TO REQUEST REMISSION OF INDEBTEDNESS.

c. TYPED NAME *(Last, First, Middle Initial)*	d. SIGNATURE	e. DATE SIGNED	f. AUTOVON NUMBER

17 APPOINTING OFFICIAL

a. RECOMMENDATION *(X one)*		b. COMMENTS
X	(1) APPROVE	
	(2) DISAPPROVE	*NISRA San Diego notified 22 Sep 88, declined investigation etc.

c. ORGANIZATIONAL ADDRESS *(Unit Designation, Office Symbol, Base, State, Zip Code)*	d. TYPED NAME *(Last, First, Middle Initial)*	e. AUTOVON NUMBER
R52192 USS JOHN PAUL JONES (DDG-32) FPO San Francisco 96601	Smith, R.N., CDR,USN	235-1982
	f. SIGNATURE R.N. Smith	g. DATE SIGNED 90 SEP 13

18. APPROVING OFFICIAL

a. ACTION *(X one)*		b. COMMENTS
X	(1) APPROVED	(*) = Distributions: (Chain of Command) CNO OP-09N NAVWPNSUPPCEN, Crane
	(2) DISAPPROVED	

c. ORGANIZATIONAL ADDRESS *(Unit Designation, Office Symbol, Base, State, Zip Code)*	d. TYPED NAME *(Last, First, Middle Initial)*	e. AUTOVON NUMBER
R52192 USS JOHN PAUL JONES (DDG-32) FPO San Francisco 96601	Smith, R.N., CDR, USN	235-1982
	f. SIGNATURE R.N. Smith	g. DATE SIGNED 90 SEP 13

DD Form 200 Reverse, OCT 84

Figure 7-19.–Report of Survey, DD Form 200 (reverse).

procedures and membership requirements are set forth in NAVSUP P-485.

MISSING, LOST, STOLEN, OR RECOVERED GOVERNMENT PROPERTY (OPNAV REPORT 5500-1)

To ensure the success of the Missing, Lost, Stolen or Recovered (M-L-S-R) Program, commands must report all M-L-S-R incidents and accurately describe the circumstances. The reporting of these incidents is independent of requesting investigative assistance by the Naval Investigative Service. The report covers all reporting of M-L-S-R property that is coded sensitive (i.e., arms, ammunition, explosives) as defined in NAVMATINST 8300.1 (series) and OD 12067 NAVAIR 11-1-116 (Catalog of Navy Ammunition Stock), and all precious metals valued over $100). In addition, sensitive items must be reported within 48 hours. This also applies to all Navy property requiring completion of a Report of Survey (DD Form 200), Report of Discrepancy (SF-364), or Transportation Discrepancy Report (SF-361).

Examples of items covered are contained in SECNAVINST 5500.4 and include, but are not limited to the following items:

1. all serialized or unserialized firearms, weapons, ammunition, explosives, and other destructive devices regardless of value;

2. gifts of presentation silver, and other valuable articles presented to United States ships or stations;

3. highly technical items;

4. classified items;

5. a cumulative loss of serialized or unserialized property items exceeding $500 for Navy-owned material in stores or end-use accounts through the same incident even though a single item does not exceed the minimum value.

Commands must report all incidents concerning M-L-S-R property, including property recovered, regardless of whether they originally reported the property missing, lost, or stolen. In addition to making the basic reports on stolen government property required by SECNAVINST 5500.4, commands must report such incidents to the nearest Naval Investigative Service (NIS) field component for investigative assistance.

CONTROLLED EQUIPAGE

If there is any single area that could cause your friendship with the supply officer to weaken, it is the area of controlled equipage. You will look at controlled equipage from an operational standpoint. The supply officer will look at it from an accountability standpoint.

Controlled equipage consists of shipboard items selected or approved for special inventory control by the fleet commanders-in-chief. The items identified as controlled equipage are listed in appendix 11 of NAVSUP P-485, and make up the Controlled Equipage Item List (CEIL).

CONTROLLED EQUIPAGE CUSTODY CARD (NAVSUP Form 306)

The supply officer is required to maintain a controlled equipage custody card (NAVSUP Form 306) (fig. 7-19) for each item of controlled equipage on board. The supply officer prepares these cards in duplicate, turning over a copy to the responsible department head and maintaining the original. The allowance quantity shown on your copy of the custody card pertains to the weapons/operations department only, and may not reflect the ship's total allowance. Custody cards for items requiring a custody signature are signed by the department head on the original. Each time the balance-on-hand figure on a signature-required custody card changes, the department head is required to sign the original of the custody card again to reestablish responsibility. Controlled equipage custody cards for nonsignature-required equipage serve the same accountability function as signature-required cards. Except for the department head's signature, they are maintained exactly like signature-required cards.

Keep your file of subcustody cards under lock and key. On these duplicate copies, obtain a custody signature from the leading petty officer who works with the equipment. When custody of an item of controlled equipage passes from one petty officer to another, be sure that the new petty officer acknowledges custody by signing your copy of the custody card.

NAVSUP Form 306, properly prepared and with representative entries, is illustrated in figure 7-20. The following guidelines explain how the form is prepared.

- Custody records are numbered consecutively for each department.

- The responsible department is identified on each custody record. When quantities of the same controlled equipage item, such as typewriters or stopwatches, are

S/N 0108-500-6502 **CONTROLLED-EQUIPAGE CUSTODY RECORD (4442)** NAVSUP FORM 306 (Rev. 1-73)

NSN	NOUN NAME	ALLOWANCE	U/I	UNIT PRICE	SHIP/ACTIVITY	DEPT.	CARD NO.
7H 6650-00-254-8969	Binoculars	8	EA	254.00	03659	OPS	5

ALLOWANCE LIST NO.	ADD'L DESCRIPTION
2-240034001	Prismatic w/filter, case, strap, and 7x50 power

SERIAL NO.
39764; ~~40101~~; ~~45999~~; 36545; 40101; ~~38972~~; 57408, 60349; 14765; 439401, 39764

O/S REQ'N (NO.)	(QTY)	O/S REQ'N (NO.)	(QTY)	O/S REQ'N (NO.)	(QTY)	O/S REQ'N (NO.)	(QTY)	CUSTODY SIGNATURE REQUIRED
~~7094-0196~~	~~2~~	~~7185-0190~~	~~3~~					[X] YES [ ] NO

TRANSACTION RECORD

DATE	DOCUMENT NO.	RECEIVED FROM / EXPENDED TO	QUANTITY REC'D	QUANTITY EXPENDED	QUANTITY BALANCE	I ACKNOWLEDGE CUSTODY OF THIS ITEM IN THE QUANTITY SPECIFIED.
4/4/77	BF				6	O.H. Muller CDR
6/15/77	7094-0196	NSC OAK	2		8	O.H. Muller CDR
7/4/77	7185-0001	SURVEY		3	5	O.H. Muller CDR
9/16/77	7185-0190	NSC OAK	3		8	O.H. Muller CDR
9/30/77	INV (CDH)				8	J W Mulgrew CDR

Figure 7-20.–NAVSUP Form 306.

prorated to two or more departments, separate custody records are prepared for each department, showing the numerical allowance for which the department is responsible.

- The NSN or NICN should be shown when it can be determined; and when applicable, the material identification code (SMIC) should be shown. The cognizance symbol and appropriate material control code should also be shown for mandatory turn-in repairables. When the NSN or NICN cannot be determined, the manufacturer's code and part number, catalog number, or other identification should be entered.

- The current unit of issue and unit price, either from the ML-N or latest applicable receipt document, should be entered, if available; otherwise, the unit of issue of a similar type of material and an estimated unit price should be entered.

- The allowance authority must be shown.

- The complete description of the item must be shown, including serial numbers when required.

- The originals of NAVSUP Forms 306 and the originals of controlled equipage ADP lists, if provided with the COSAL, can be maintained in any space that the supply officer considers convenient and, when not in use, should be kept in locked file equipment.

- Receipts and expenditures should be entered promptly. Each entry should show the date of the transaction, receipt or expenditure document number, activity received from or expended to, the quantity received or expended, and the balance. When a department heads signature is required, better accountability of on hand balances results.

FINANCIAL CONTROL OF SHIPBOARD SPENDING

The supply officer is responsible to the commanding officer for recording and controlling the money spent for general stores and technical materials chargeable to your type commander's funds. This section explains basic financial control of shipboard spending and how it relates to you.

OPERATING BUDGETS

After each Navy appropriation or fund passed by Congress becomes law, it is assigned to Navy systems commands, bureaus, and offices that have administrative control over its expenditure.

Before any Navy activity can expend money or incur obligations under an appropriation, however, the systems command, bureau, or office administering the appropriation must issue an authorization. The most common type of authorization is an operating budget.

An operating budget is assigned directly or indirectly to fleet commanders and other naval commands, such as your type commander. The fleet commanders allot funds from the budget to type commanders.

Type commanders (and the ships of their command) use these allotments to finance (1) procurement of material from NSA (except fuel, subsistence items, ship's store resale items, clothing, and medical and dental material); (2) procurement of material and services by purchase; and (3) direct labor charges for work performed by naval shore stations.

Type commanders limit the amount your commanding officer may spend by assigning your ship an operating target (OPTAR), which cannot be exceeded without the type commander's approval. Some type commands will specify how the money should be spent (for example, X dollars for repair parts; Y dollars for consumables; Z dollars for equipage); others permit each ship to make its own breakdown.

OPTAR FUNDS

The commanding officer apportions the ship's OPTAR between planned expenditures for repair parts, controlled equipage, and consumables. He does this according to past usage data provided by the supply department's financial records and according to the expected needs of each department. Most commanding officers also establish a contingency fund to serve as a reserve for unexpected or emergency expenditures.

Consumables and repair parts are budgeted by the supply officer in departmental budgets. Each department gets a portion of the command's consumable and repair parts money. These departmental budgets are what you are allowed to expend each quarter to maintain and operate your equipment and spaces.

BUDGET REPORTS

Weekly, the supply officer prepares a budget report for the commanding officer, such as those illustrated in figure 7-21 and 7-22. This report is divided into two parts. The first part is concerned with

DEPARTMENTAL BUDGET REPORT - EMRM								
SHIP:			QUARTER: 1ST		PERIOD: 1-10 OCT –		FISCAL YEAR 19–	
DEPARTMENT	BUDGET GRANT	BALANCE C/F	ADJUSTMENTS*	STRM ISSUES	STOCK DTO REQNS	10 DAY EXPENDITURES	CUMULATIVE EXPENDITURE	BALANCE CARRIED FWD
OPERATIONS	4,000.00	4,000.00	0.00	500.00	500.00	1,000.00	1,000.00	3,000.00
ENGINEERING	140,000.00	140,000.00	-550.00**	2,000.00	10,000.00	11,450.00	11,450.00	128,550.00
COMBAT SYS	170,000.00	170,000.00	-1,000.00**	5,000.00	4,000.00	8,000.00	8,000.00	162,000.00
SUPPLY	15,000.00	15,000.00	0.00	100.00	0.00	100.00	100.00	14,900.00
CO CONTINGENCY	5,000.00	5,000.00	0.00	0.00	0.00	0.00	0.00	5,000.00
SFOEDL	10,000.00	10,000.00	1,000.00	0.00	0.00	1,000.00	1,000.00	9,000.00
SUB TOTAL	344,000.00	344,000.00	-550.00	7,600.00	14,500.00	21,550.00	21,550.00	322,450.00
STOCK REPN/INCREASE	0.00	0.00	0.00	-7,600.00	7,600.00	0.00	0.00	0.00
TOTAL TYCOM GRANT	344,000.00	344,000.00	-550.00	22,100.00	21,100.00	21,500.00	322,450.00	322,450.00

*ADJUSTMENT COLUMN WILL INCLUDE INTER-DEPARTMENT TRANSFER OF FUNDS AND SFOEDL/CANCELLATION DIFFERENCES
**CANCELLATION DIFFERENCE

Figure 7-21.–Departmental Budget Report - EMRM.

DEPARTMENTAL BUDGET REPORT - OTHER								
SHIP:			QUARTER: 1ST		PERIOD: 1-10 OCT –		FISCAL YEAR 19–	
DEPARTMENT	BUDGET GRANT	BALANCE C/F	ADJUSTMENTS*	STRM ISSUES	STOCK DTO REQNS	10 DAY EXPENDITURES	CUMULATIVE EXPENDITURE	BALANCE CARRIED FWD
OPERATIONS	17,000.00	17,000.00	0.00	1,000.00	4,000.00	5,000.00	5,000.00	12,000.00
ENGINEERING	25,000.00	25,000.00	-2.000.00CR	500.00	3,200.00	3,700.00	3,700.00	23,300.00
COMBAT SYS	23,000.00	23,000.00	0.00	1,500.00	4,100.00	5,600.00	5,600.00	17,400.00
SUPPLY	11,000.00	11,000.00	0.00	450.00	2,400.00	2,850.00	2,850.00	8,150.00
NAV/AD	3,000.00	3,000.00	0.00	0.00	500.00	500.00	500.00	2,500.00
MEDICAL	6,000.00	6,000.00	0.00	200.00	750.00	950.00	950.00	5,050.00
VEHICLE RENTAL	3,000.00	3,000.00	0.00	0.00	3,000.00	3,000.00	3,000.00	0.00
PHASED REPL	13,000.00	13,000.00	0.00	0.00	6,000.00	6,000.00	6,000.00	7,000.00
DAMAGE CNRL	12,000.00	12,000.00	0.00	0.00	1,000.00	1,000.00	1,000.00	11,000.00
HABITABILITY	6,000.00	6,000.00	0.00	0.00	500.00	500.00	500.00	5,500.00
PORT COSTS	5,000.00	5,000.00	0.00	0.00	0.00	0.00	0.00	5,000.00
CO CONTINGENCY	5,000.00	5,000.00	2,000.00	0.00	0.00	0.00	0.00	3,000.00
SFOEDL	5,000.00	5,000.00	500.00	0.00	0.00	500.00	500.00	4,500.00
SUB TOTAL	134,000.00	134,000.00	500.00	3,650.00	25,450.00	29,600.00	29,600.00	104,400.00
STOCK REPN/INCREASE	0.00	0.00	0.00	-3,650.00	0.00	0.00	0.00	0.00
TOTAL TYCOM GRANT	134,000.00	134,000.00	500.00	0.00	29,100.00	29,600.00	104,400.00	104,500.00

*ADJUSTMENT COLUMN WILL INCLUDE INTER-DEPARTMENT TRANSFER OF FUNDS AND SFOEDL/CANCELLATION DIFFERENCES

Figure 7-22.–Departmental Budget Report - Other.

the EMRM(equipment maintenance related material) departmental budget and the second part pertains to your repair parts budget. These reports let you know how well you are staying within your budget. This report reflects charges for consumables and repair parts issued from supply department storerooms, and for requisitions not carried and not in stock. All your figures should be substantiated by the pink copies of NAVSUP 1250-1, covering your department's transactions for that reporting period.

The pink copies of the NAVSUP 1250-1 should include the requisition numbers of material ordered for you that was not in stock or not carried. This will give you a good picture of what you have outstanding. When you receive these pink copies, put them into a special file for outstanding requisitions. Having this file will help you and the supply department determine the status of any outstanding material in which you have a particular interest. This file will also help you decide if the material is still required. If you no longer need the material, notify supply, so they can cancel your requisition.

SUMMARY

As a department head or manager having equal responsibilities, you must understand the basics of how an afloat supply department works, and use what you know to secure appropriate support from supply. This chapter has summarized points of contact between you and a supply department. If you comply with the letter and the spirit of the suggestions made in this chapter, you will find that your supply department is better able (and more willing) to provide the service that you should rightfully expect from them.

REFERENCES

Afloat Supply Procedures, NAVSUP Publication 485, REV 2, Naval Supply Systems Command, Washington, D.C., 1990.

Coordinated Shipboard Allowance List (COSAL) Use And Maintenance Manual, SPCCINST 4441.170A, Navy Ship's Parts Control Center, Mechanicsburg, Pa., 1989.

Maintenance and Material Management (3M) Manual, OPNAVINST 4790.4B, Department of the Navy, Office of the Chief of Naval Operations, Washington, D.C., 1987.

Surface Force Supply Procedures, COMNAV SURFLANTINST 4400.1D, Naval Surface Force United Atlantic Fleet, Norfolk, Va., 1989.

Uniform Material Movement And Issue Priority System (UMMIPS), OPNAVINST 4614.1F, Department of the Navy, Chief of Naval Operations, Washington, D.C., 1983.

CHAPTER 8

WORK BEYOND THE CAPABILITY OF SHIP'S FORCE

OVERVIEW

This chapter explains your role in requesting and monitoring maintenance that is beyond the capability of your ship's force.

OUTLINE

Introduction

Fleet maintenance policy

Equipment condition/assessment

Maintenance levels

Depot level maintenance programs

Ship repair facilities and naval shipyards

Mobile technical units (MOTUs)

Direct fleet support

Space and Naval Warfare Systems (SPAWARS) Command detachments

Miniature and Microminiature Electronic Repair and Certification Program (2M)

As electronics material officer, you are responsible for advising the commanding officer of what electronic equipment needs repairing and of the priorities to be assigned to individual repair items. To do this you must know the condition of your equipment, the purposes of the various types of ship availabilities, and the kinds of repairs that may be made during each type of availability. You must also understand the regulations governing alterations and the kinds of assistance available through contract field service technicians.

Ships cannot continue to operate reliably without repairs. To keep a ship in prime condition, the ship's force must give constant attention to material upkeep. To ensure that the ship is maintained properly, definite intervals of time are allotted for general overhaul and repair. But even when the ship's force follows routine planned maintenance procedures and schedules carefully, damage due to storms, collisions, fires, and so on, may require emergency repair work beyond their capability. Such repairs, and scheduled alterations, may be made by either forces afloat (including repair activities afloat) or repair activities ashore. In this chapter, we discuss the types of repairs and modifications made by these facilities and the basic requirements of the repairs. We also discuss the various types of maintenance above organizational maintenance and your role in each type.

GENERAL FLEET MAINTENANCE POLICY

General fleet maintenance policy is covered in detail in *Policies and Procedures for Maintenance of Ships*, OPNAVINST 4700.7H. Some of the general guidelines are as follows:

1. The fleet will be kept fully capable of meeting all expected threats and ships will be kept in a material condition that will allow them to accomplish their assigned missions.

2. Maintenance will be done at the lowest possible level, taking into consideration urgency, priority, capability, and cost.

3. The maintenance of ships is considered a continuing process that encompasses all levels of the chain of command. Maintenance actions are either preventive or corrective. Preventive maintenance

actions are intended to maximize the reliability of ships and to minimize the total maintenance workload.

4. Each new ship design will include a Class Maintenance Plan and Modernization Policy document which will describe the specific maintenance and modernization programs (including required availabilities) that apply to the class. Class Maintenances and Modernization Policy documents will be generated for older ship classes on a case-by-case basis. The goal of this process is to conduct maintenance necessary to achieve maximum operational availability at the lowest practical cost.

5. Every ship will have a planned maintenance package that will describe all required preventive maintenance, to be conducted according to the 3-M manual, OPNAVINST 4790.4B, and OPNAVINST 4700.7H.

6. Intermediate maintenance activities (Fleet Commander in Chief assets) will make repairs and modernization changes that are beyond the capability of the organizational level but which do not require depot level assets.

7. Depot level maintenance activities (part of the shore establishment–naval and private shipyards and other designated overhaul points, or Fleet Commander in Chief assets–Naval Ship Repair Facilities) will perform repairs and modernization work that is beyond the capability of intermediate maintenance activities.

8. Maintenance logistics support will include:

a. Personnel of the proper ratings and skills assigned to all maintenance levels

b. Training and training facilities for maintenance personnel at all maintenance levels

c. A Coordinated Shipboard Allowance List (COSAL) that supports the ship class maintenance plan

d. Required parts and materials

e. Up-to-date technical documentation for all maintenance levels

f. Planned Maintenance System (PMS) documentation

g. Test equipment

h. Repairables, reworked spares, and designated overhaul points

NAVY SHIP MAINTENANCE STRATEGY

The material condition and configuration of Navy ships is defined by the Navy's Ship Maintenance and Modernization Program, which consists of the ship maintenance program and the Fleet Modernization Program (FMP). The ship maintenance program is designed to keep the ships at a level of material condition adequate to maximize their operational availability. The Fleet Modernization Program is designed to update the ships as required to meet current and projected enemy threats and to incorporate safety, environmental, reliability/maintainability, and other improvements. While the maintenance and modernization programs are distinct, they are not independent. This chapter addresses the ship maintenance program, with reference to the modernization program as necessary. The modernization program was addressed in chapter 6.

The Navy ship maintenance strategy is defined as the process of identifying and using the appropriate maintenance assets in a predetermined manner to keep the material condition of Navy ships at the desired level. These assets include personnel, material, facilities, programs, and procedures. The specific maintenance plan is likely to differ among ship types and classes, but the overall goal is the same.

The Navy ship is unique in that the responsibility for both the operation and maintenance of the ship rests with the ship itself. Other Navy organizations exist primarily to support the ship.

Class Maintenance Plans are the heart of the Navy's ship maintenance strategy. The translation of these plans into maintenance actions requires the assessment of equipment conditions, determination of maintenance requirements and execution of maintenance actions. These parts of the maintenance strategy are discussed in the following paragraphs.

ASSESSMENT OF EQUIPMENT CONDITION

A thorough knowledge of actual equipment condition in relation to its designed condition is the basis for maintenance decisions. Equipment condition is a broad term that includes static parameters, such as size and shape, and dynamic parameters, such as speed, temperature, pressure, and voltage. While the ship's force is in the best position to know the condition of the ship and equipment, the complexities of modern design and engineering dictate that specialized assistance be used to determine the condition of much of the equipment. Such assistance is provided by numerous organizations within the Fleet and Systems Commands. This assistance is used as necessary to ensure that a comprehensive status of equipment condition is available at all times.

Programs and organizations that are available for use in assessing equipment condition include:

Ship's Force Self-Assessment

Current Ship Maintenance Project (CSMP)

Machinery Condition Assessment (MCA)

Test and Monitoring Systems (TAMS)

Pre-Overhaul Test and Inspection (POT&I)

Work Definition Inspection (WDI)

Planned Maintenance System (PMS)

Fleet Inspections

Board of Inspection and Survey (INSURV)

Machinery History and Trend Analysis

Total Ship Test Program (TSTP)

Submarine Systems Maintenance Monitoring and Support (SMMS)

Submarine Performance Monitoring Program (PMP)

System and Equipment Maintenance Monitoring for Surface Ships (SEMMSS)

The CSMP is the primary system for gathering information about the material condition of the ship and must be kept complete and current.

LEVELS OF MAINTENANCE

As you should recall from chapter 6, there are three levels of ship maintenance, each requiring a greater degree of capability. Organizational level maintenance and intermediate level maintenance are within the capability and are the responsibility of the operating forces. Major maintenance and repair capability beyond the operational and intermediate levels resides at the depot level. The depot level consists of naval and private shipyards, ship repair facilities, and assigned Navy, Department of Defense (DOD), or commercial Designated Overhaul Points (DOPs).

ORGANIZATIONAL (SHIPBOARD) LEVEL MAINTENANCE

Recall that the first level of maintenance is the organizational level, consisting of the ship itself and the sailors on board the ship. Organizational level maintenance is the combination of corrective and preventive maintenance done by the ship's crew. The work is a blend of equipment operation, condition monitoring, planned maintenance actions and repair ranging from simple equipment lubrication to component change out and, in some cases, complete rework in place. These types of actions are part of the Planned Maintenance System (PMS) described in the 3-M manual. In situations where PMS is not available or does not apply, maintenance is governed by existing technical manuals and instructions issued by appropriate systems commands.

INTERMEDIATE LEVEL MAINTENANCE

Intermediate level maintenance is maintenance that is normally performed by Navy personnel stationed on tenders, repair ships, aircraft carriers, and at fleet support bases normally not designated as IMAs, SIMAs, and SIMA NRMPs. Individual IMAs vary in size and capability, but they all provide the same type of support, such as the examples listed below:

1. Planned maintenance, tests and inspections, repair work, service, and alterations designated by the TYCOM or other proper authority to be done by a specific IMA to meet the needs of the units being serviced.

2. Authorized work done on components, modules, electronic miniature/microminiature printed circuit boards, subassemblies, and equipment maintenance coded for intermediate level repair.

3. Calibration, certification, and repair services provided to fleet units for electrical/electronic test and monitoring equipment; pressure, vacuum and temperature measuring devices; and mechanical measuring instruments.

4. Technical assistance to a ship's force in diagnosing unresolved system or equipment problems and assistance in making the repairs, as necessary.

5. Maintenance and repairs requiring special instruments, skills, and other resources not available on the tended units.

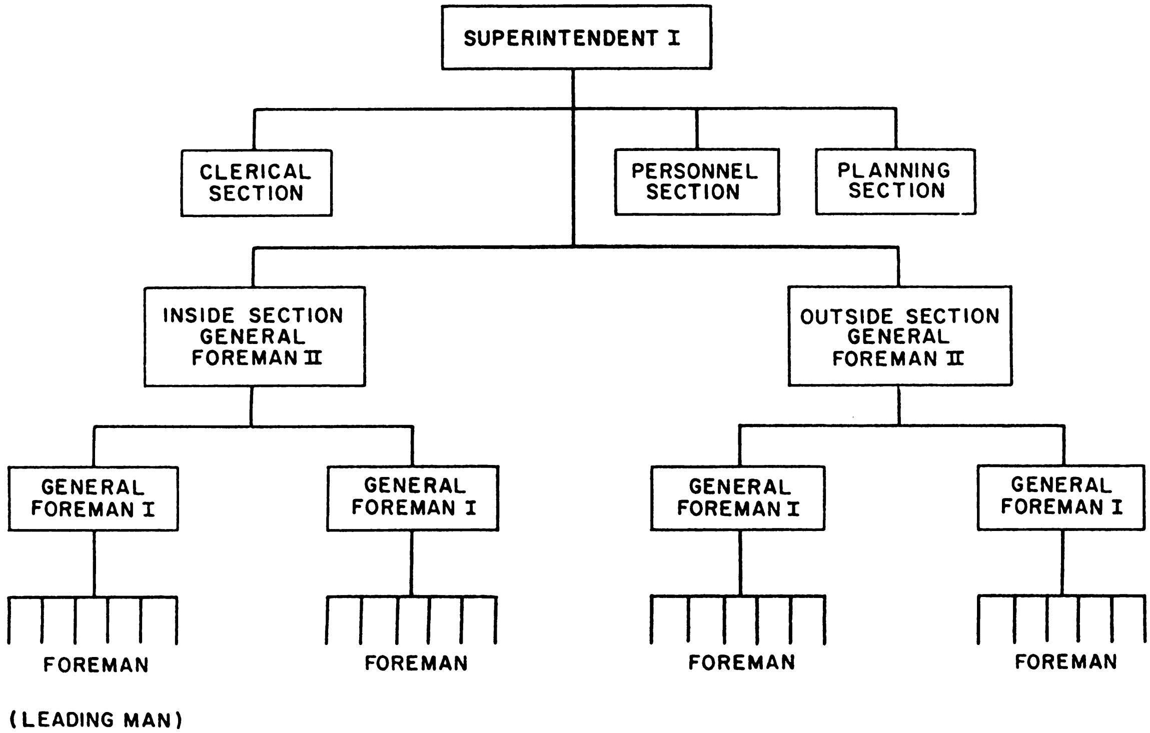


Figure 8-1.–Organization of a typical production department shop.

6. Assistance in the emergency repair manufacture of parts or subassemblies for which replacements are not available.

Intermediate level maintenance activities use the Intermediate Maintenance Management System (IMMS), a part of the 3-M system, to develop and process the maintenance actions for IMA upkeep periods. This includes early identification and assignment of work items to maximize the use of resources.

Repair ships and tenders (ADs, ARs, ASs) have the mobility necessary to provide intermediate level support and repair of battle damage and other emergent (unexpected) repairs to advanced and forward areas when required. They also have additional capabilities that are not normally found at shorebased IMAs, such as medical and dental facilities, supply and logistics support, and administrative services.

Intermediate Maintenance Activity Availabilities (IMAVs)

Ships are scheduled for an intermediate maintenance availability (IMAV) or an upkeep period alongside repair ships or at SIMAs at specific time intervals that vary with different types of ships. The availability periods, which are usually planned well in advance, are based on the tended ships' quarterly employment schedules.

When a ship receives its employment schedule, or is otherwise notified, it must ensure that the necessary paperwork is completed in advance of the scheduled availability period. This should not be a problem if deferred work is continuously documented on the CSMP. The requirement for maintenance assistance (work request) is documented on the Ship's Maintenance Action Form, OPNAV 4790-2K.

Automatic Work Requests (OPNAV 4790/2R), prepared from up-to-date CSMP information, are sent with a forwarding letter to the type commander or authorized representative. Most of the ship's availability worklist items are approved and authorized. However, the ship may have to furnish more detailed information on certain work requests. The action taken by the reviewing officer will depend upon how well the work requests are written and the extent to which they follow established policies and procedures. Upon completion of this screening, the ship's work requests are forwarded to the Readiness Support Group (RSG) for assignment. This is done well in advance of the assigned period of availability to allow repair department personnel to schedule the work and make necessary preparations.

Arrival Conference

When a ship comes alongside for a regular availability or an upkeep period, an arrival conference is normally conducted immediately. The conference is

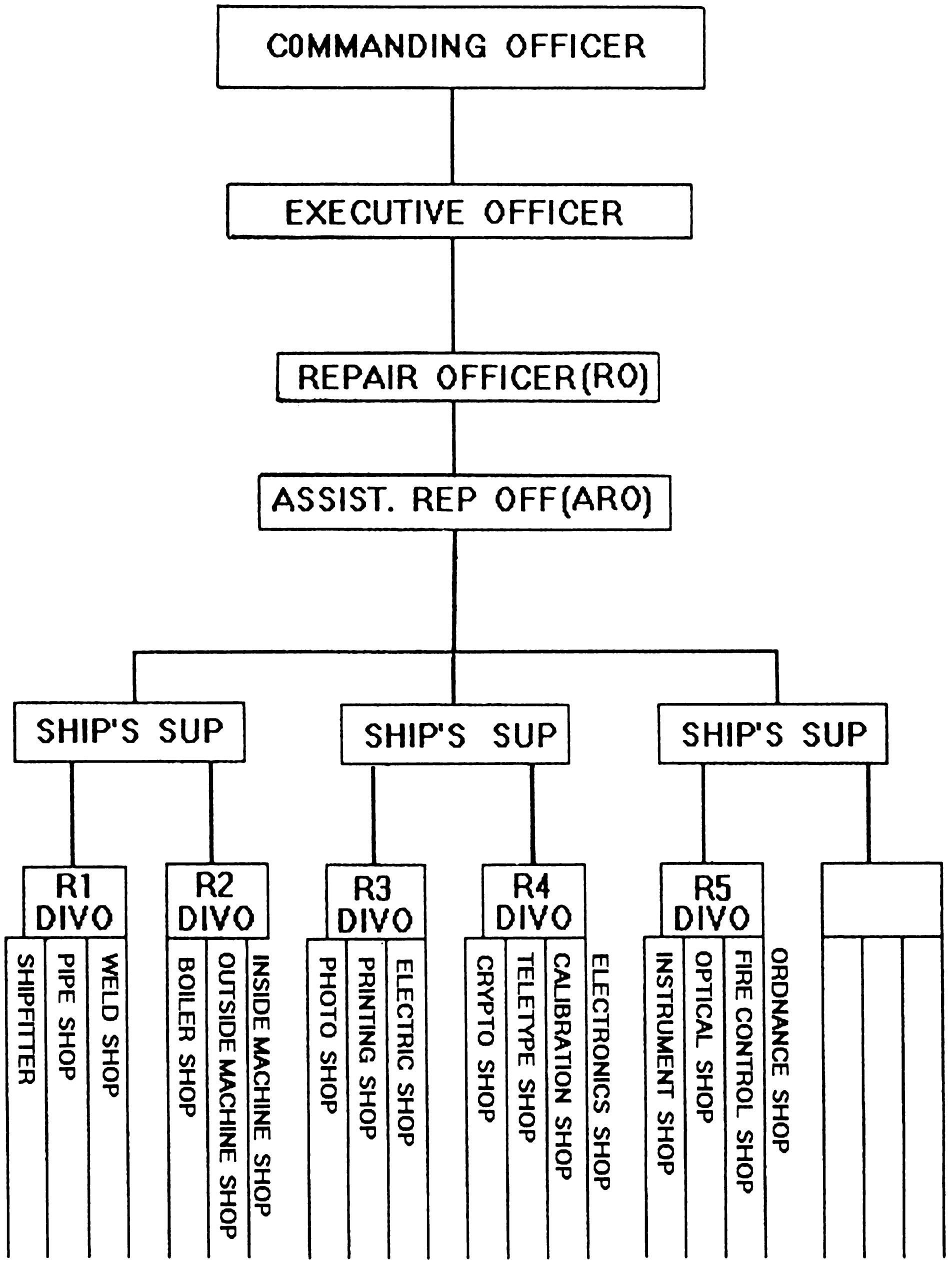


Figure 8-2.–SIMA and repair ship repair department organization.

attended by representatives of the ship seeking repairs, the repair department that is to provide the repairs, and the type commander representative. The needs of the ship and the urgency of each job are discussed. The arrival repair conference serves to clarify all uncertainties for repair department personnel, who have received and studied the work requests in advance.

Arrangements are also made for the repair ship to provide the primary services of steam and electricity, if required. In addition to these services, the repair ship may take over communication watches commensurate with the type of repairs being made. Fresh water and fuel are normally supplied through the use of barges.

The repair department in a repair ship, tender, or SIMA conducts repairs in a manner similar to that of a production department in a naval shipyard (see figure 8-1), even to the extent of assigning ship superintendents as representatives of the repair officer. Figure 8-1 illustrates the organization of a shipyard production department. Figure 8-2 illustrates the organization of the repair departments of SIMAs and repair ships. You will primarily deal with the R4 division, which is electronics repair.

Work Requests

Work requests are made up by the ship and are forwarded through proper channels to the repair activity. As soon as the work requests have been approved at the arrival conference, the jobs that require delivery to the tender should be prepared and delivered. It is very important to start these repair jobs early so all necessary jobs can be completed within the availability period. Equipment that is not needed for the operation of the ship may be disassembled in advance so that the defective parts can be delivered to the tender as soon as the work requests are approved.

All material delivered to the tender must be properly tagged and identified. The information on each tag should include the number and name of the ship, the department, division, and the Job Sequence Number (JSN) for that job. Reference material such as blueprints and manufacturers' technical manuals should be identified with the ship's name and number to ensure its return when the job is completed.

Checking the Progress of Tender Work Requests

You can check on tender repairs that are being made on your ship by discussing them with the petty officer in charge of the job. The petty officer in charge should know at all times the status of the repair work (including ship's force repair work) being done for the space or equipment. Checking on the progress of work at the IMA requires planning and coordination between the ship and the IMA. Remember, though, personnel in the various shops are normally very busy completing repairs requested by several commands, so following up on your jobs should not interfere with their routines. Try to be as courteous as possible. Courtesy will go a long way in helping you get the information you need.

Ship Superintendent

Some tenders and repair ships have a chief petty officer who acts as ship superintendent, handling all problems and maintaining direct contact with ship personnel. He will act as a liaison officer between the ships alongside and the tender in regard to repair department jobs. Additionally he will report daily to a representative of each ship being served.

By maintaining a daily running progress report or chart that indicates the percentage of completion of each job, he can keep a close watch on the progress of the repair work ensuring that jobs are not unnecessarily delayed, overlooked, or forgotten, and that all work undertaken is satisfactorily completed. For the convenience of customer ships, repair ships with computer systems generally print out, on the average of three times a week, a status of work in their repair shops.

The ship superintendent will notify your ship's personnel when they need to witness tests required for repairs, and to pick up completed work. In the electronics division, you will be dealing with the calibration and repair of a lot of General Purpose Electronics Test Equipment (GPETE). This process will also provide you with external documentation on any piece of test equipment that is beyond economical repair (BER) and will give you justification to purchase a replacement GPETE item. Electronic equipment repair may be included in the package for technical assistance or for welding services; i.e., equipment brackets or test equipment shelves. You may also require the services of the Air Conditioning and Repair (AC & R) shop. Electronic Cooling and associated fan rooms dedicated to a specific piece of equipment, such as the AN/SPS-49 radar, will be assigned to the electronics division for PMS and maintenance. The ship superintendent will ensure that the acceptance signature is signed on completed work. He will also obtain signatures from designated officers if work requests are canceled or changed. This is another step to ensure that QA requirements are met in all work on and testing of ship equipment.

If the tender provides a ship superintendent, it is quite easy for ship's personnel to check on the progress of the work. If the tender does not provide a ship superintendent, the tended ship generally appoints a petty officer to perform similar duties for the division or department to minimize the number of people checking the status of work.

Repair Shops

You will need a general knowledge of the repair department shops and their functions to have a complete understanding of the repair department potential as a whole. Table 8-1 describes shops in groups corresponding to the divisions that exist in the organization of a typical destroyer tender, AD, which is representative of most tenders.

Facilities assigned to other departments in the tender or repair ship assist the repair department by performing certain repair functions. For example, the battery shop, the internal combustion engine shop, the refrigeration shop, and the oil and water test laboratory

Table 8-1.–Division Repair Shops

R-1 DIVISION, HULL REPAIR OFFICER	
SHIPFITTER SHOP	Performs aluminum and steel welding on hull structures and heavy gage ventilation ducts
SHEET METAL SHOP	Fabricates and repairs light gage sheet metal
PIPE AND COPPER SHOP	Fabricates pipe and tubing of steel, copper, copper-nickel alloy, stainless steel and brass
WELD SHOP	Fabricates steel, aluminum, brass, copper, stainless steel, and cast iron
CARPENTER SHOP	Fabricates gangways, lockers, furniture, boxes, crates, signs, decorations, and boats
CANVAS SHOP	Fabricates miscellaneous canvas covers and awnings
R-2 DIVISION, MACHINERY REPAIR OFFICER	
INSIDE MACHINE SHOP	Repairs or fabricates mechanical parts that require machining on lathes, milling machines, boring mills, shapers, grinders, and drill presses; presses on or removes bushings, bearings, shafts, and other work
AC & R SHIP	Repairs and tests electronic cooling systems
OUTSIDE MACHINE SHOP	Repairs all types of machinery used in naval ships such as high and low pressure globe and gate valves, relief valves, boiler safety valves, reducing and regulating valves, and steam traps; tests and sets gages
BOILER SHOP	Inspects boilers of naval ships; bend and replaces boiler tubes
FOUNDRY SHOP	Pours castings of steel, cast iron, Monel brass, copper, and aluminum
R-3 DIVISION, ELECTRICAL REPAIR OFFICER	
ELECTRIC SHOP	Inspects, repairs, and makes adjustments to generators, motors, transformers, magnetic coils, switchboards, and test panels; rewinds ac and dc motors; sets and adjusts voltage regulators; and renews cable
GYRO SHOP	Inspects, repairs, and makes adjustments to gyro compasses, dead-reckoning equipment, underwater logs, motion picture projectors, automatic telephone systems; repairs interior communications (IC)
PRINTING SHOP	Performs printing and typesetting
PHOTO SHOP	Provides photographic and printing services

Table 8-1.–Division Repair Shops–Continued

R-4 DIVISION, ELECTRONICS REPAIR OFFICER	
ELECTRONICS SHOP	Repairs and aligns radars, radar repeaters, communications, transmitters and receivers, and ESM equipment; replaces antennas
CALIBRATION SHOP	Repairs and/or calibrates test equipment associated with radars, sonars, communication, electronic countermeasure equipment, fire control
TELETYPE SHOP	Repairs and/or calibrates tty equipment
CRYPTO SHOP	Repairs and/or calibrates crypto equipment
R-5 DIVISION, ORDNANCE SYSTEMS REPAIR OFFICER	
ORDNANCE SHOP	Repairs gun mounts, receivers, regulators, loading machines, projectile and powder hoists, and missile-launching systems
FIRE CONTROL SHOP	Conducts tests of electrical fire control circuits for continuity, grounds, and short circuits; repairs circuits; repairs, adjusts, and calibrates fire control radars
SONAR AND UNDERWATER FIRE CONTROL SHOP	Repairs, tests, and calibrates all types of sonars, underwater fire control systems including depth finders
OPTICAL SHOP	Repairs, calibrates, and/or collimates binoculars, ship's telescopes, spyglasses, borescopes, gunsight telescopes, and telescopes; repairs parallel motion protractors; and repairs magnetic compasses
INSTRUMENT SHOP	Clean, repairs, and adjusts all models of clocks, timers, comparing watches, sinuous course clocks, typewriters; makes minor adjustments to calculators, adding machines, duplicating machines; and cleans repairs, and calibrates tachometers
DRAFTING SHOP	Drafts sketches and reproduces drawings; paints signs; and sketchs and paints artwork as required

are assigned to the engineering department, but may provide services to the repair department. Services such as compressed air, auxiliary steam, electricity, fresh water, and feed water are supplied to tended ships by divisions of the engineering department. The deck divisions of the weapons department (deck department on ships without a weapons department) furnish mooring lines, brows, cargo handling facilities, boat transportation, and other services to the ships being repaired or tended. On a repair ship or tender having a weapons department, the torpedo workshop and the special weapons shop may be assigned to the divisions within the weapons department. In fact, all of the departments of the tender or repair ship may be considered to be service departments, which the repair officer coordinates, as necessary, to meet the requirements of ships being tended or repaired. Medical, dental and supply departments also provide various services.

The functions in most AR and AS shops are similar to those on the AD. The AS, however, has additional shops, such as the rubber shop that is equipped for thermosetting tube grommets or rubber-covered electric cable. The shop manufactures any T-type gasket up to

18 inches in diameter and any molded rubber product within limits of the press. Other shops are the submarine battery shop for the repair, rebuilding, or cycling of submarine storage batteries, and the special weapons shop with special tools adapted to whatever special devices are currently employed with torpedoes or submarines. The submarine engine shop that operates under the outside machinist section contains special tools adapted to General Motors or Fairbanks Morse diesels, and also special equipment adapted to the repair of high pressure air systems.

DEPOT LEVEL MAINTENANCE

Depot level maintenance is maintenance that requires skills and facilities beyond the organizational and intermediate levels and is performed at naval shipyards, private shipyards, naval ship repair facilities, or other shorebased activities. During depot availabilities, large scale maintenance and repairs requiring industrial facilities are performed. Approved alterations and modifications, which update and improve the ship's military and technical capabilities, are also made. During its lifetime, a ship may undergo any of the following types of industrial availabilities.

Regular Overhaul (ROH)

A regular overhaul is an availability during which general repairs and alterations are made at a naval shipyard, private shipyard, or other shorebased repair activity.

Ships in the U. S. Navy undergo regular overhauls, at the intervals and durations set forth in OPNAVNOTE 4700, to receive major maintenance, modernization, and conversion. During an overhaul, the shipyard will do whatever work that, in the opinion of the type commander, is beyond the ship's manpower or resource capability. All ships receive a complete and thorough overhaul within available funding and following sound engineering practices. The primary overhaul objective is to complete whatever outstanding repairs and major maintenance items are needed to ensure reliable operation during the ship's ensuing operational cycle. To reduce interruptions, no operational commitments are scheduled during the overhaul period. Overhauls are normally scheduled in each ship's home port area whenever possible, with the planned duration of overhaul standardized by ship types. The actual duration may vary depending upon the amount and scope of industrial work and overhaul activity workload.

The overhaul of a ship, from the start of planning to the completion of the work, is done through the cooperative efforts of the type commander (TYCOM), the PERAs (Planning and Engineering for Repairs and Alterations), the shipyards/SUPSHIPs, and the ship's force. All members of this team are specialists in the overhaul business, with the exception of ship's force, who are the operators as well as the maintainers of their ship. They possess intimate knowledge of the equipment. But, as a whole, they are less experienced in planning and conducting an overhaul than any of the other participants in the process. To plan and conduct an overhaul effectively, the ship's force must know what to do and how to do it in a timely manner, with a cooperative attitude toward the other participants in the overhaul process.

Overhaul is an extremely complex operation (see table 8-2) and represents some of the most important uses of Navy fiscal assets. Table 8-2 illustrates the numerous milestones (events) that take place before, during, and after a regular overhaul. As you review the list, remember that it represents a typical overhaul. Because the various TYCOMs conduct their ship overhauls somewhat differently, often with different terminology and emphasis, you should consult your own TYCOM references for information concerning the details of your ship's overhaul. Your TYCOM has specific guidelines with which you should become intimately familiar. The information in this section is based on the *NAVSURFLANT Maintenance Manual*, COMNAVSURFLANT 9000.1C, and on *Policies and Procedures for Maintenance of Ships*, OPNAVINST 4700.7H. Most of the information also applies to the other availabilities as well.

Every ship overhaul requires the development of two basic work packages:

1. A modernization work package that includes NAVSEASYSCOM and type commanders' authorized SHIPALTs, NAVSEASYSCOM authorized ORDALTs, Type Commander Issued Alterations (TIAs) and certain electronic field changes. Modernization was addressed in chapter 6 and will only be referred to in this chapter.

2. A repair work package that includes all other repair work to be done by the industrial activity, the ship's force, and the IMA. The section below discusses the major actions and reports of the typical work package.

PRE-OVERHAUL TEST AND INSPECTION (POT&I).–The POT&I is a series of tests and

Table 8-2.–Regular Overhaul Milestones

NO.	MILESTONE	CODE	ACTION COMMAND	ROH	SRA/PMA
1	Review CSMP and make sure that all ship deferred maintenance actions desired for accomplishment are documented.	1	SHIP	Continuous	
2	Review FMPMIS and prepare recommended list of Title "D" and "F" SHIPALTs for (COMNAVSURFLANT) type desk review.	1	COMNAVSURFLANT/ NAVSEADET PERA	A-26 to A-24 months	A-18 to A-16
3	D and F SHIPALT authorized.	1	COMNAVSURFLANT	A-24	A-16
4	Issue K SHIPALT advance planning letter.	1	COMNAVSEASYSCOM	A-19	A-16
5	Issue advance planning letter, with proposed milestone target dates.	1	NAVSEADET PERA	A-18	A-14
6	Design shipcheck before development of Ship Installation Drawings (SIDs).	1	DESIGN AGENT	A-17 to A-14	A-14 to A-12
7	Advance planning briefing.	1	COMNAVSURFLANT/ NAVSEADET PERA/ SHIP	A-16 to A-12	A-14 to A-12
8	Pre-Overhaul Test and Inspection (POT&I) or WPD (including combat systems, Assessment of Equipment Condition (AEC), main propulsion and auxiliary systems, etc.) and inspection of boilers (if possible).	1	NAVSEADET PERA/ DEPOT ACT./SHIP	A-14 to A-10	A-12 to A-10
9	POT&I/WPD Completion Conference	1	COMNAVSURFLANT NAVSEADET PERA/ SHIP/DEPOT ACT.	A-14 to A-10	A-12 to A-10
10	Issue POT&I/WPD conference report (10 days after conference).	1	NAVSEADET PERA/DEPOT ACT.	A-13 to A-9	A-11 to A-9
11	Issue proposed Ship Alteration and Repair Package (SARP).	1	NAVSEADET PERA	A-11 to A-7	A-10 to A-7
12	Initiate ship's force material planning and procurement.	1	SHIP	A-9	A-7
13	Work Definition Conference(s) (including combat systems pre-WDC).	1	DEPOT ACT., NAVSEADET PERA, COMNAVSURFLANT, IMA, SHIP	A-9 to A-6	A-9 to A-5
14	Issue Authorized SARP.	1	NAVSEADET PERA/DEPOT ACT.	A-260 to A-170 days	A-250 to A-140
15	Issue post-WDC report.	2	NAVSEADET PERA	A-255 to A-165 days	A-245 to A-135
16	Issue list of work items screened for forces afloat accomplishment (before forces afloat WDC).	1	NAVSEADET PERA	A-180 to A-140	A-150 to A-110
17	Complete Bid Specifications.	2	SUPSHIP	A-210 to A-150	A-135 to A-110
18	Review Bid Specifications for errors, omissions, duplications (May require conference to resolve).	2	NAVSEADET PERA/ COMNAVSURFLANT/SHIP	(within 10 days after spec completion)	
19	Issue solicitation for bids or proposals to contractors.	2	SUPSHIP	A-210 to A-150	A-135 to A-110
20	Issue authorized Integrated Test Planning Document.	1	NAVSEADET PERA	A-160	
21	AEC Update.	1	NAVSEADET PERA/NAVSSES	A-150 to A-120	

Table 8-2.–Regular Overhaul Milestones–Continued

NO.	MILESTONE	CODE	ACTION COMMAND	ROH	SRA/PMA
22	Award contract.	2	SUPSHIP	A-120 to A-90	A-30
23	Develop GPETE Management Program.	1	SHIP	A-120 to A-90	A-110 to A-30
24	Forces Afloat WDC.	1	SHIP/NAVSURFLANT READSUPPGRU/NAVSEADET PERA	A-90 to A-60	A-90 to A-45
25	Order EMRM material for ship's force work.	1	SHIP	A-90 to A-60	A-90 to A-45
26	Develop off-load plan for arrival at shipyard (including off-load assistance, security and storage arrangements).	1	SHIP	A-90 to A-20	A-60 to A-10
27	Review Ship Selected Records (SSR) for changes required as a result of authorized work. Turn over items (including notes as to changes previously accomplished) to SUPSHIP/NSY.	1	SHIP	A-90 to A-60	A-90 to A-45
28	Ship rep visit shipyard for preliminary off-ship berthing and storage inspection.	1	SHIP/DEPOT ACT.	A-60 to A-30	A-30 to A
29	Pre-ROH/SRA/PMA IMAV (or RAV).	1	SHIP/NAVSURFLANT READSUPPGRU (or SUPSHIP)	A-60 to A	(same as ROH)
30	Phase II POT&I, Boiler SAI (as applicable).	1	SHIP/NAVSEADET PERA/NAVSSES/DEPOT ACT.	A-60 to A	
31	Off-load ammunition and fuel as required (NAVSURFLANT approval required). Also off-load hazardous material and oily waste.	1	SHIP	A-30 to A-1	
32	Work Package Validation Conference.	1	COMNAVSURFLANT, GRUCOM, IUC, SHIP, READSUPPGRU	A-30	
33	Start ROH/SRA/PMA, start ILO, start Combat System Technical Training.	1	SHIP, DEPOT ACT,	A	
34	Send start message to CINCLANTFLT.	1	COMNAVSURFLANT	A	
35	Arrival Conference.	1	DEPOT ACT., IUC, SHIP	A to A+3	
36	CASCAN all outstanding CASREPs which are scheduled to be corrected during yard period.	1	SHIP	A to A+3	
37	Execute Memorandum of Understanding with SUPSHIP/NSY concerning QA (private sector), crew move aboard and LOE preparations.	1	SHIP/DEPOT ACT.	A to A+7	
38	Submit Weekly Progress Reports.	1	SHIP	A to C	
39	25%, 50%, 75% point review conferences.	1	SHIP, COMNAVSURFLANT, IUC, DEPOT ACT.	A to C	
40	Start crew training in preparation for Initial Light Off Exam (LOE) by PEB.	1	SHIP, COMNAVSURFLANT, MTT	C-120	
41	CSMTT Visit.	1	SHIP, IUC, CSMTT	C-120	
42	Start Combat System Level Testing.	1	SHIP, DEPOT ACT.	C-90	

Table 8-2.–Regular Overhaul Milestones–Continued

NO.	MILESTONE	CODE	ACTION COMMAND	ROH	SRA/PMA
43	Prepare Dock trial, Fast Cruise, and Post-Repair Sea Trial agendas.	1	SHIP	C-45	
44	Post-Repair Boiler Inspection.	1	COMNAVSURFLANT, SHIP, NAVSSES	C-45	
45	Initial Light Off Exam.	1	PEB/SHIP	C-40	
46	Start crew training in preparation for Post-Repair Sea Trials.	1	SHIP	C-40	
47	Dock Trials.	1	DEPOT ACT.	C-25	
48	Fast Cruise.	1	SHIP	C-20	
49	Post-Repair Sea Trials.	1	SHIP	C-15	
50	Send Post-Repair Sea Trials Discrepancy Report.	1	SHIP	(on completion of sea trials)	
51	Visual TEMPEST Inspection (with Configuration Control Diagram).	1	DEPOT ACT.	C-10	
52	Completion Review Conference.	1	DEPOT ACT., SHIP, COMNAVSURFLANT, IUC, NAVSEADET PERA	C-5	
53	Complete ROH/SRA/PMA.	1	DEPOT ACT., SHIP	C	
54	Send ROH/SRA/PMA completion message to CINCLANTFLT.	1	COMNAVSURFLANT	C	
55	Send CASREPs for inoperative equipment/systems.	1	SHIP	C	
56	PMS/CSMP update. Report completion of all SHIPALTs, Field changes, ORDALTs.	1	SHIP	C	
57	Send letter report of any unsatisfactory work (photographs and later updates also may be sent).	1	SHIP	C+10	
58	Combat System Post-Overhaul Exam. (If required.)	1	SHIP/IUC/CSMTT	C+15	
59	Post-availability AEC survey. (If required.)	1	NAVSEADET PERA/ NAVSSES	C+30	
60	End of guarantee period for work performed by shipyard. All unsatisfactory work must be reported by this date to be corrected by shipyard. Deficiencies discovered later should also be reported.	1	SHIP	C+90	
61	Send availability evaluation report (by letter) to COMNAVSURFLANT (N41) via chain of command.	1	SHIP	C+90	
62	Complete Ship Selected Records (SSR) update.	1	DEPOT ACT.	C+90	

inspections conducted aboard the ship to determine what work needs to be done during the overhaul.

Before the POT&I occurs, NAVSEADET PERA will help the ship's force update the CSMP. The CSMP validation and the writing of the definitive work requests is a key step toward preparing a correct work package. As a result of this updating, equipment repair and test and inspection requirements may be revealed. Work items that must be undertaken by the shipyard are included in the CSMP as deferred action items.

The POT&I is normally conducted jointly by ship's force and representatives of a naval shipyard, SUPSHIP, or private contractor appointed by NAVSEADET PERA. The POT&I team consists of planners and engineers who will conduct a shipcheck during in port and underway periods. The underway POT&I phase includes an Assessment of Equipment Condition (AEC), which is a vibration analysis of certain mission-essential machinery. The ship will notify the POT&I team of any additional CSMP items found after the previous CSMP update. Knowledgeable petty officers should be assigned to individual POT&I inspectors to make sure that current ship conditions are reflected in the POT&I report. Ensuring the success of the POT&I effort is the primary responsibility of the commanding officer. Ship's force should continue documenting new items discovered after the POT&I and those which require outside help.

Not all areas of the ship can be inspected during POT&I due to ship readiness or steaming condition, filled tanks, electronics in use, or time constraints. Consequently, later POT&I visits may be required, or various other upkeep periods or inspection results may be used for "target of opportunity" condition status, such as INSURV/CSRR/ASIR reports. To obtain a better overhaul, make sure that NAVSEADET PERA is notified of all such inspection opportunities, or receives a copy of any inspection report having equipment condition status.

POT&Is, design ship checks, and any other ROH/SRA/PMA planning visits are generally conducted in CONUS. These visits usually occur over an 8-month period between 14 months and 6 months prior to the start of the availability. However, ships are normally deployed during all or most of this period, which tends to make some overseas visits unavoidable. The end result of the POT&I is the preliminary Ship Alteration and Repair Package (SARP). As the EMO, you may very well be the ship's technical representative during the overhaul. Therefore, you should thoroughly review the preliminary SARP for completeness and to ensure that you are ready to attend the Work Definition Conference (WDC).

THE WORK DEFINITION CONFERENCE.– The single most important planning event is the Work Definition Conference (WDC) that will take place about 5 to 9 months before the start of the overhaul. The WDC is normally conducted on board ship and includes key members of the ship's force (i.e., commanding officer, executive officer, department heads, leading petty officer, and work center supervisors) and representatives of the type commander, IUC, NAVSEADET PERA, and the shipyard/SUPSHIP. At this conference, alteration and repair package problems are resolved and screening decisions are made about the industrial and forces afloat repair packages can be undertaken, based on the funds and industrial/SF man-days available. For some ships, a combat systems pre-WDC will be held before the WDC to pre-screen combat systems repairs. As EMO, you must attend the combat systems pre-WDC.

The Ship's Force Work Package (SFWP) can be defined after all decisions have been made at the WDC. The end result of the WDC is the SARP, which is the shipyard and ship's force work package.

SHIP ALTERATION AND REPAIR PACKAGE (SARP).–For most ships, a SARP is the document that defines and authorizes work to be done during the overhaul, assigns work level (organizational, intermediate, or depot) for each work item, and indicates cost estimates for each shipyard job. The success of the overhaul depends on the planning effort that went into the preparation of the SARP. The SARP is divided into two parts: shipyard work, and ship's force/IMA work. The purposes of the SARP are listed below:

1. Integrates related customer work requirements
2. Resolves redundant and conflicting work requirements
3. Identifies work on a ship system basis
4. Establishes a single source document for all customer authorized work
5. Lists all work deferred, or not authorized because of time and funding constraints, for use in planning future maintenance availabilities

The SARP is maintained as a continuing document, which contains the information necessary to take the following actions:

1. Estimate the overhaul cost and duration
2. Make early decisions by higher levels of command concerning budgeting, funding, operating schedules, and overhaul duration
3. Perform advanced planning, design work, and material procurement

Key inputs for developing the SARP are as follows:

1. The Current Ships Maintenance Project (CSMP) as of the ROH start date
2. Results of the Pre-Overhaul Tests and Inspections (POT&I)
3. Type commander Title "D" SHIPALT Authorization

4. NAVSEASYSCOM Title "K" SHIPALT Advance Planning/Authorization Letter

5. Class Maintenance Plan items

Approximately 90 days prior to the beginning of the overhaul, or when the SARP has been screened for the ship, the following actions will be taken:

1. Work discovered during the POT&I and assigned to the IMA will be documented on OPNAV Form 4790/2K and coded as such.

2. Work previously documented into the CSMP file and coded to be done by an activity other than an IMA, but which was later recoded to be done by an IMA, will be updated by the submission of a correction document (OPNAV 4790/2K) to change type of availability code.

The above work items, along with those already coded in the ship's CSMP file to be done by an IMA (plus any desired master job catalog items), will form the IMA work package for pre-overhaul, concurrent, and post-overhaul IMAVs.

FORCES AFLOAT WORK DEFINITION CONFERENCE (FAWDC).–The FAWDC is intended to further define the scope of work items assigned to Forces Afloat (FA) during the WDC, and to assign responsibility for specific repair work to be done before and during the availability. Attendees will include representatives from the type commander, ship's force, IUC, NAVSEADET PERA, READSUPPGRU/IMA, and the shipyard/SUPSHIP. The overall purpose of the FAWDC is to make optimum use of the resources available to the ship's force. The specific purposes are to accomplish the following:

1. Place constraints on the ship's force work package, taking into account shipboard training, testing, leave, schools, and Inactive Equipment Maintenance (IEM)/Planned Maintenance System (PMS) requirements.

2. Assign responsibility for specific repair works to be done during the pre-, concurrent, and post-Intermediate Maintenance Availability (IMAV).

3. Defer or cancel work on repair items that are not in need of corrective maintenance; are nonmission essential; or do not fall within the ship's force work package constraint.

4. Ensure that all attendees understand, concur, and commit to the assignment and scope of all FA screened work requests.

5. Make sure Readiness Support Group (READSUPPGRU) representatives depart from the FAWDC with well prepared, accurate 4790/2Rs for work to be done by IMAs.

6. Make sure the naval shipyard/SUPSHIP delivers a tentative schedule of key milestones (e.g., undocking, LOE, and start combat systems testing) to aid the ship's force in coordinating the IMAV Required Delivery Dates (RDD) with shipyard work.

7. Obtain agreement between the shipyard/SUPSHIP, ship's CO, and appropriate READSUPPGRU/IMA concerning the conditions under which IMA work may be done on board during the availability.

The FAWDC is conducted in a standardized manner, usually as described below, to ensure proper representation, timing and documentation.

1. The FAWDC is scheduled by the type commander in CONUS about 90 days before the beginning of the availability (A-90 days) to make sure the IMA has enough time for adequate advanced planning.

2. The type commander will screen the FA availability work request (AWR) package, which has individual work items assigned to the READSUPPGRU/IMA, ship's force, or an outside activity. The IMA will accept work based on its capabilities and assigned capacities. For those items assigned to the ship's force, the corresponding manhours will be subtracted from the IMA's total available manhours. If a work request cannot be handled due to a work center industrial manpower constraint, work-around solutions will be developed. Work will be deferred or canceled on repair items that are not in need of corrective maintenance or are not of high enough priority to be included in the work package.

3. 4790/2Rs will be checked for completeness simultaneously with the screening. The narrative must be corrected by ship's force to reflect the results of screening actions. Required Delivery Dates (RDDs) and Quality Assurance (QA) levels will be entered or changed to reflect the scheduled key production milestones.

EMERGENT ESSENTIAL REPAIR REQUESTS (EERRs).–Repairs not identified before the ship submits its primary work package (prior to the POT&I) and repairs identified after the Work Definition Conference (WDC) is over are classified as emergent essential repairs. This category of repairs is limited to repairs that (1) have not been previously requested, (2) must be completed during the overhaul, and (3) cannot be deferred to a post-overhaul intermediate or technical availability.

EERRs must be requested by message to the TYCOM, with an information copy to the overhaul activity, the IUC, and the appropriate PERA.

EERRs are extremely costly, both in time and dollars. Failure to anticipate and plan ahead can have a significant impact on the ship's overhaul and could delay its return to unrestricted operations. Due to the limited funding reserved by the TYCOM for such items, the ship must control new work and be prepared to recommend trade-offs of other authorized work if the reserved funding is depleted.

Emergent essential repairs must be submitted as they are discovered, after coordination with the overhauling activity.

PLANNING AND ENGINEERING FOR REPAIRS AND ALTERATIONS (PERAs).–PERA, as agent of both COMNAVSEASYSCOM and the TYCOM, is responsible for the development of a complete and integrated work package. Due to the increased complexity of naval ships, reduced ship manpower, budget limitations and increasing lead-times required to buy material, intensified management of preplanning aspects is necessary to coordinate the total work package. PERA coordinates the efforts of all commands and activities in direct support of the alteration and repair effort and includes required planning, management, and engineering services. The primary objective of the PERA Program is to provide the intensive management required for effective, efficient, orderly, and timely ship overhauls. There are three surface PERAs:

PERA (SURFACE) HQ	Cruisers/Destroyers. Planning and overall PERA direction. Located at Philadelphia NAVSHIPYD.
PERA (SURFACE) PACIFIC	Combat Support Ships planning, located at the former Hunter's Point Naval Shipyard, San Francisco.
PERA (SURFACE) ATLANTIC	Amphibious Ships and Craft planning, located at Norfolk Naval Shipyard.

There are also submarine and aviation PERAs:

SUBMARINE MAINTENANCE-ENGINEERING/PLANNING AND PROCUREMENT (SUBMEPP)	Submarines located at Portsmouth NAVSHIPYD
PERA (CV)	Aircraft carriers and other aviation-type ships located a Puget Sound NAVSHIPYD

The PERA offices integrate the requirements of the various systems and type commands. They also manage the planning and engineering efforts for overhauls of assigned ship types and for vital interrelated programs. Based on ship modernization planning documents, they assist the ship logistic divisions and type commanders in the development of class modernization and maintenance packages for assigned ships. The PERAs develop a complete and integrated ship overhaul planning work package, which is fully usable by an overhauling activity with minimum translation and minimum additional planning.

FLEET MANAGEMENT SYSTEM-REAL TIME (FMS-RT).–Effective management of resources is a continuing challenge at every level of command. FMS-RT was developed to help meet this challenge. FMS-RT is a management system that assists the ship in preparing for an industrial availability and in managing the Forces Afloat portion of the work package; (i.e., ship's force, SIMA, SPAWARS) and the material, time, and personnel associated with it.

The goal of FMS-RT is to provide the ship's managers with the best and latest information so they may make decisions based on currently available manpower, time, work and material. Throughout the availability, FMS-RT can provide the ship's availability managers (from the shipyard) with the information they need to make decisions based on current projections of time, manpower, work, and material. FMS-RT can also make available all of the historical data of the availability and can provide useful information about future availabilities for the ship's class.

The ship's TYCOM directs the appropriate PERA to assist the ship in installing FMS-RT. PERA is tasked to provide the system and the support required to assist the ship through advisory and training visits. Total responsibility for using FMS-RT and for the activities related to the availability rests with the ship.

Several months before an industrial availability is scheduled to begin, a representative of the appropriate PERA will discuss the use of FMS-RT with the ship's management personnel. Following this, but before the ship enters its availability, two or three training visits are made to the ship, depending on the TYCOM's policy. Detailed training in job planning, work and manpower scheduling and the use of the FMS-RT data forms is provided for the work center supervisors, who are the key managers of the Ship's Force Work Package.

The microcomputer-based FMS-RT is a management tool designed to aid the ship's force

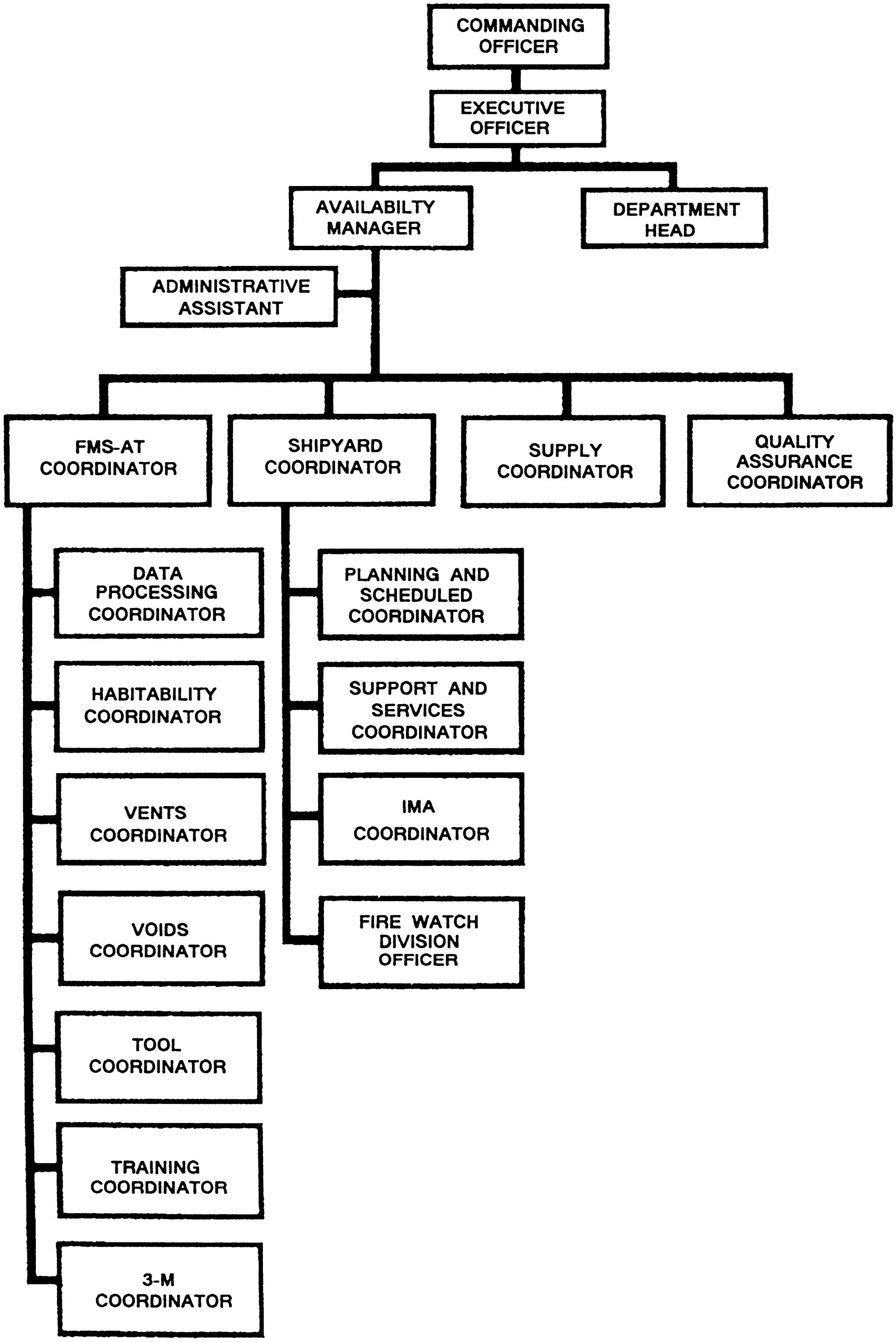


Figure 8-3.–Typical FMS-RT Staff Organization.

management in doing its assigned portion of the industrial availability work. It provides control of jobs, personnel, material, and time. It produces data that is compatible with CSMP, Naval Supply System, SARP, and shipyard data. It produces printed records and graphic reports with up-to-the-minute accuracy. It also tracks work designated as mission essential.

A greater degree of independent control is provided by FMS-RT because the system is designed to operate on microcomputers located on or near a ship, as opposed to a central host computer. In fact, FMS-RT provides the following benefits:

– greater flexibility in report production

– greater control over data manipulation

– unhindered operation, day or night

– operation at sea or in forward areas

– suited to a variety of management styles

The system uses a series of menus and data screens to update ship's force data files and to produce reports from those files. The menu-driven system is designed to be operated by users with limited microcomputer experience.

FMS-RT STAFF.–The FMS-RT staff (fig. 8-3) is a special staff appointed by the commanding officer to help him manage the Ship's Force Work Package (SFWP) during an industrial availability. The staff is headed by the availability manager, who acts as a department head during the availability.

Department heads remain responsible for the management of their departments throughout the availability. FMS-RT coordinators, division officers, and work center supervisors are responsible to, and work for, the department heads.

The following three points must be emphasized:

- Staff positions may either be combined or may be collateral duties on smaller ships.
- The primary concern of the staff is the performance of applicable functions rather than the specific structure of the organization.
- The FMS-RT organization does not change the basic shipboard organization.

PREOVERHAUL CONSIDERATIONS.–Thus far, we have covered the types of work that will be done, the process to get the work done, and who will be involved in the overhaul process. There are several other factors you must consider immediately prior to or upon your arrival at the shipyard.

1. Tagout–A lot of work will require tagout. This will be an extensive effort, and you should attempt to have as much as possible done before your arrival at the shipyard.

2. Security–The industrial environment lends itself to a wide range of security problems. Some items to consider are

– Classified publications and materials

– Test equipment

– Commercial navigation equipment on the bridge

– CCTV

– Portable and hand tools

To simplify security, off load these items prior to arriving at the shipyard. You should be able to arrange a secure area off the ship. If you keep these items on board, you will have difficulty maintaining their security.

3. Operating Space Items–Turn in all spare parts that are maintained in your spaces to the Integrated Logistics Overhaul/Integrated Logistics Review (ILO/ILR) site. Be sure to get receipts for everything.

4. Technical Manuals–Off load what you can to the ILO/ILR site. Store any that you do not off load in your secure storage area.

5. Inactive Equipment Maintenance (IEM)–Although your equipment will be in a non-operational status for the overhaul period, it still requires maintenance. Use IEM procedures to maintain the equipment.

6. NAVELEX/NAVSEA Turnaround Items–Before arriving at the shipyard, off load any equipment that will be overhauled off of the ship.

THE OVERHAUL PERIOD.–You will find many things you need to plan for and deal with in this new environment. The majority of the ship's force has probably never been exposed to a shipyard. Probably the most noticeable change is that the normal shipboard routine is nearly shattered. The best way to handle this is to pre-plan as much as possible, be flexible, and keep your division informed.

There will also be a severe manpower shortage due to many new duties such as fire watches, ILO/ILR team requirements, FMS-RT staff, extensive school requirements to support new equipments, and tiger teams. You will also have people being transferred and their billets gapped because your ship is non-operational.

Additionally, there will be environmental problems from the nature of the work being done. For example, there will be dirt everywhere, you will have little or no onboard air conditioning, it will be noisy from the chipping and grinding, and smoke will abound from all of the welding. If you are at an activity away from your homeport, there will be geographical problems as well. Nevertheless, the ship's force should be able to complete all work on schedule.

QUALITY ASSURANCE.–Quality assurance is a term that encompasses both the actions and the state of mind necessary to ensure high quality workmanship. While you are in the shipyard, your concern for quality should be second only to your concern for safety. The Navy's concern for quality is embodied in QA programs that provide a framework for determining the degree of certainty of ship readiness.

The overall QA Program is intended to improve equipment reliability, safety of personnel, and configuration control. The goals of this program are to protect personnel from hazardous conditions, increase the time between equipment failures, and ensure proper repair of failed equipment.

The wide range of ship types and classes and equipment differences within ship classes complicates maintenance support. It also increases the need for a formal program to provide a high degree of confidence that repairs will consistently meet appropriate standards. Guidance is set forth in type commander's instructions that establish minimum QA requirements and procedures.

Quality assurance requirements are published in QA manuals. The manuals apply to every ship and activity of the Navy, but they apply primarily to the repairs and maintenance done by IMAs. In all cases, specifications must either be met or noncompliance must be recorded and reported on a Departure from Specifications Request. Departures from specifications must also be reported to appropriate levels so that departure approvals or restrictions may be issued.

Since there is a wide range of ship types and equipment, and the resources available for maintenance and repair vary, the information in this QA manual is general in nature. Each activity must implement a Quality Assurance Program to meet the intent of the type commander's QA manual.

THE SHIP SUPERINTENDENT.–The ship superintendent is the representative of the repair superintendent, who, in turn, represents the production officer. The ship superintendent is responsible for coordinating, arranging, and accomplishing authorized work on a ship during its period in the shipyard. The shipyard customarily assigns a ship superintendent well in advance of the ship's arrival at the yard.

Before the ship arrives, the ship superintendent will obtain and study a considerable amount of information:

- Departure report for the last availability of the ship in the shipyard
- Copies of all outstanding job orders and work requests issued to the ship to become familiar with the current jobs
- Information from the current type desk officer concerning the time and place of the arrival conference
- List of proposed work
- List of civilian planners and estimators assigned to the ship
- Time of the ship's arrival and its berth assignment
- Booklet of plans from the planning department to determine general ship arrangements
- List of civilian shop supervisors assigned to the ship
- List of special jobs requiring immediate attention
- Information on lengthy or complex jobs

From 18 to 24 hours before the ship is due to arrive in the yard, the ship superintendent ensures that the service shops are informed of the berth assigned and the time of arrival.

The ship superintendent is at the dock when the ship arrives and ties up, and makes certain that the services the ship requires are furnished promptly. The ship superintendent is one of the first contacts the ship has with yard personnel, and throughout the overhaul, is the liaison with the yard. Upon first arriving aboard ship, the ship superintendent delivers to the commanding officer, or to the executive officer if the commanding officer is absent, copies of orders and regulations which outline and specify procedures on points that mutually affect the ship and the shipyard.

These orders and regulations cover subjects such as: (1) the appointment of ship inspectors for the overhaul,

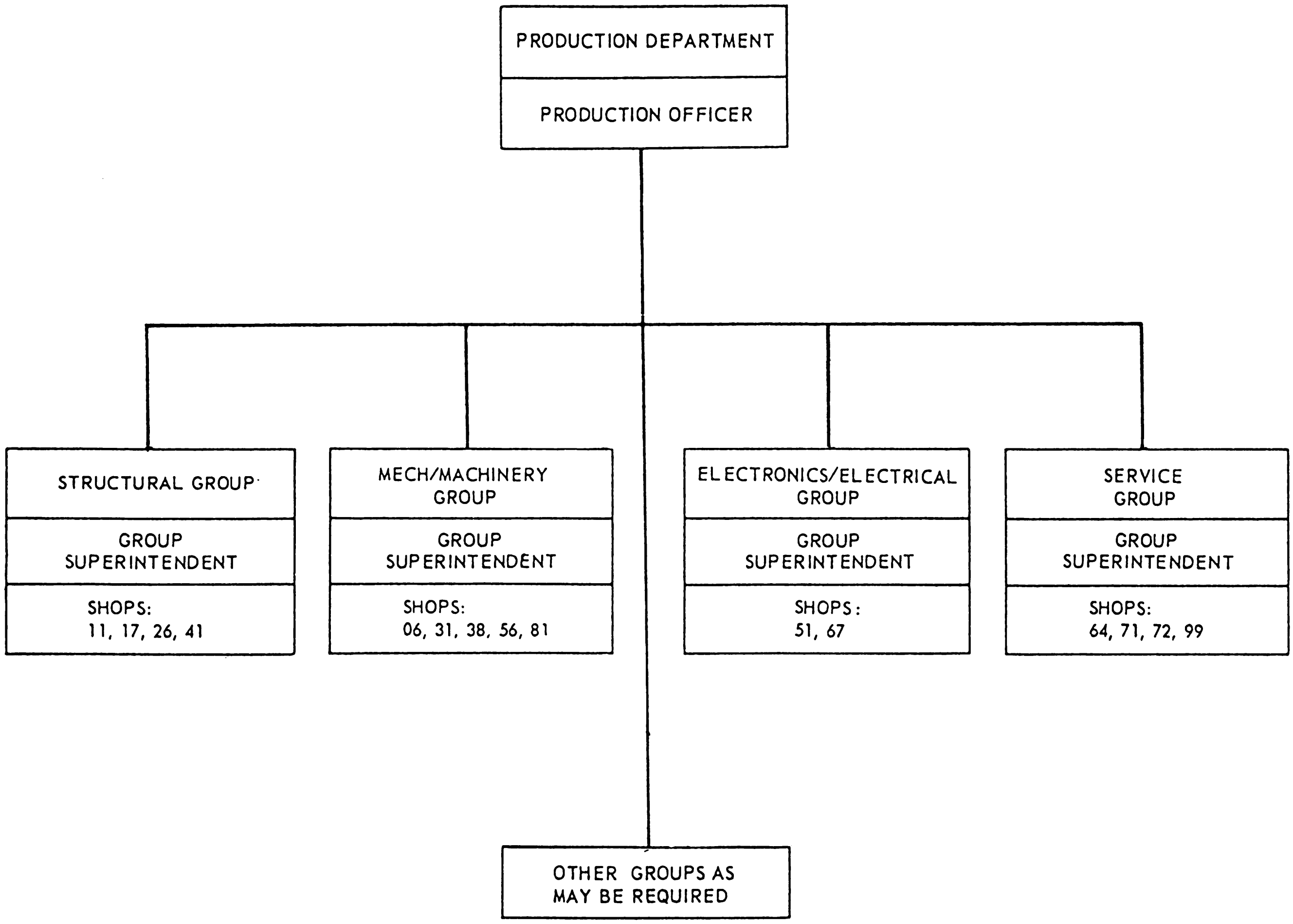


Figure 8-4.–Shop group organization of the production department.

(2) the requirement for fire watches for various types of work, and (3) general shipyard information for ships. As soon as the ship's force is secured from the Sea and Anchor Detail, the ship superintendent requests a meeting with the heads of departments. At the meeting the ship is (1) notified of the time and place of the arrival conference, (2) advised of the urgent necessity for fire watches, the basic organization and duties of fire watches, and the place and manner of obtaining portable fire extinguishers, and (3) requested to furnish a suitable place on board ship to serve as a ship superintendent's office for the duration of the overhaul.

At Navy shipyards, the shipyard commander, conducts frequent (usually weekly) conferences with the commanding officer to review the progress of work. The ship superintendent and other appropriate shipyard supervisory personnel also attend the conference. Because of the responsibility for the production, coordination, and progress of jobs, the ship superintendent must carefully monitor the performance of work in key jobs. During the course of the overhaul, there are frequent conferences with shop personnel, ship personnel, the cognizant type desk officer, and other yard personnel, to ensure a timely completion of all authorized work.

SHOPS.–A shop in a naval shipyard is a unit assigned certain specific work, usually by trades, and manned with specially trained and qualified personnel adept in the type of work assigned. The shop usually performs its type of work for the entire yard. Most of the shops are assigned to the Production Department. Transportation, Shop 02; power plant, Shop 03; and maintenance, Shop 07, are assigned to the public works department. All production department shops are under the supervision of the production officer. Each shop group is under the control of a civilian group superintendent.

A typical production department shop group organization is shown in figure 8-4. Each shop is assigned a number and a name. Certain shops are not located in all shipyards; some shops, however, are common to all shipyards. At some shipyards, certain shops may be combined with another shop.

Table 8-3.–Production Department Index

The following Production Shops are located in all Naval Shipyards:	
06	Central Tool
11	Shipfitter Shop
17	Sheet Metal Shop
26	Welding Shop
31	Inside Machine Shop
38	Outside Machine Shop
51	Electric Ship
56	Pipe and Copper Shop
64	Woodworking Ship (may include Shop 94, Pattern Shop, in some shipyards)
67	Electronics Shop
71	Paint Shop
72	Riggers and Laborers Shop (may include Ship 74, Sail Loft, in some shipyards)
74	Sail Loft
99	Temporary Service Shop
The following Production Department Shops are located only in certain shipyards:	
23	Forge Shop
25	Gas Manufacturing Shop
27	Galvanizing Shop
35	Optical Shop
36	Weapons Shop
37	Electrical Manufacturing Shop
41	Boiler Shop
68	Boat Shop
81	Foundry
94	Pattern Shop
97	Ropewalk

A list of Production Department shops, by number and name, common to all naval shipyards is provided in table 8-3.

If you need additional information concerning SHIPALTS, ships' work requests, and SUPSHIP procedures, refer to the *Ship Repair Contracting Manual (Repair Manual)*, NAVSEA 0900-LP-079-5010.

Equipment Certification/Testing Phase

As the ship approaches the end of the overhaul period and jobs are completed, equipment certification and testing will become a high priority. When approximately 25 percent of the overhaul is complete, the ship will receive an Integrated Testing Plan (ITP). The ITP will combine separate test and certification requirements for Combat Systems, Combat Systems Support Systems, Propulsion Systems, and Auxiliary Systems.

The ITP will depict all jobs assigned to the shipyard and to the ship's force, and will give the required start and stop dates to meet the testing schedule.

All tests in the ITP must be performed. Test will be included for both newly installed and idle equipment. Use the information in the ITP for planning, so your work can be completed on time. Do not be responsible for a work stoppage during the Testing Phase, as this could result in delays and cost overruns for the overhauling activity.

The ITP is broken down into three sections. The first is the Test Responsibility Matrix which consists of the following:

- Equipment to be tested
- Changes to systems
- Activity responsible for test document preparation

Next is the Test Index which lists:

- All applicable standards for the overhaul
- Source of each test (i.e., tech manual)
- Work Center or Activity responsible for conducting the test
- Estimated time required
- Number of personnel required

The last section is the Test Sequence Network, which contains test flow diagrams for each major ship system. This is the integrated network for all of the testing phase. This section is arranged to show the sequence in which the various tests will be performed. For some areas the sequence is critical. For example, before test two can begin, test one must be completed.

Testing is an extensive, time-intensive effort for the ship's force. This phase will last approximately 3 months and may require personnel to work 12 hours a day, 6 days a week. Be prepared to have all hands available during this phase. Ensure that ship's force testing, which must be done prior to overhaul activity testing, is completed on time.

The bottom line of the testing phase is that your equipment must be operational for post repair trials.

Post Repair Trials

Near the end of every overhaul during which major repairs are made, appropriate trials are conducted to test the overall effectiveness of the repairs. The commander of the naval shipyard (or SUPSHIP) and the commanding officer of the ship determine the nature and extent of the post repair trials based on the work performed. A full-power trial will be scheduled following each regular overhaul to ensure that the propulsion plant is capable of full power operation. The object of the post repair trials is to determine if the work has been completed, if the results sought have been fully achieved, and if the ship machinery, weapons, and electronics are fully ready for service.

Post repair trials are witnessed by the ship superintendent, any shipyard (or SUPSHIP) personnel designated, and a duly appointed representative of the ship, to observe whether or not the work performed is satisfactory. When the overhaul is done at a private shipyard, the contractor is permitted to have representatives on board to witness the trials. The following actions must be verified before commencement of post repair trials:

1. The review and use of procedures for correct line-up, lighting off, operation, and securing of the system or equipment.
2. The rigging, connecting, and use of all hoses, fittings and devices needed for the test.
3. The operation of all systems and equipment in all modes, such as emergency; cross-connected, normal, secondary and local, including the

operation of any remote operating devices and gauges.

4. Checking of all electrical, mechanical, local and remote indicators for proper readings.
5. Testing of all communications between normal control stations and locations involved in operating the system or performing the test.
6. Calibration and adjustment of each item as needed.
7. Inventory of consumables, fittings, devices, and portable test equipment to make sure that enough are on board to ensure proper operation through duration of trial.

DOCK TRIAL.–The primary purpose of dock trials is to conduct preliminary main propulsion, electrical, weapon, electronic, engineering auxiliary system tests, and any others necessary to make sure that the ship is ready for operations at sea. All special sea and anchor detail and general quarter stations, modified as necessary by sea detail requirements, are manned throughout the trial.

FAST CRUISE.–After a major RAV or scheduled depot-level availability (ROH/SRA/PMA) is completed, a fast cruise of at least 24 hours is conducted. For availabilities in excess of 60 days, the duration of the fast cruise is at least 48 hours.

The purpose of the fast cruise is to test to the maximum extent possible all ship systems and equipment, as well as the adequacy of all ship general and emergency bills and watch station assignments. Basic casualty drills for watch sections are required during the fast cruise to give the crew some experience before sea trials, which normally follow within a week.

The fast cruise is conducted under "At-Sea Conditions" as soon as possible after the dock trial is complete. Prior to the fast cruise, all industrial work should be complete, including painting out, and removal shipyard equipment and industrial debris.

POST REPAIR SEA TRIAL.–This trial provides the final determination of a ship's material readiness and ability to rejoin the Fleet as an active participant after overhaul or major repair. Between the completion of the dock trial and the beginning of the sea trial, the ship's force must correct and retest all defects that would affect safe operations at sea. They must also reconfirm all satisfactory conditions determined during dock trials. During sea trials, special sea detail stations must be manned at condition three or general quarters stations, as necessary.

This is an especially critical time for electronics personnel. It is the first time that newly installed, repaired, or modified equipment can be operated under actual operational conditions without being landlocked.

Readiness for Sea

Normally, the type commander allots the ship a readiness for sea (RFS) period immediately following the overhaul. This provides time for the ship's force to complete additional preparations prior to the ship's returning to an unlimited operational status. The time may be used (1) to load ammunition and supplies, (2) for special exercises and maneuvers at sea, or (3) to prepare for a special mission. The RFS period allotted to a ship will not normally exceed 7 days, and frequently it will be less. If there is an immediate special operational need for the ship, the RFS period may be omitted entirely. Neither the shipyard commander nor SUPSHIP is permitted to use the RFS period to do work that the shipyard has been unable to complete before completion of the overhaul. If the shipyard needs additional time, it must request an extension of the availability from the TYCOM. This concludes the discussion on the regular overhaul. We will now discuss the remaining overhauls and availabilities.

Complex Overhaul (COH)

A complex overhaul is an overhaul that requires extraordinary coordination and management of the planning and industrial phases to produce a high level of confidence that the overhaul will be completed satisfactorily. This may be due to time, manpower, or funding constraints. It may also be due to the complexity or interrelationships of the various ship subsystems affected by the overhaul. All CV, LHA, AGF, and nuclear powered surface ship overhauls are, by definition, complex overhauls.

Baseline Overhaul (BOH)

A baseline overhaul is an overhaul that is designed to restore a ship's subsystems and equipment to a baseline condition. The intent of the BOH is to provide an extensive overhaul that, together with a well engineered and executed maintenance program, will enable the ship to carry out its mission throughout an extended operating cycle.

Selected Restricted Availability (SRA)

A selected restricted availability is a scheduled maintenance period during which repairs are made and selected alterations are installed by depot activities, sometimes with intermediate level maintenance assistance. These availabilities are assigned to do work that is required to sustain the material condition of the ship between overhauls, particularly when the ship is on an extended operating cycle. SRAs are used to perform required depot level maintenance of ships on progressive overhaul strategies. SRAs are short, labor-intensive availabilities that are generally scheduled at specific times throughout the operating cycle. They are scheduled sufficiently in advance to ensure advanced planning time and funds are used effectively.

Docking Selected Restricted Availability (DSRA)

A docking selected restricted availability is a selected restricted availability that is extended by approximately 1 month to include drydocking of the ship.

Phased Maintenance Availability (PMA)

A phased maintenance availability is a short, labor-intensive period used by depot level maintenance activities to do general repairs and alterations. Ships assigned to phased maintenance programs are maintained through PMAs instead of regular overhauls.

Docking Phased Maintenance Availability (DPMA)

A docking phased maintenance availability is a phased maintenance availability extended to include drydocking of the ship.

Restricted Availability (RAV)

A restricted availability is a repair period during which an industrial activity does specific work, with the ship present, but incapable of fully performing its assigned missions and tasks.

Technical Availability (TAV)

A technical availability is a period during which a repair activity does specific work, normally with the ship not present, and still able to perform its assigned mission and tasks fully.

Voyage Repair (VR)

A voyage repair is emergency work necessary to enable a ship to continue on its mission and which can be done without requiring a change in the ship's operating schedule or to the general steaming notice in effect.

Service Life Extension Program (SLEP)

The SLEP is a depot level program used to extend the service life of a ship beyond that for which it was initially designed. After undergoing a SLEP, a ship will be maintained and modernized through normal overhaul procedures.

DEPOT LEVEL MAINTENANCE PROGRAMS

Depot level maintenance is scheduled and performed according to the applicable Class Maintenance Plan. There are currently three programs that ships fall under for depot level maintenance.

ENGINEERED OPERATING CYCLE PROGRAMS

Engineered Operating Cycle (EOC) Programs provide a structured, engineered approach for maintaining ships of specific classes. EOC programs provide a maintenance strategy, the goal of which is to maximize the reliability of ships while maintaining or increasing their operational availability. They anticipate intermediate and depot level maintenance and modernization requirements. This enables planners to program resources at appropriate points in the ship's operating cycle. Engineering analyses are the basis for defining periods of assigned maintenance availabilities.

PROGRESSIVE SHIP MAINTENANCE PROGRAM

Progressive maintenance supports specific ship classes that are designed for reduced manning and limited organizational level maintenance. It also supports specific ships homeported in forward deployed areas with operational schedules that limit length of time available for performing maintenance. Ships with reduced manning are designed to have components only removed and replaced, with maintenance and repair performed by intermediate and depot level activities to compensate for reduced organizational level maintenance. These design concepts have required the development of maintenance and logistic support systems different from those required for other surface ships.

PHASED MAINTENANCE PROGRAM

The Phased Maintenance Program (PMP) is a maintenance program in which depot level maintenance is performed through a series of short, frequent phased maintenance availabilities (PMAs) instead of regular overhauls. To the maximum extent practical, repairs are authorized based on the actual material condition of the ship and its equipment. The program also features innovative material support procedures. The goals of PMP are maximum ship availability, improved operational readiness, and upgraded material condition.

The essential features of Phased Maintenance are listed below.

Operating and Maintenance Schedules

Ships are scheduled for PMAs of 2 to 4 months duration at intervals of approximately 15 to 18 months. Minor variations accommodate differences in operating cycles between ship classes. One PMA in the cycle is extended by one month to include drydocking. Both repairs and modernization are included in the PMAs. Total depot level manday allocations, including both repair and modernization, and planned and emergent work, are specified for the cycle.

Condition-Directed Repair

Adherence to the principle of reliability-centered maintenance (RCM) is mandatory. Only those repairs necessary to sustain proper functioning of equipment are identified and authorized to be made.

Port Engineers

The port engineer has broad experience in ship maintenance and repair and is assigned to the type commander staff for intense maintenance management of assigned ships. The port engineer remains with the same ships through their cycle, and is involved in the planning, budgeting, authorizing, and execution of all maintenance actions.

Material Support

Phased maintenance uses a special material support program, the Insurance Item Management Program (IIMP), to prevent delays to scheduled PMA completions. As part of the IIMP, major equipment items are procured and maintained in the Navy supply system for use as changeout items when necessary repairs cannot be completed within PMA time schedules. IIMP repair parts are also procured and maintained in the Navy or Defense Logistics Agency (DLA) supply systems for use when material lead times will not support on-time completion of repairs. Selection of equipment items and repair parts is restricted to critical systems only.

SHIP REPAIR FACILITIES

Typically, a ship repair facility (SRF) is located outside the continental limits of the United States and employs civilian personnel indigenous to the country in which it is located: Guam; Subic Bay, Philippines; and Yokosuka, Japan. The SRF is supervised by naval officers assisted by enlisted and civil service personnel and has drydocks and shops capable of doing nearly all ship repair work. Typical usage includes voyage repairs and overhaul of ships whose home ports are in the area. No new construction is done at SRFs.

Ship repair facilities perform the following tasks and functions:

1. Provide logistic support, including drydocking, overhaul, repair, alteration, and conversion of naval ships and service craft and ships of other government departments, as assigned

2. Perform voyager repairs and related work, including drydocking of naval ships

3. Install and maintain shorebased electronic equipment and provide technical guidance to assigned naval activities

4. Perform additional related functions requested by competent authority

For the EMO, services such as calibration lab work, crypto repair, antenna repair, and other electronics work are available.

NAVAL SHIPYARDS

Naval shipyards, under the management control and technical direction of the Naval Sea Systems Command, perform the following tasks and functions:

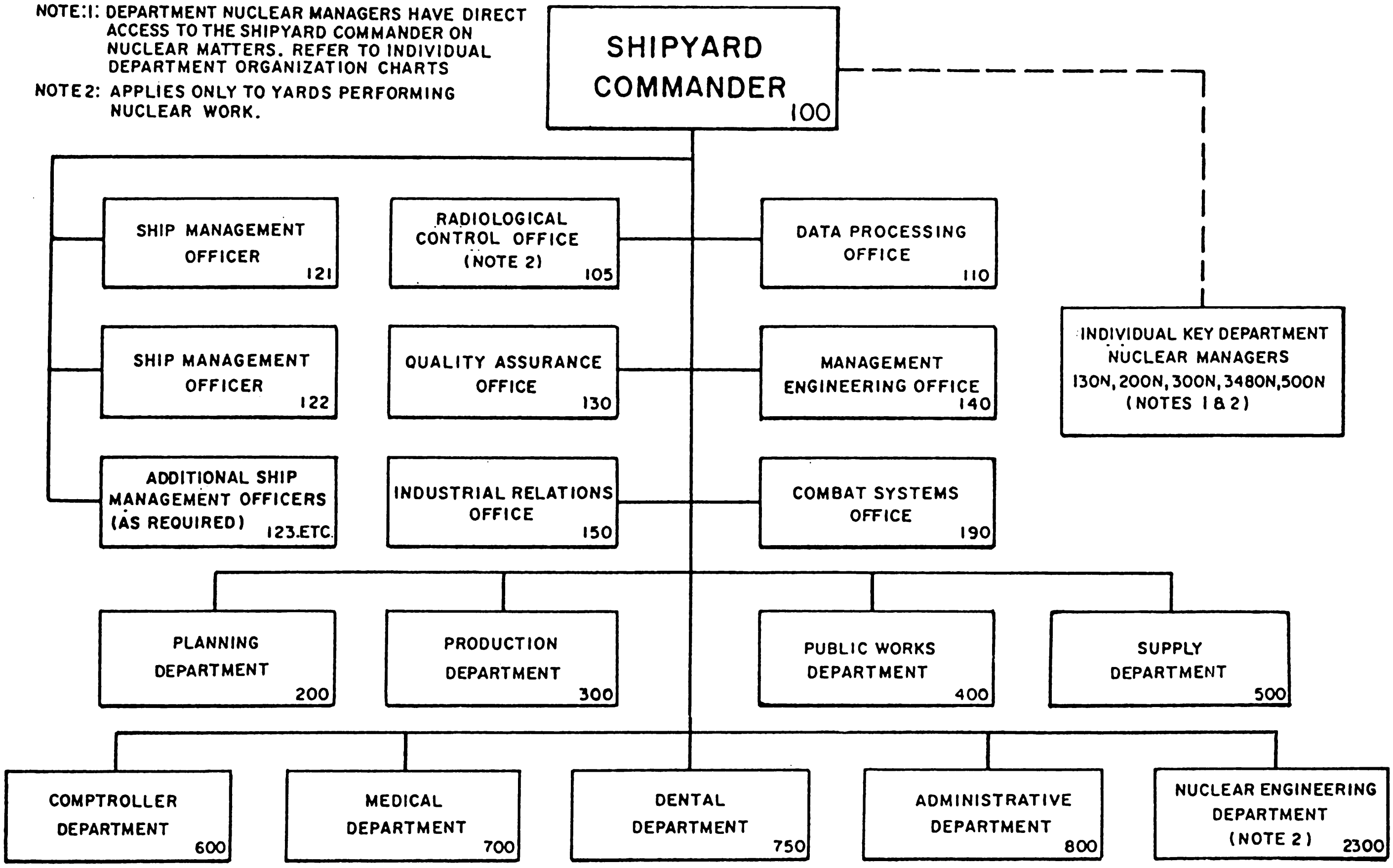


Figure 8-5.–Naval shipyard organization.

1. Provide logistic support to activities and units of the active fleet of the U.S. Navy and the naval shore establishment
2. Perform authorized shipwork in connection with the new construction, conversion, overhaul, repair, alteration, activation, inactivation and outfitting of naval ships and service craft
3. Design naval ships
4. Operate as planning yards for ship alterations and prepare allowance lists for ships under construction and conversion
5. Perform research, development, test, and evaluation work as assigned
6. Serve as primary and secondary stock points for designated material controlled by systems commands and offices of the Navy Department
7. Provide accounting, civil payroll, public works, industrial relations, medical, dental, berthing, messing, fire protection, security, and other services to naval activities and other government agencies, as assigned
8. Perform work for other U.S. Government departments, private parties, and foreign governments, as directed by competent authority

Shipyard management comprises all elements of administration, from the shipyard commander to the individual who is charged with supervising the smallest group. Management is charged by the Navy Department with the complete administration, coordination, management, operation, and technical control of all phases of naval shipyard activity. The line of authority and control passes from the shipyard commander through the heads of departments, divisions, and offices to the administrative units. The organization of a typical U.S. Navy shipyard is illustrated in figure 8-5.

MOBILE TECHNICAL UNITS (MOTUs)

MOTUs are fleet controlled support units located at areas of major fleet concentration. Their mission is to improve fleet combat system readiness by helping ship's force achieve technical self-sufficiency. They do this by providing on-the-job training in the maintenance and operation of combat system equipment.

MOTU training is often done in a classroom, for convenience. But more often it is given as onboard technical assistance when technical problems beyond the capability of the ship's force are being corrected. MOTU training may also consist of reviews, tests, or trials of system performance. MOTUs also certify fleet miniature/microminiature (2M) repair stations and 2M technicians.

There are MOTUs located at the following ports:

MOTU	LOCATION
MOTU TWO	Norfolk, Va.
MOTU FOUR	Groton, Conn.
MOTU FOUR (DET)	Newport, R.I.
MOTU SIX	Naples, Italy
MOTU TEN	Charleston, S.C.
MOTU TWELVE	Mayport, Fla.
MOTU FOURTEEN	Kings Bay, Ga.
MOTU SIXTEEN	Staten Island, N.Y.
MOTU ONE	Pearl Harbor, Hawaii
MOTU FIVE	San Diego, Cal.
MOTU SEVEN	Yokosuka, Japan
MOTU NINE	San Francisco, Cal.
MOTU ELEVEN	Long Beach, Cal.
MOTU FIFTEEN	Seattle, Wash.

MOTUs provide the following services, to the extent of their technical capability and manning, for units of the Navy:

1. On-the-job training (OJT) to fleet personnel in electronics and ordnance equipment maintenance
2. Technical assistance in the repair and installation of electronic and ordnance equipment that is beyond the capabilities of forces afloat
3. Informal maintenance instruction on selected equipment, either on board ship or at the local MOTU
4. Checks, reviews, or inspections of electronic and weapon systems for surface and submarine units
5. Shipboard AN/ULM-4 facility services as required by fleet commanders
6. TACAN operational checks
7. Other assistance in the field of electronic and weapon systems not specifically listed above, as appropriate and within the capability of the MOTU

MOTUs will accept requests for technical assistance only after all efforts by the ship's force have failed to correct the problem and if assistance from other ships is unavailable or unsuccessful. If you need MOTU assistance, make your request in time to permit completion of the work during normal working hours. Overtime is not normally authorized except for emergency services to meet operational commitments, which require a CASREP or message request for technical assistance.

When a MOTU provides onboard services, the enlisted technicians regularly assigned to the equipment must be present and available. Ship's technicians are to perform the work required, advised and assisted by MOTU personnel. You, as the EMO must also be present to coordinate details and to keep your chain of command informed of progress. Your ship must provide test equipment (calibrated), technical manuals, repair parts, maintenance requirement cards (MRCs), and adequate working facilities so that MOTU personnel may carry out their assignment promptly and efficiently.

Whenever MOTU personnel are embarked outside the local MOTU area, the ship on which they are working is required to report their initial arrival and final departure times by message. This, in addition to timely Situation Report (SITREP) messages, will keep all concerned advised of the work status, and the need for additional assistance. Additionally this will assist in the efficient use of personnel by advising when the technicians will be available for reassignment.

MOTUs will give first priority to CASREPs and situations that affect primary mission readiness. They will schedule routine checks and inspections as resources allow. MOTUs do not provide numerical "grades" for inspections, but rather a report of material conditions found, and recommended corrective action.

DIRECT FLEET SUPPORT (DFS)

DFS consists of engineering and technical assistance that is beyond assistance available from fleet activities. This assistance is provided by electronic field engineers who are civilian electronics personnel under contract with the Naval Sea Systems Command or Naval Electronics Systems Command. You may request DFS assistance at any time except when your ship is in a shipyard. However, your first call for assistance must be to a MOTU and then to the TYCOM RSG.

1. Support provided to the fleet for correcting operational and maintenance problems which are beyond the capability of ship's force, IMAs, SRFs, or MOTUs. This support includes advice, instruction, and training of fleet personnel in the operation and maintenance of equipment on board ships under the operational control of fleet and reserve force commanders.

2. Reviews, tests, and inspects to evaluate the effectiveness and material condition of ship equipment and systems under the operational control of FLTCINCs.

Navy policy dictates that fleet and shore activities be self-sufficient by providing their own technical services to the maximum extent practical. DFS is available for technical problems that are beyond the capability of the fleet but do not require industrial services. The primary objective of DFS is to provide technical assistance and to promote maintenance self-sufficiency through instruction and guidance to ship's forces. The FLTCINCs may request DFS from the systems commands or their designated representatives. Some of the major DFS programs are listed below:

1. Naval Engineering Technical Services from NAVSEACENs and other NAVSEA engineering activities

2. Contractor Engineering Technical Services (CETS) from NAVSEA

3. Fleet Engineering Technical Services (FETS) from NAVELEXCENs and other COMSPAWAR-SYSCOM engineering activities

A secondary objective of DFS is to provide training to ship's force in the operation and maintenance of their equipment and also to intermediate level activities that provide maintenance support to the ship.

FIELD ENGINEERING SERVICES

Ordinarily, electronics work assigned to or undertaken by field activities of the NAVSEA, NAVAIR, or SPAWARS is done by naval military and civilian personnel. However, when necessary, the Naval Sea Systems Command or the Space and Naval Warfare Systems Command will provide the professional services of electronic field engineers.

These engineers provide technical information to naval personnel on unusual design, planning, installation, and maintenance problems associated with the introduction of new equipment. The major justification for their use, however, is their contribution in helping naval personnel to perform their duties more efficiently through training. At naval shipyards, for instance, they train and instruct shipyard personnel in the installation, checkout, and adjustment of equipment. Shop personnel are given detailed information on the fine points of equipment maintenance techniques. On board ships, electronic field engineers familiarize the ship's force with the adjustment, maintenance, and operation of installed electronic equipment.

In addition, electronic field engineers train naval personnel at regularly established schools. These schools usually provide classroom instruction on newly developed equipment.

You can obtain field engineering services by submitting a request to your operational or type commander. The appropriate systems command will arrange on-call engineering services if they are not already available through the MOTU.

SPACE AND NAVAL WARFARE SYSTEMS (SPAWARS) COMMAND DETACHMENTS

The Space and Naval Warfare Systems (SPAWARS) Command was created to deal with the increasing problems associated with shipboard equipment maintenance (maintainability, reliability, and availability). SPAWARS detachments provide a direct line of communication with shipboard personnel responsible for electronic maintenance, with industrial activities which support the fleet, and with the manufacturers who design and build the equipment.

The detachments are not maintenance activities, as such, but rather engineering management arms of the systems command, organized to resolve maintenance problems by taking or recommending remedial action. They are concerned with maintenance in its fullest sense–design, installation, training, logistics, and technical information. Each detachment has the following major divisions: ASW, radar and tactical data systems, engineering and logistic support, and combatant craft engineering.

Each division is subdivided into branches with project engineers and technicians assigned to exercise engineering maintenance management over each piece of assigned equipment.

The routine duties of SPAWAR DETs include: investigation of maintenance deficiencies and trouble reports; engineering analyses and corrective recommendations; preparation of maintenance tips and procedures; development of field changes; reliability and maintainability analyses; training and manpower studies; and revision of technical manuals, maintenance standard books, and other documents. In addition, information gained from shipboard experience is furnished to the systems command for continued improvement in new design.

Casualty reports and maintenance reports are investigated for corrective measures. Field changes are studied and released as developed. Articles and helpful maintenance tips appear in the Electronics Information Bulletin (EIB). For assigned equipment, maintenance requirement cards receive final engineering approval.

Experience and information gathered from maintenance reports, casualty reports, and shipboard interviews are applied to the research and development program and manufacturing stages to prevent future maintenance problems.

SPAWARS FLEET LIAISON PROGRAM

Forces afloat are the highest priority customers of SPAWARSCOM. SPAWARS technical logistic support capability is maintained to ensure quick response to fleet requests for assistance. The implementation of the Fleet Liaison Program established direct lines of communication and provided "one-stop shopping" sources for support necessary to meet fleet operational requirements.

The Fleet Liaison Office provides advice and consultation services for the operating forces in the subject areas listed below:

1. Material support information
2. Administrative procedures
3. Technical data
4. Resolution of interface and compatibility problems
5. Safety problems
6. Configuration and field change problems
7. Equipment maintenance
8. On-the-job and informal training not readily provided for elsewhere

A primary goal of the Fleet Liaison Program is to provide a single point-of-contact for the fleet in electronic matters by receiving, investigating, and evaluating problem areas. After investigating a problem, a fleet liaison team will recommend, initiate, and coordinate corrective actions.

There are six SPAWARS Field Activities that have Fleet Liaison Offices: NAVELEXSECCEN Washington, D.C.; NAVELEXCEN Charleston, S.C.; NAVELEXCEN Portsmouth, MN; NAVELEXCEN San Diego, Calif.; Vallejo, Calif; and NAVELEXACT St. Inigoes, Md. Additionally, SPAWARS DET Mayport, Fla., has a Fleet Liaison Officer assigned.

SUPPORT AND TEST EQUIPMENT ENGINEERING PROGRAM (STEEP)

A major technical problem and excessive expense for the Navy has been the replacement of inoperable printed circuit boards (PCBs). Technological advances in equipment design have changed the Navy's repair philosophy from one of component replacement to one of module replacement for a number of modern systems.

Under this maintenance philosophy, faulty modules are returned to the supply system in exchange for replacement modules. The damaged modules are processed for contractor repair, repair within the Navy establishment, or discarded, all at great expense to the Navy. A recent study of various ships found that thirty-five percent of all PCBs turned in for Depot Level Repair (DLR) showed no evidence of failure (NEOF). In some specific systems, the percentage was as high as sixty-five percent. Additionally, many of these modules, turned in for depot level repair, could have been easily repaired on board ship.

To address this problem, the Navy instituted STEEP. This program has the following two supplementary programs:

- Miniature/Microminiature Electronic Repair and Certification (2M)
- Automated Test Equipment (ATE)

MINIATURE AND MICROMINIATURE ELECTRONIC REPAIR AND CERTIFICATION PROGRAM (2M)

Electronic systems with removable circuit boards are characterized by increased packaging complexity, multi-layer construction and the extensive use of microminiature devices and subminiature components. The increased use of such sophisticated systems and equipment calls for expanded electronic repair capability at all maintenance levels. This capability must include properly trained personnel, adequate repair equipment, and special facilities. The Navy's repair policy is to perform maintenance at the lowest practical level which will ensure an economical use of resources and achieve required operational readiness.

The surface ship 2M electronic repair program provides the tools, test equipment, and training for the repair of printed circuit boards and miniature components. The program covers surface ships, intermediate maintenance activities. COMNAVSEASYSCOM is the technical agent and the FLTCINCs are the operational administrators.

Miniature Electronic Repair

Miniature electronic repair is the repair of single-sided and double-sided PCBs including the removal and installation of dual-in-line packages and other microelectronic packages; the repair of PCB laminate and printed wiring; and the removal and application of conformal coating. However, these repairs are only authorized under the NAVSEA 2M program with the proper training, parts, and equipment.

Microminiature Electronic Repair

Microminiature electronic repair is the repair of multi-layer PCBs. This usually requires sophisticated equipment, such as stereo microscopes. Microminiature electronic repair includes miniature repairs and repairs to multi-layer modules, and small "daughter" boards that are too complex or dense for miniature electronic repair; repairs to flexible PCBs and printed circuit cables; the removal and installation of special connectors, eyelets, and terminals; electroplating, microsoldering, and complete rebuilding; and repairs to optical encoders and edgelighted panels.

2M Repair Limitations

The 2M program excludes internal repairs to microelectronic components, but their removal or replacement is acceptable. Other exclusions include internal repairs to critically sensitive components, such as miniature radio frequency balanced mixers, or repairs which require special calibration equipment.

Categories of 2M Repair

There are four categories of 2M repair: Normal, Progressive, Emergency, and Discard.

NORMAL REPAIR.–The Source, Maintenance, and Recoverability (SM&R) code identifies the maintenance levels that may remove, repair, replace, or condemn an item.

PROGRESSIVE REPAIR.–The progressive repair concept applies to depot level repairables (DLRs). This is the sequential movement of DLRs from the ship to an IMA and then to a depot. The IMA verifies the condition of the printed circuit boards and miniature electronic components and repairs them if possible. If the DLR repairs are beyond the capability of the IMA, the DLRs are sent to the depot.

EMERGENCY REPAIR.–Based on the operational necessity, the unit commanding officer may authorize local repair of depot or intermediate level repairables.

DISCARD.–The condition of an item must be verified at a 2M station before the item is discarded. When it is operationally feasible, ships should send items which are coded for O-level discard to the I-level activity for verification and possible repair.

Technicians who repair electronic assemblies and subassemblies must receive formal training in miniature or microminiature repair; on-the-job training is not acceptable for certification. With suitable proficiency and training, personnel may be awarded one of the following Naval Enlisted Classifications:

1. NEC 9503-2M Inspector
2. NEC 9509-2M Inspector/Master Inspector
3. NEC 9526-2M Microminiature Repair Technician
4. NEC 9527-2M Miniature Repair Technician

Maintenance activities performing miniature and microminiature electronic repair must meet the technical criteria of COMNAVSEASYSCOM.

Certifications will be conducted periodically by MOTUs.

Each TYCOM has specific requirements for 2M repairs. Some that may apply are discussed here.

2M Station Requirements

The 2M Handbook contains information on 2M repair stations and quality assurance standards for workmanship. Only certified repair stations may perform 2M repairs. All repairs to shipboard electronic equipment must be done at a 2M station by a certified 2M technician. Additionally,

1. 2M stations must have appropriate PMS coverage for the soldering station and ATE;
2. 2M technicians must conduct AEL tool inventory quarterly and keep records for one year;
3. A 2M log must be kept at each 2M station for documenting 2M usage, repair parts, and so on; and
4. 2M station(s) are maintained and recognized as electronic equipment.

2M Personnel Requirements

All activities which maintain 2M stations must meet the administrative and training requirements listed below.

ADMINISTRATIVE REQUIREMENTS.–The activity must maintain at least two certified repair technicians for each level of 2M repair station on board. Only certified 2M repair technicians are authorized to perform 2M repairs. Activities that have a single 2M station are authorized to train up to three 2M technicians, and activities having multiple 2M stations are authorized to train two 2M technicians per station.

The 2M technician does not have a primary NEC assignment. A secondary NEC coupled with an existing billet is identified in the Navy's Master Billet File and the unit Enlisted Distribution Verification Report (EDVR) for the ratings ST, FC, ET, DS, CTM, GM, IC, GSE, EW, WT, and OTM. Prospective 2M repair technicians must satisfy the following requirements:

1. Have at least 12 months obligated service remaining on board upon completion of 2M training.
2. Must fulfill all CANTRAC requirements.
3. Must be graduate of the Basic Shipboard Soldering Course and be recommended for 2M training.

TRAINING REQUIREMENTS.–The 2M program requires formal training for the two NECs 9526 (MC) and 9527 (MN). After completion of training, 2M repair technicians are issued certification cards. Continued NEC qualification requires annual recertification by a qualified 2M inspector, instructor, or certification agent. The *Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards* (NAVPERS 18068E) lists guidelines for revising and deleting NECs when technicians no longer meet certification requirements or are no longer working in the 2M program. Direct your quota requests for 2M training to the rating detailer.

2M Certification Requirements

To ensure adherence to established standards, activities are required to have their 2M repair stations certified every 18 months and their 2M technicians certified every 12 months. Certification inspections are conducted by MOTU 2M Inspectors. Be sure your ship's recertification inspections (both station and personnel) are conducted before you deploy if the current certifications will lapse during the deployment.

When the 2M/ATE audit is finished, the MOTU Inspector will issue a letter to your activity, appropriate IUC, and COMNAVSURFLANT, and the In Service Engineering Agent (ISEA). This letter will specify the status of your 2M repair capability, noting specific deficiencies, and giving specific recommendations for corrective action.

AUTOMATIC TEST EQUIPMENT (ATE) PROGRAM

The ATE program was developed to support 2M. It provides technicians the capability to troubleshoot suspected faulty PCBs and electronics modules (EMs). This capability greatly enhances the ship's ability to be self-sustaining and improves readiness. An additional benefit is the OPTAR savings incurred by making sure that only defective PCBs/EMs are replaced and turned into the supply system.

There is a variety of ATE in the fleet today, and more advanced technology will likely cause other types to become available. In this area we will address the AN/USM-465 since it is currently the only ATE authorized by the supply system. Along with the USM-465 is a *Catalog of Automatic Testing Capability* *for Electronic Modules and Printed Circuit Boards.* This catalog lists the equipment and PCBs/EMs for which ATE Test Program Sets (TPS) are available. COMNAVSUPSYSCOM has authorized using the AN/USM-465 and associated TPS to certify modules and boards repaired and tested by 2M repair stations as Ready For Issue (RFI) so they can be returned to the supply system. This authorization is limited to PCBs/EMs listed in the ATE catalog and is valid only as long as the 2M repair station certification is current. PCBs/EMs turned in to supply as RFI must be certified by the 2M technician, properly packaged, and marked as having been repaired at a shipboard or IMA 2M repair station.

Additionally, if the module is determined by ATE to be faulty and cannot be repaired by 2M, it must be turned into supply as NRFI.

Table 8-4 shows the number of 2M stations an AN/USM-466s authorized for various types of ships and craft.

MODULE TEST AND REPAIR (MTR) PROGRAM

The MTR program can help you reduce the time required to correct certain faults in your electronic equipment. It was created to provide short distance, quick turn around repair of pcb's that cannot be repaired aboard smaller ships in a task force. It provides an electronic repair facility aboard one of the larger combatant surface craft in the task force. For example, a carrier or battleship might have an electronic repair bench fitted with a USM-465 (ATE) and a HUNTRON TRACKER 5100DS integrated with a Zenith 248 computer. Suppose you were the EMO aboard one of the smaller ships and had a PCB that your technicians could not fix. You could simply send the board to the MTR facility by helicopter. Technicians in the facility would use the HUNTRON TRACKER and the computer to identify the faulty component. They would then use the computer's electronic repair parts inventory to locate a replacement part in one of the many bins kept in the workspace. Other technicians in the 2M lab could then repair the board and send it back to you by helicopter. Whenever you are on a ship assigned to a task force, find out which ship is carrying the MTR facility. Then, use it whenever you need it. SIMAs and tenders also have MTR facilities. By taking a short walk with the board and a 2K, you will have your equipment operational sooner than if you had sent the board to higher level facilities. You will also save the NAVY money as well.

SUMMARY

This chapter has pointed out some of the resources that you, as the EMO, can draw from to keep your electronic equipment working at designed specifications. Whether it be MOTU, a repair availability, or shipyard overhaul, you must plan your course of action. In the daily shipboard routine, a technician may have a problem repairing a piece of electronic equipment. You should consult your leading chief and determine if the technician is making reasonable progress with troubleshooting. You must make the decision on when to call a MOTU. With a repair availability approaching, you must know what equipment to submit for repair. Most of the package will be repair and calibration of test equipment. In the case of a shipyard overhaul, you must know which major jobs to submit, such as refurbishment of antenna masts and platforms. On most ships you will own the main mast and any other additional masts on which your radar and communication antennas are mounted. You and the leading chief should make a combined visual inspection to note the condition of cabling, cabling hangars, connectors, and the general preservation of platforms and antennas. Remember, since you may have to wait 3 or more years for a major overhaul, you should get your major repair work done whenever you have facilities available. Your CSMP and Zone inspection discrepancy list should point out a large percentage of anticipated work.

REFERENCES

NAVSURFLANT Maintenance Manual, COMNAVSURFLANT 9000.1C, Commander Naval Surface Forces Atlantic Fleet, 1984.

Policies and Procedures for Maintenance of Ships, OPNAVINST 4700.7H, Office of the Chief of Naval Operations, Washington, D.C., 1987.

Ship Repair Contracting Manual (Repair Manual), NAVSEA 0900-LP-079-5010, Naval Sea Systems Command, Washington, D.C., 1985.

Ships' Maintenance and Material Management (3M) Manual, OPNAVINST 4790.4B, Officer of the Chief of Naval Operations, Washington, D.C., 1987.

Table 8-4.–Authorized 2M/ATE Deployments

Ship Class/Shore Site	Mini Station	Micro Station	AN/USM-465
AD	2	2	1
AE	1	–	–
AF	–	–	–
AFS	1	–	–
AGF	2	1	1
AK	–	–	–
AO	1	–	–
AOE	–	1	1
AOR	–	1	1
AR	2	2	1
ARL 24	1	–	–
ARS	1	–	–
ATF	–	–	–
ATS	1	–	–
BB	2	1	1
CG	2	1	1
CGN	2	1	1
DD	2	1	1
DDG 2, 37 classes	1	1	1
DDG 51 class	2	1	1
DDG 933 class	2	1	1
FF	1	–	1
FFG	–	1	1
LCC	2	1	1
LHA	1	1	1
LHD	1	1	1
LKA	1	–	–
LPD	1	–	1**
LPH	1	1	1
LSD 32, 36 classes	1	–	–
LSD 41 class	–	1	1
LST	1	–	–
MCM	–	–	–
MSO	–	–	–
PHM	–	–	–
PHMRON MLSG	1*	1*	1
ACU	–*	1*	–
SIMA	2*	1*	1***
MOTU	1*	1*	–****

* Minimum capability. Additional 2M stations may be set up for repair support.

** USS NASHVILLE (LPD 13) only.

*** Additional AN/USM-465 issued to SIMA Norfolk and SIMA Little Creek.

**** For ATE certificaation and training as required.

CHAPTER 9

TEST EQUIPMENT

OVERVIEW

Test equipment is almost as important to you as spare parts.

You must have the correct, properly calibrated, test equipment to ensure proper repairs. In this chapter we will introduce basic test equipment and explain how you account for and keep it calibrated.

OUTLINE

Test and monitoring systems (TAMS)
General-purpose electronic test equipment (GPETE)
Automatic test equipment (ATE)
SCAT codes
Shipboard TAMS management
Test equipment stowage
Test equipment calibration
General test equipment resources and information

One of your primary EMO duties is to manage the maintenance of electronic equipment. Most of the equipment for which you will be responsible is in your department. However, you will be responsible for some in other departments. Maintenance of Navy electronics equipment is divided into two main categories, preventive and corrective. As illustrated in figure 9-1, testing is the major function ETs perform when they do maintenance.

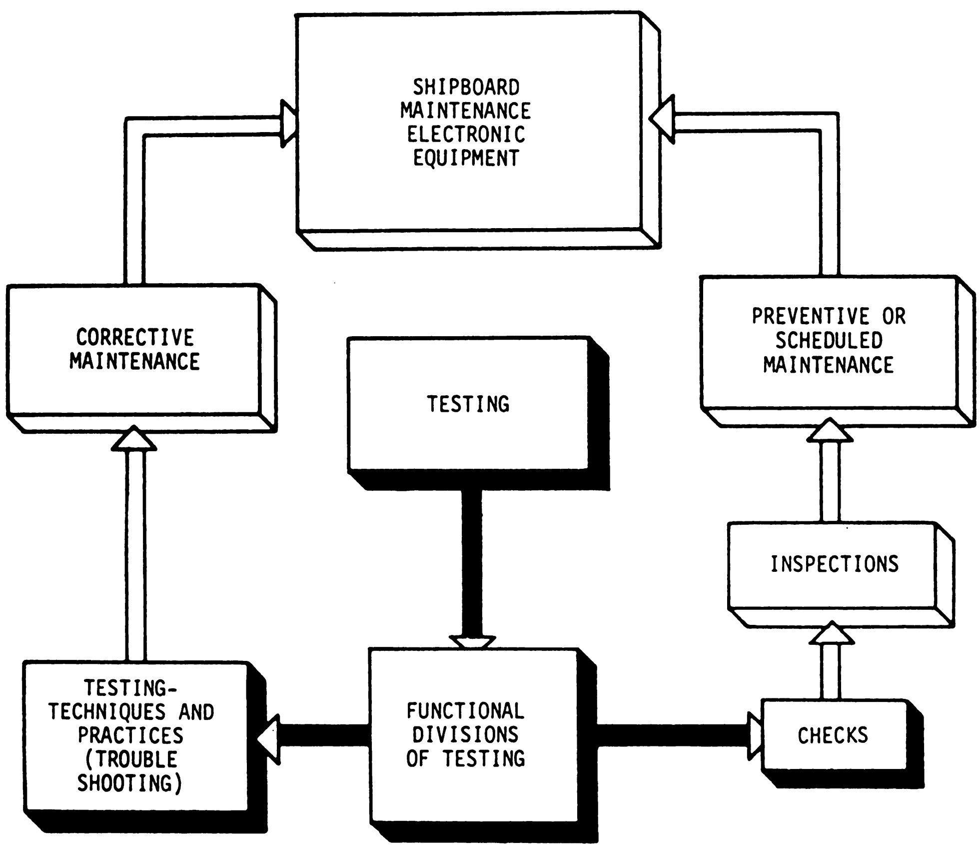


Figure 9-1.–Electronic maintenance functional diagram.

Testing and test procedures are sometimes referred to as tests, measurements, or checks. These terms are used interchangeably and overlap in meaning depending upon their use and results. For example, both a power output measurement and a frequency check may be part of a test to determine if a transmitter is operating properly. These tests are performed using various types of test equipment.

Basic testing procedures and some of the general-purpose test equipment used by the ET are discussed in Navy Electricity and Electronics Training Series (NEETS), Module 16, *Introduction to Test Equipment*, NAVEDTRA 172-16-00-84. Safety precautions to be followed are provided in the *Electronics Technician 3 & 2*, Vol. 1, NAVEDTRA 10196. Further information for the processes involved in testing are given in the EIMB Handbook on *Test Methods and Practices*, NAVSEA 0967-LP-000-0130, and the EIMB Handbook on *Test Equipment*, NAVSEA 0967-LP-000-0040.

In this chapter, we will explain the primary system used by the Navy to conduct tests on and monitor the operation of electrical and electronic circuits and equipment. We will introduce the basic equipment used for testing. We will then explain the administrative and calibration systems associated with test equipment.

TEST AND MONITORING SYSTEM (TAMS)

To properly manage the ship's test equipment, you must understand the different terms and definitions associated with the Test and Monitoring Systems (TAMS). TAMS is the Navy's Life Cycle Management program for test equipment and is described fully in NAVSEAINST 9082.1. As depicted in figure 9-2, there are four levels within TAMS.

LEVEL I–SYSTEM

Any equipment classified by the definitions listed in the management, technical, and functional levels are considered to be a part of the systems level (Level I) of TAMS.

LEVEL II–MANAGEMENT

The management level (Level II) of TAMS consists of automatic test equipment (ATE); calibration standards; and test, measuring and diagnostic equipment (TMDE).

Automatic Test Equipment (ATE)

Automatic test equipment is designed to analyze operational or static equipment parameters to determine if the performance of the equipment being tested is degraded and, if so, to what extent. This equipment may also be designed to isolate the causes of unit malfunctions. The decision making, control, or evaluative functions are conducted with minimum reliance on human intervention.

Calibration Standards

Calibration standards are devices that are used to ensure the accuracy of measuring devices (both tools and equipment). Accuracy is ensured by periodically comparing the units of measure of the measuring devices (length, temperature, weight, voltage, and so on) to the units of the standards.

Test, Measuring and Diagnostic Equipment (TMDE)

This category includes any device that is used to measure, calibrate, gauge, test, inspect, diagnose, or otherwise examine materials, supplies, and equipment to determine whether or not they meet the requirements listed in technical documents.

LEVEL III–TECHNICAL

The technical level (Level III) of TAMS consists of electrical test equipment, mechanical test instruments (MTI), and electronic test equipment (ETE).

Electrical Test Equipment

Electrical test equipment is specifically designed and primarily used to measure the current, voltage, resistance, and frequency of electrical power distribution equipment or systems.

Mechanical Test Instrument (MTI)

A mechanical test instrument is any device that is used to conduct tests in units such as pressure, temperature, flow, linear, optical torque, weight, mass, and vibration, and indicates the results directly, in the units being measured.

Electronic Test Equipment (ETE)

Electronic test equipment is used to check the electronic functions of other equipment. Each piece of

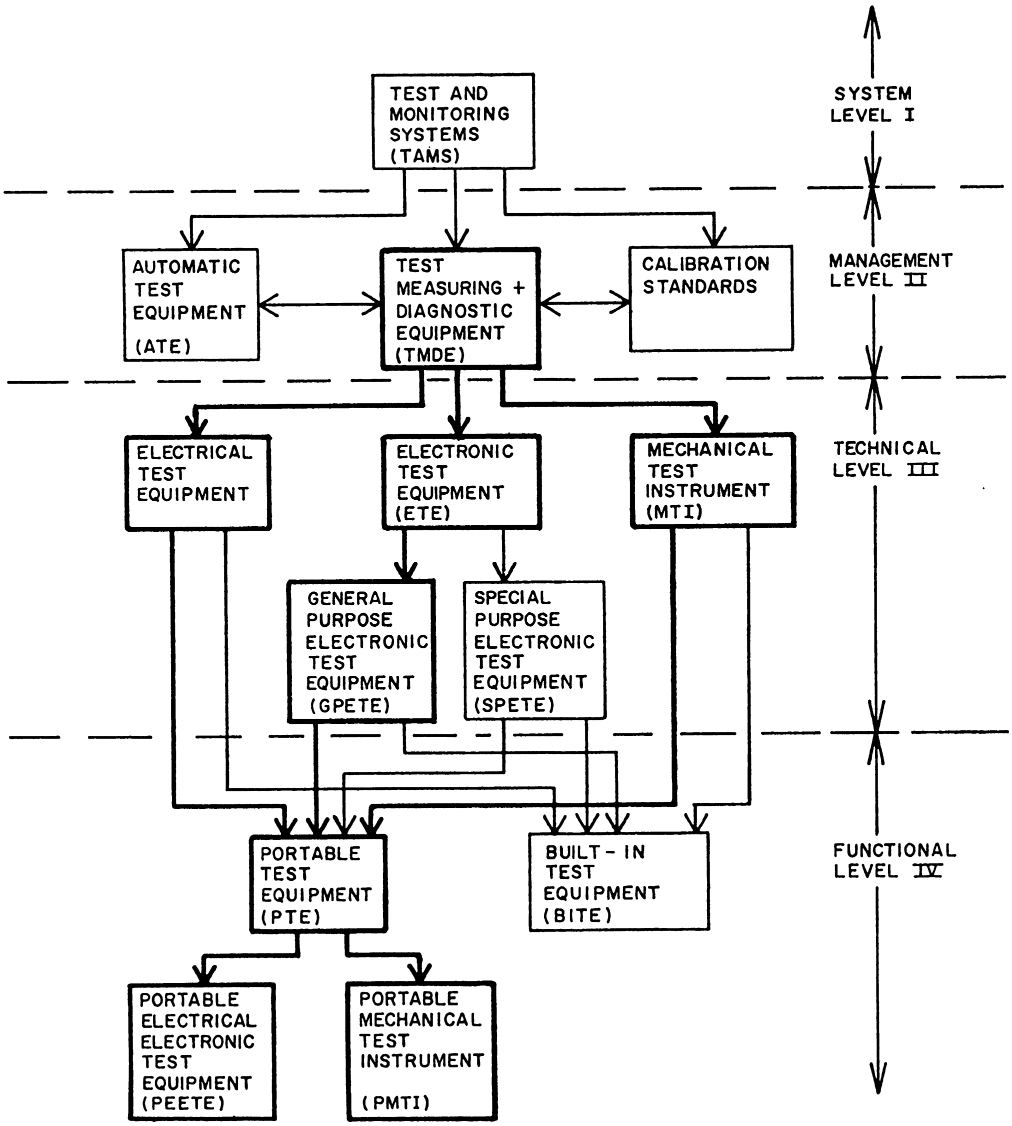


Figure 9-2.–Genealogy of test and monitoring systems.

electronic test equipment is classified as either "general purpose" or "special purpose," as defined below:

GENERAL-PURPOSE ELECTRONIC TEST EQUIPMENT.–Electronic test equipment that has the ability, without modification, to test two or more prime equipments or systems of basically different designs.

SPECIAL-PURPOSE TEST EQUIPMENT (SPETE).–Electronic test equipment that is specifically designed to test a single prime equipment or system.

LEVEL IV–FUNCTIONAL

The functional level (Level IV) of TAMS consists of built-in test equipment (BITE) and portable test equipment.

Built-In Test Equipment (BITE)

Built-in test equipment includes all devices that are functionally separate from, but permanently connected to, the prime equipment or system, and used solely for testing that prime equipment or system. This includes all devices that are permanently installed and that were originally provided to monitor or troubleshoot the prime equipment or system.

Portable Test Equipment (PTE)

Portable test equipment is not permanently connected to the prime equipment or system. It is used by organizational or intermediate level personnel to perform planned or corrective maintenance on

SCAT	DESCRIPTION	MODEL NUMBER	FSC
4372	Signal Generator Frequency Range: 450-1200MHz Frequency Accuracy: ±1% Output Level: 0-5mW Modulation: AM and pulse, internal and external Output Impedance: 50ohms	CAQI-612A	28480
4378	Sweep Generator Frequency Range: 250kHz-1GHz Sweep Width: 20kHz-200MHz Sweep Rate: variable to at least 60Hz Output Voltage: 0-0.5V Output Impedance: 50ohms	SG-1020/UR CCAQ-1520A CCAQ-121CJ CCTR-900B	NA 80138 80138 01113
4385	Signal Generator Frequency Range: Discrete Frequency: 1-18GHz RF Comb: 100 MHz-18GHz Frequency Accuracy: ±1% Output Level: Discrete Frequency: –40dBm at 1-12.5GHz RF Comb: –30dBm at 100MHz-18GHz Modulation: Internal: 1kHz squarewave External: pulse Amplitude: 10-20V Pulse Width: 5us-lms Repetition Rate: 10-400Hz Output Impedance: 50ohms Power Meter: may be used to monitor output signals or to measure external signals Power range: –30 to –10dBm full scale Accuracy: ± 2.0dB Frequency Range: 10MHz-18GHz	SG-1016/U	NA
4404	Function Generator Waveforms: sine, square, triangular Frequency Range: 0.01Hz-200kHz Output: 30V peak to peak	CDDT-142 CAQI-3310A	23338 28480

Figure 9-3.–SCAT Codes.

shipboard prime equipment or systems. There are two categories of portable test equipment, electrical/ electronic and mechanical, as described in the following paragraphs.

PORTABLE ELECTRICAL/ELECTRONIC TEST EQUIPMENT (PEETE).–The PEETE category includes GPETE, portable electrical test equipment and items to support GPETE. Any reference to PEETE in this TRAMAN also applies to GPETE.

PORTABLE MECHANICAL TEST INSTRUMENT (PMTI).–The PMTI category includes any device that satisfies the definitions of PTE and MTI as previously mentioned.

SCAT CODES

The SCAT (Sub-Category) code system was developed to group pieces of electronic test equipment that have the same purpose and operating characteristics. The *Electronic Test Equipment Application Guide*, NAVSEA 069-LP-019-7000, is the basic document of the SCAT code system.

Each SCAT code is associated with a specific set of required equipment operating characteristics and examples of equipment that has those characteristics. Figure 9-3 shows four SCAT codes, their associated equipment operating characteristics, and examples of equipment that has those characteristics. It also shows the federal supply code (FSC) of each of the examples. Test equipment is assigned SCAT codes in the 4000 to 4999 series. By using the SCAT code system, you and your technicians will be able to identify alternative test equipment to meet your ship's needs.

GENERAL-PURPOSE ELECTRONIC TEST EQUIPMENT (GPETE)

In the following paragraphs, we will discuss various types of meters and test equipment used to test a variety of electronic equipment.

METERS

The three basic types of electrical meters used to test electrical and electronic equipment and circuits are the ammeter, ohmmeter, and voltmeter. All of these, except their electronic versions, use a basic meter movement (see fig. 9-4) to indicate measurements. The meter pointer is moved by a magnetic field created as current travels through the movement coils. The direction and distance the meter pointer moves depends on the direction and amount of current flowing through the movement coils. Electronic meters use either a light emitting diode (LED) display or a liquid crystal display (LCD) readout.

Ammeter

The ammeter is used to measure current. The ammeter consists of a basic meter movement and a combination of resistors. A multiposition switch or a series of pin jacks is sometimes used to connect various sizes of resistors to permit the same meter to be used for different current ranges. An ammeter must always be placed in series with the circuit to be measured and must

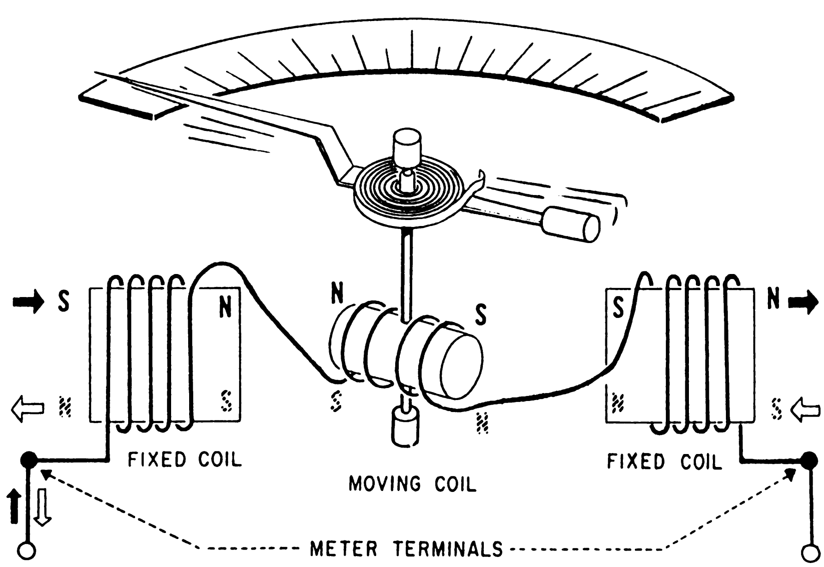


Figure 9-4.–Basic meter movement.

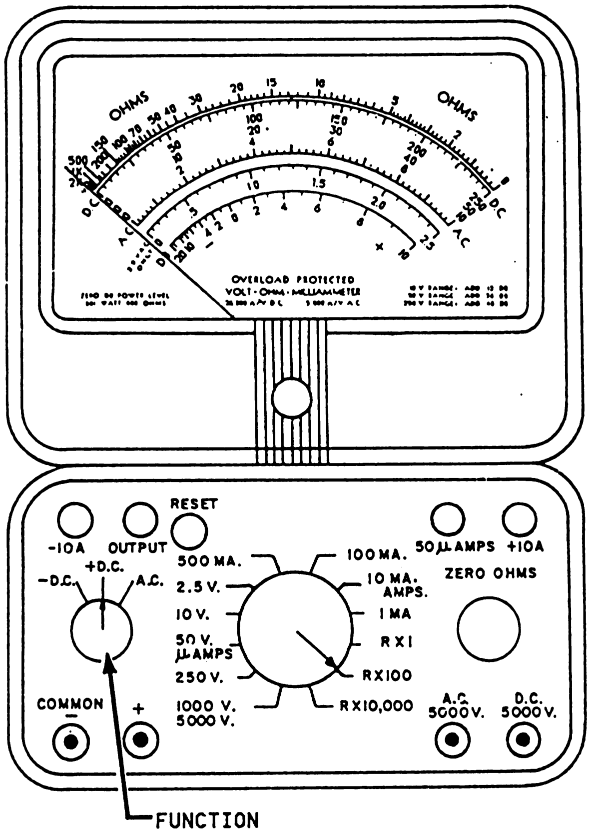


Figure 9-5.–Typical nonelectronic multimeter (SCAT 4245).

be placed on the highest range before it is connected to a circuit.

Ohmmeter

The ohmmeter is widely used by Electronic Technicians in making resistance measurements and continuity checks. Technicians find wide use for this instrument in checking cables and locating malfunctioning components in electrical circuits. The ohmmeter consists of a basic meter movement, a voltage source, and one or more resistors used to adjust the current through the meter movement. The meter must be adjusted for "zero resistance" before it is used to take resistance measurements. An ohmmeter must NOT be used on an energized circuit. Using an ohmmeter to check an energized circuit will likely result in the destruction of the ohmmeter.

Voltmeter

The voltmeter also uses the basic meter movement. Because the current is directly proportional to the

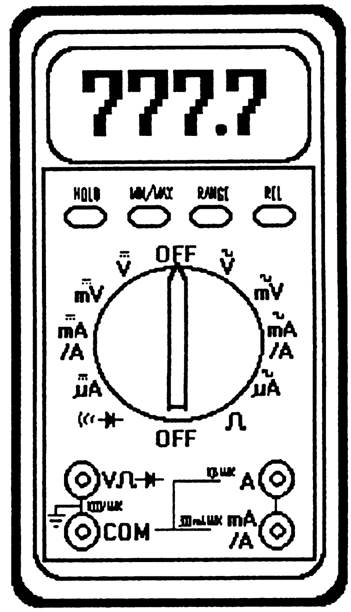


Figure 9-6.–Typical portable electronic multimeter (SCAT 4237).

voltage applied, the scale can be calibrated directly in volts.

The sensitivity of voltmeters is given in ohms per volt. This sensitivity is an indication of how accurately voltages in a circuit will be measured. In many cases, a sensitivity of 1,000 ohms per volt is satisfactory. However, if the circuit in which the voltage is being measured has a high resistance, a greater sensitivity is required for accurate readings; thus, the higher the sensitivity, the more accurate the reading. Because of the "loading effect," good technicians are careful NOT to use a meter with low sensitivity to measure circuit parameters. Circuit loading will cause incorrect readings and can also cause the circuit to operate improperly.

Multimeter

During troubleshooting, a technician is often required to measure voltage, current, and resistance. To eliminate the need to obtain three or more meters, the technician will use a multimeter. The multimeter contains a voltmeter, an ammeter, and an ohmmeter in one unit. Multimeters are of two types, nonelectronic and electronic. Nonelectronic multimeters may have either an analog (meter) (fig. 9-5) or LCD readout, are highly portable, and are available for quick measurements without a warmup period. Electronic multimeters have a digital readout and are more accurate than nonelectronic multimeters because of their advanced electronic circuitry. Some electronic multimeters use alternating current as a power supply to enable them to take even more accurate measurements than the battery-powered models. However, the ac-powered models require a warmup period before they can be used.

MULTIMETER (NONELECTRONIC) (SCAT 4245).–The nonelectronic multimeter is designed to permit the technician to measure approximate voltage, resistance, and current with a completely self-contained portable instrument. It can measure either ac or dc voltage, resistance, or direct current in a wide range of values. Most multimeters have an accuracy of 2 percent to five percent at low frequencies. However, the accuracy of nonelectronic multimeters decreases as the frequency of the voltage being measured increases. When the frequency is above the audio range (10,000 hertz), the voltage reading is no longer accurate. Where accuracy at the higher frequencies is desired, an electronic multimeter or an ac vacuum tube voltmeter should be used.

MULTIMETER, ELECTRONIC (SCAT 4237).–Nonelectronic multimeters measure only approximate values of voltage, current, and resistance. In situations where precise measurements are required, such as in the servicing of electronic equipment, the electronic multimeter (fig. 9-6) is used. The ac-powered electronic multimeter shown in figure 9-7 will provide even more precise measurements.

INSULATION TEST SET (MEGGER) (SCAT 4452).–The insulation test set (MEGGER), (fig. 9-8) is

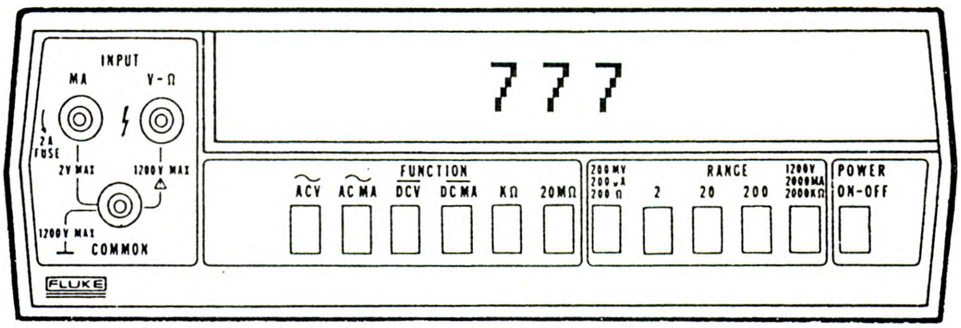


Figure 9-7.–Electronic multimeter, ac powered (SCAT 4237).

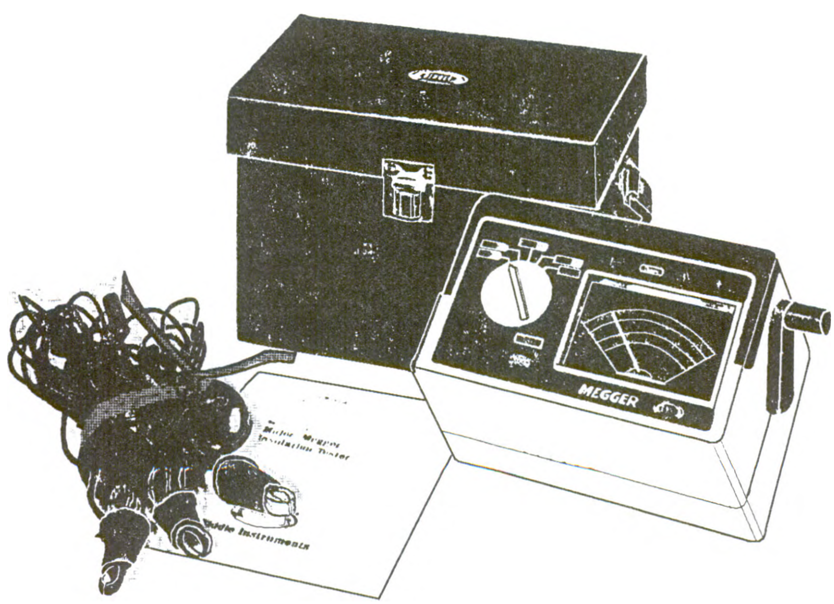


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Figure 9-8.–Insulation Test Set 212159 (SCAT 4452).

Figure 9-9.–Ac/dc differential voltmeter (SCAT 4208).

used to measure the quality of the insulation present in insulated cables. It may also be used to test the insulation in high voltage capacitors. The MEGGER does this by applying a high voltage to the conductor and measuring the leakage of the associated current. A multimeter cannot provide such a quality test because it cannot supply a high enough voltage. The MEGGER consists of a hand-driven dc generator and an indicating meter. The name MEGGER is based on the fact that the test set measures resistance of many megohms.

Ac/dc Differential Voltmeter, (SCAT 4208)

The differential voltmeter is a reliable, precision voltmeter, used to compare an unknown voltage with an internal reference voltage, and to indicate the difference in their values. The differential voltmeter used in many Navy electronics shops is the 893A (fig. 9-9). This meter is accurate enough for the precision work of a calibration laboratory, yet rugged enough for general shop work.

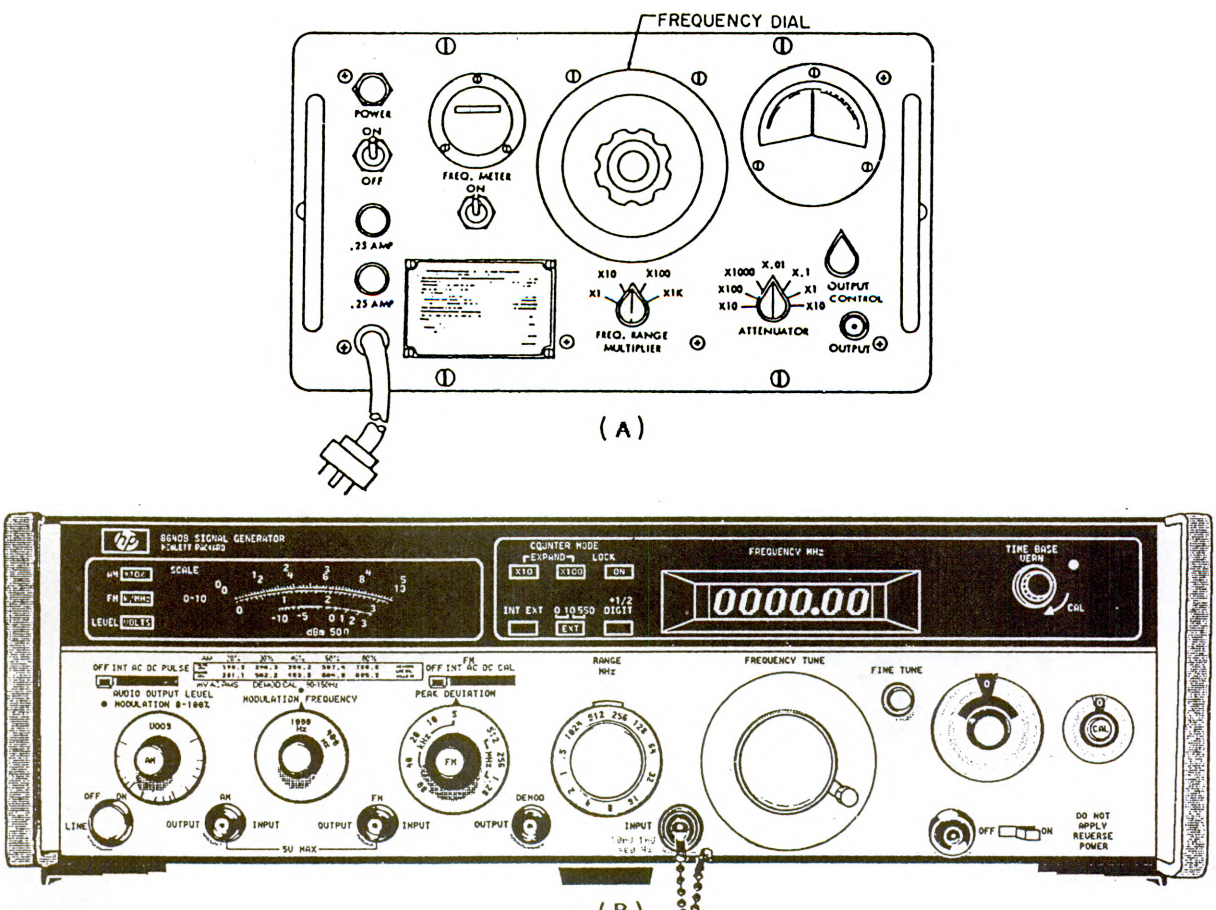

Figure 9-10.–(a) Af signal generator (AN/URM-127) (SCAT 4358); and (b) rf signal generator (HP-model 8640B) (SCAT 4370).

SIGNAL GENERATOR

The maintenance of electronic equipment often requires the technician to inject standard ac energy, both audio frequency and radio frequency, into a circuit. Sources of this energy are called signal generators. They are used in testing and aligning radio transmitters, receivers, and amplifiers. They may also be used to troubleshoot various electronic devices, and occasionally for measuring frequency.

The principal function of a signal generator is to produce an alternating current of the desired frequency, amplitude, and modulation required to meet measurement criteria. It is very important that the amplitude of the generated signal be correct. Many signal generators have output meters that permit the output to be adjusted and maintained at a standard level over a wide range of frequencies. Two signal generators, the AN/URM-127 (0-10,000 Hertz)and the HP-8640B (500 kilo-Hertz to 1,000 mega-Hertz), are shown in figure 9-10. As you can see, the desired frequency determines which signal generator is used. Audio generators, video-signal generators, radio-frequency generators, frequency-modulated rf generators, and special types which combine some of these frequency ranges.

FREQUENCY COUNTER (SCAT 4296)

Frequency measurements are an essential part of preventive and corrective maintenance for electronics equipment. Frequency measurements for radio equipment are made during tuning, preventive maintenance, and corrective maintenance procedures. The type of test equipment selected depends on the frequency to be measured and the required accuracy. Signal frequencies of radio transmitters that operate in the low-frequency to the very-high-frequency range are normally measured by frequency meters and calibrated radio receivers.

Frequency-measuring equipment and devices, particularly those used to determine radio frequencies, make up a distinct class of test equipment because of the important and critical nature of such measurements. The requirement of precise calibration is extremely important in all frequency-measuring work. To provide accurate measurements, every type of frequency meter must be calibrated against some frequency standard.

The HP5328A frequency counter (fig. 9-11) can be used to measure frequency, period, period average, time interval, time interval average, and ratio. The HP5328A provides a 9-digit LED display, display storage, and leading zero blanking. Decimal point and unit readouts are displayed automatically. Two independent selectable input channels are provided for time interval measurements.

245.3X

Figure 9-11.–Digital Readout Electronic Counter HP5328B (SCAT 4296).

FREQUENCY STANDARD

A frequency standard, although not a piece of test equipment, is presented here because of its use in providing a stable frequency reference that is used mainly for communications equipment operation.

Frequency standards are divided into two general categories: primary and secondary. The primary frequency standard is determined and maintained by the U.S. Bureau of Standards. It has long-term stability and accuracy that are determined by comparison with a standard interval of time. A secondary frequency standard is a highly stable and accurate standard that has been calibrated against the primary standard. An example of a secondary standard is the AN/URQ-10.

Frequency Standard AN/URQ-10 (fig. 9-12) is a compact, multipurpose, secondary frequency standard designed for continuous duty operation aboard ship or at shore facilities. The standard operates from a 115-volt, 50- to 400-Hz single-phase ac source or internal batteries (for short periods), and provides three highly stable output frequencies (100 kHz, 1 MHz, and 5 MHz). The newest frequency standard is the AN/URQ-23.

OSCILLOSCOPE

An oscilloscope is used to analyze waveforms. It displays signals on a crt and shows signal amplitude versus time. The basic principles and a general description of the operation of an oscilloscope are covered in the *Navy Electricity and Electronics Training Series* (NEETS).

The oscilloscope shown in figure 9-13 operates on the same principle as the ones described in NEETS Module 16. It is a 100 Mhz, four channel, dual sweep oscilloscope for general- purpose use. This oscilloscope is extremely portable and has memory capability.

CAPACITANCE-INDUCTANCE-RESISTANCE BRIDGE (SCAT 4457)

Capacitance, inductance, and resistance are measured for precise accuracy by alternating current bridges composed of capacitors, inductors, and resistors in a wide variety of combinations. These bridges operate on the principle of the Wheatstone bridge, in which an unknown resistance is balanced against known resistances. The unknown resistance is calculated in terms of the known resistance after the bridge has been balanced. One type of bridge circuit is the 250DE shown in figure 9-14. This instrument is self-contained, battery-operated, and completely portable. An internal generator supplies ac and dc, and an internal solid-state ac-dc detector indicates bridge balance.

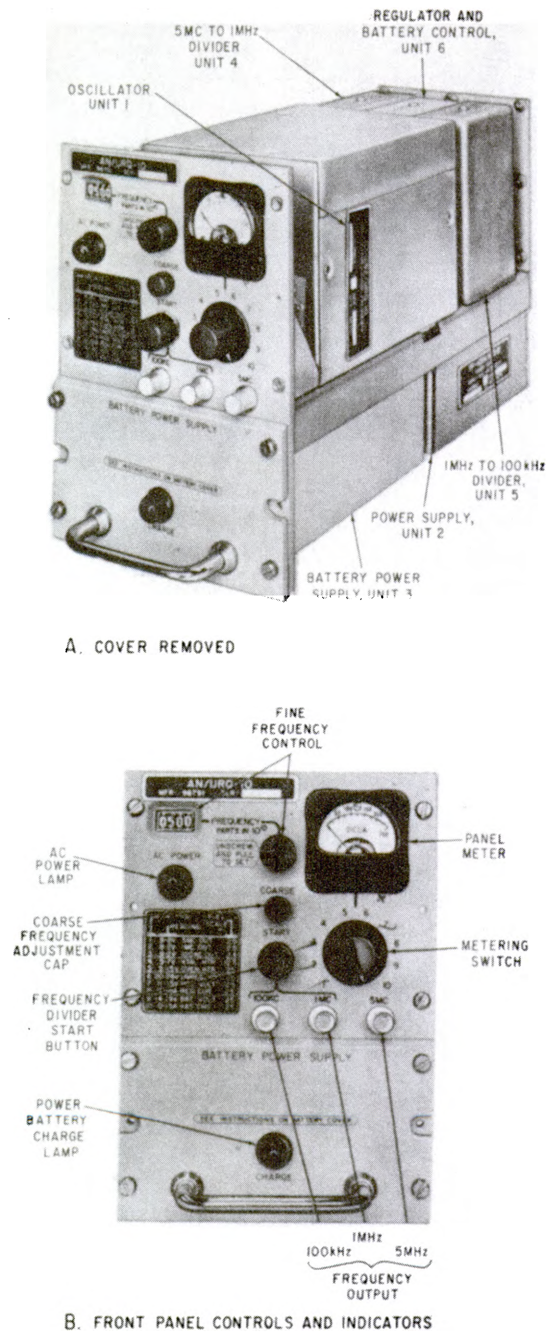

Figure 9-12.–Frequency Standard AN/URQ-10 (not test equipment).

WATTMETER

A wattmeter is a device that measures the incident (forward) and reflected power of a transmitted signal. There are two basic types of wattmeters: thruline and microwave.

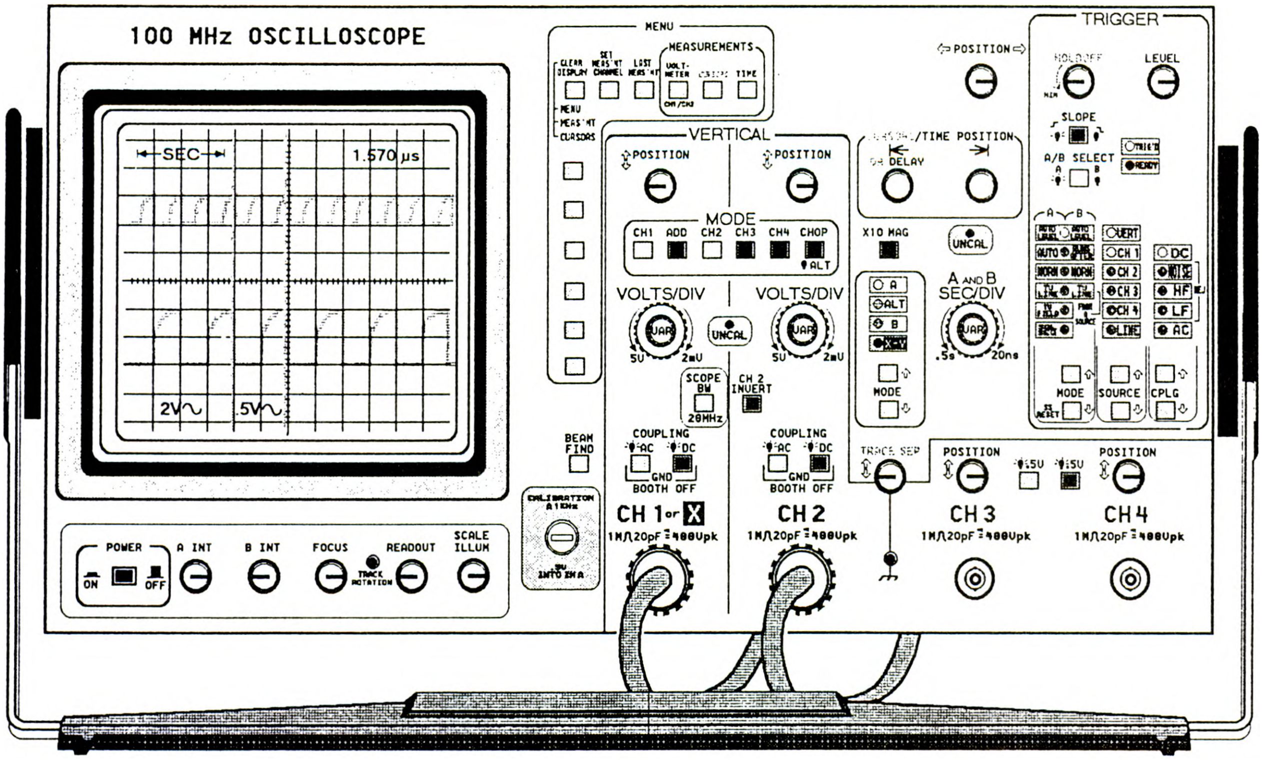

Figure 9-13.–Oscilloscope (SCAT 4308).

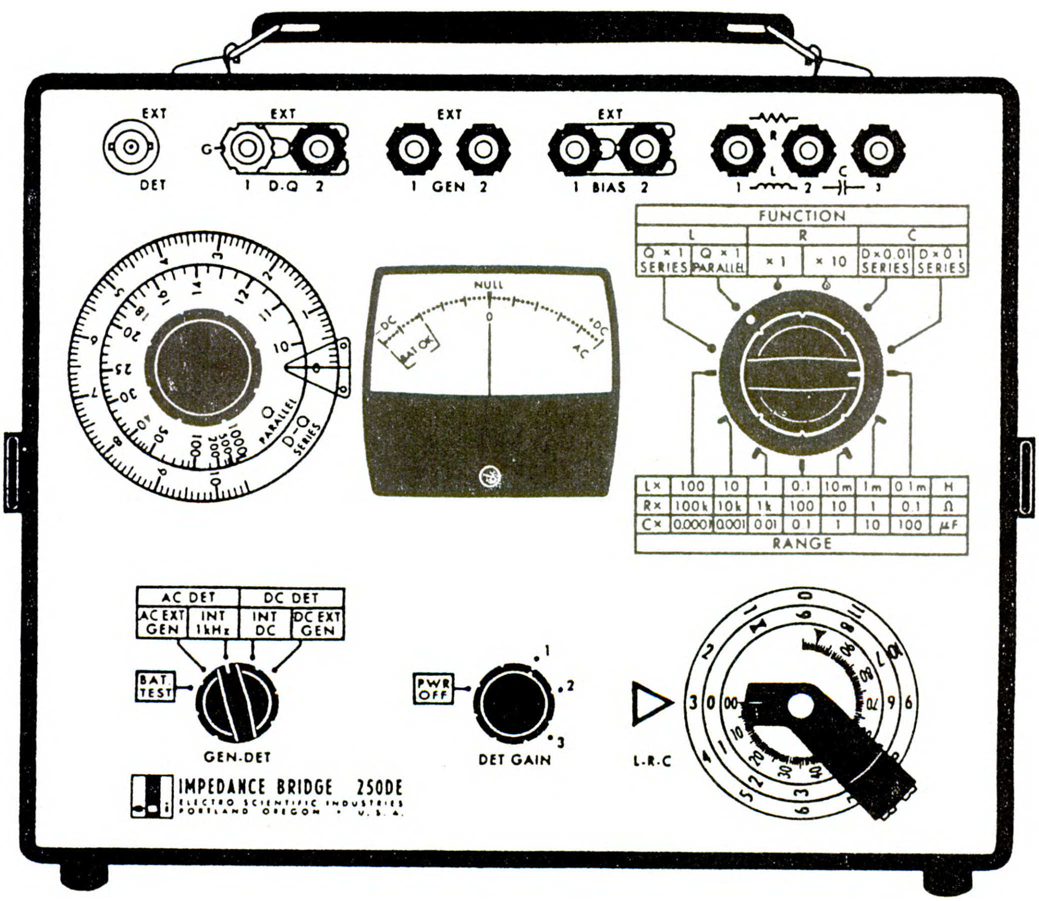

Figure 9-14.–Capacitance-Inductance-Resistance Bridge (250DE) (SCAT 4457).

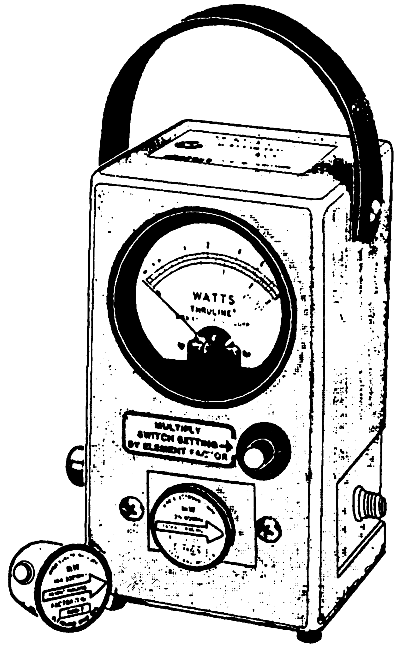

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Figure 9-15.–Rf Thruline Wattmeter, Bird Model 4410 (SCAT 4958).

Rf Thruline Wattmeter (SCAT 4958)

A thruline wattmeter (fig. 9-15) is designed to measure incident and reflected rf power from 10 to 1000 watts with a frequency range of .2 to 1000 MHz. Detector elements, each rated to cover a portion of the frequency and power ranges, are provided with the wattmeter. A nameplate on the element indicates the power and frequency range. The detector-element rotates 180° along the coaxial primary line inside the metal cases for forward or reverse power measurement.

Microwave Power Meter (SCAT 4957)

For higher frequency power measurements in which a thruline wattmeter is unsuitable, the HP-431C (fig. 9-16) is used. Nevertheless, the Model 4410 may be preferred for a particular transmitter due to its power handling capability, attachments, or ruggedness.

TUBE TESTER (SCAT 4548)

Although most new electronic equipment has solid-state circuitry, a large amount of tube-type equipment is still in use in the fleet. Until the tube-type equipment is replaced by solid state equipment, technicians will need devices to test the tubes.

A representative field-type electron tube tester (AN/USM-118B) designed to test all common low-power tubes is shown in figure 9-17. The tube test conditions (which are as close as possible to the actual

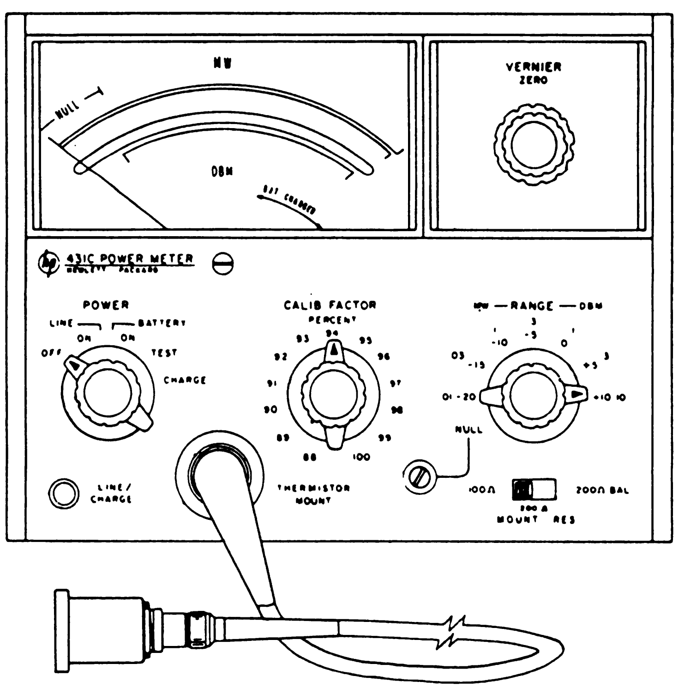
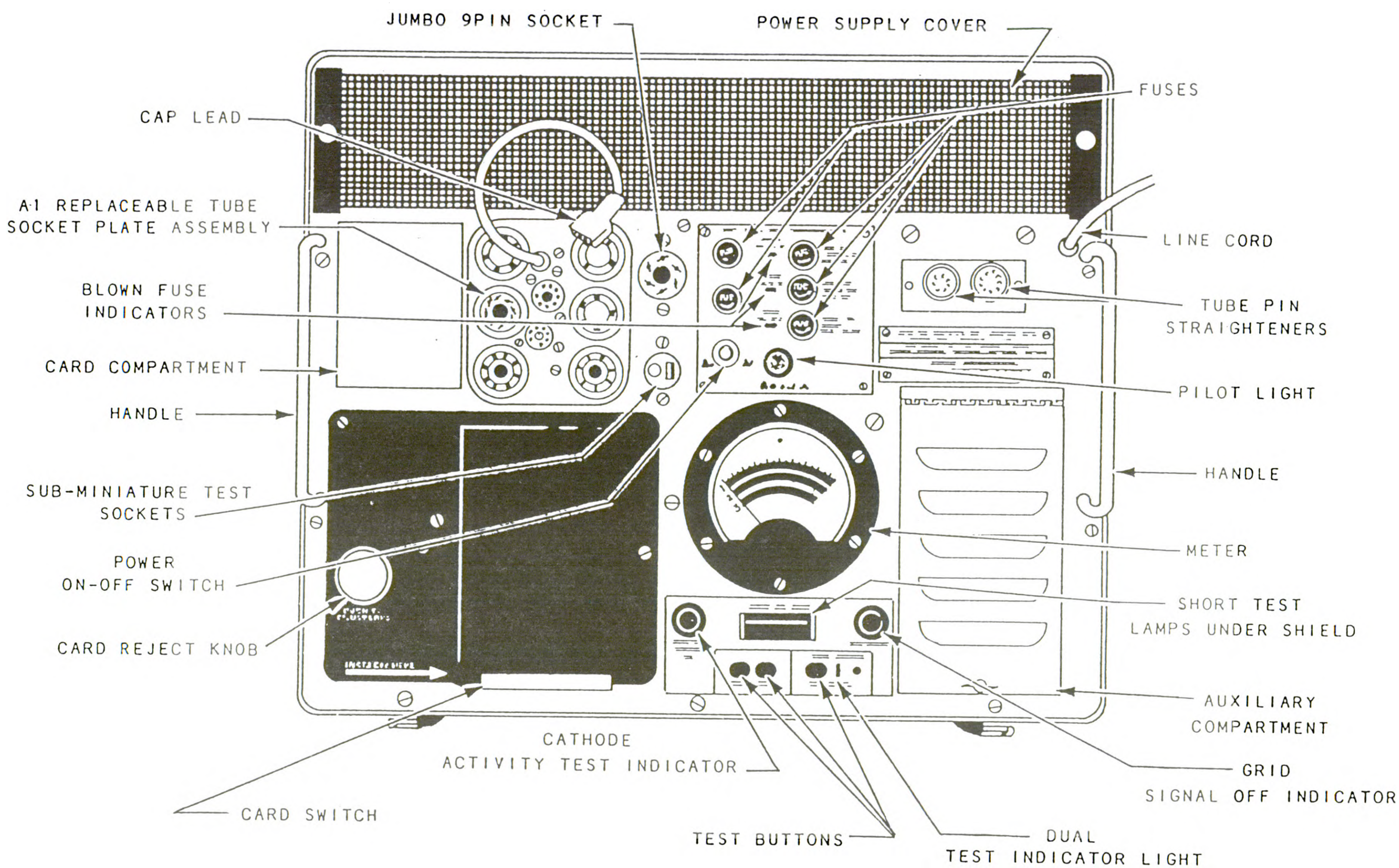


Figure 9-16.–Power meter HP-431C (SCAT 4957).



20.346

Figure 9-17.–Tube Tester AN/USM-118B (SCAT 4548).

tube operating conditions) are programmed on prepunched cards. The card switch automatically programs the tube tester when it is actuated by a card. A compartment on the front panel of the tester provides storage for the most frequently used cards. The cover of the tester (not shown) contains operating instructions, brackets for storing the technical manual, the power cord, a calibration cell for checking the meter, calibration cards, blank cards, and a steel hand punch.

TRANSISTOR TESTER, (SCAT 4557)

Laboratory transistor test sets are used in experimental work to test all characteristics of transistors. For maintenance and repair, however, the technician does not need to check all the characteristics. A check of two or three performance characteristics is usually enough to determine whether a transistor needs to be replaced. Two of the most important characteristics used for transistor testing are the transistor current gain (beta) and the collector leakage or reverse current (Ico). These are discussed in the Navy Electricity and Electronics Training Series (NEETS).

OCTOPUS

Before the beginning of solid-state circuitry, circuit components were checked with an ohmmeter. To check a component, the technician simply unsoldered all but one of the component's leads from the circuit and conducted the tests. Electronic part miniaturization and microminiaturization have made troubleshooting by desoldering obsolete. The complexity of printed circuit boards and the delicacy of many solid-state components drastically limit the amount of heat and physical movement that can be applied during a component test.

An ohmmeter, moreover, cannot detect a shorted inductor or open capacitor even after the component is lifted from the circuit, and some ohmmeters generate enough current at low range to damage solid-state components. Normally, as electronic parts decrease in size, their current-handling capacity also decreases, and the use of ohmmeters becomes even more undesirable.

To test solid-state components without using an ohmmeter, the technician can use a shop-made in-circuit tester, called an "octopus." An octopus is basically a box that, with its power cord and multiple leads protruding from its sides, resembles an octopus. The octopus enables the technician to use a standard oscilloscope to test components without removing them from the circuit. This setup provides the technician a visual display of each component's condition. For example, a good capacitor is indicated by an "O" pattern. A good semiconductor is indicated by an "L" pattern. A shorted component is indicated by a horizontal line, while an

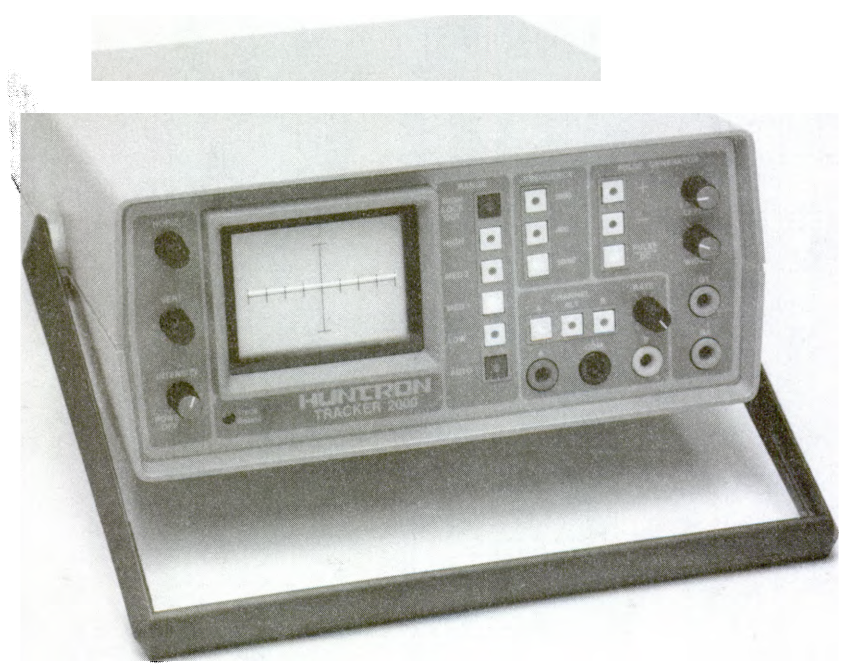


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Figure 9-18.–Huntron Tracker, HTR2000 (SCAT 4557).

open component produces a vertical line. By using this setup, the technician can troubleshoot by comparing the display pattern of a component known to be good with the pattern produced by a suspect component.

The octopus is designed to test delicate components quickly without delivering more than 1.0 milliampere of ac. Also, it energizes components during test, without removal of circuit interconnections, much the same as they are energized in the circuit during normal service.

Construction details and other uses for the octopus are given in the *EIMB Handbook on Test Equipment*, NAVSEA 0967-LP-000-0040. If your shop has an octopus, or if a technician makes one, be sure it is electrically safety checked and listed on the portable test equipment inventory. Do NOT "hide" it in a drawer, only to have it found during a safety inspection.

Technicians may also conduct in-circuit tests of components with the semiconductor test set HRT1005B-1 (Huntron Tracker) described in the following paragraph.

HUNTRON TRACKER

The Huntron Tracker, HTR1005B-1 (fig. 9-18), is a rugged octopus-type tester designed to test all electronic components and printed circuit boards. The set uses an x-y oscilloscope system to provide various scope patterns to indicate good and bad components.

AUTOMATIC TEST EQUIPMENT

Recall from chapter 8 that the only piece of automatic test equipment now authorized for ATE use is the portable service processor, AN/USM-465. It is used in the Navy supply system to certify electronic components as "ready for issue" (RFI). The AN/USM-465 (fig. 9-19) is a microcomputer-controlled, portable test system that performs automatic GO/NO-GO testing and fault isolation on digital printed circuit board assemblies. The AN/USM-465's sturdy aluminum case, light weight, and small size make it ideal for the field service environment.

The AN/USM-465 is packaged as a single-compact assembly. Contained within this assembly are a microprocessor based system, memory, and a set of peripherals that enable the technician to create, list, save, load, and run board test programs. The peripherals include a keyboard, a magnetic tape cartridge drive, a 16-character display, 16 LED status lights, a DMM, a 20- character thermal printer, an "IEEE-4888" Interface

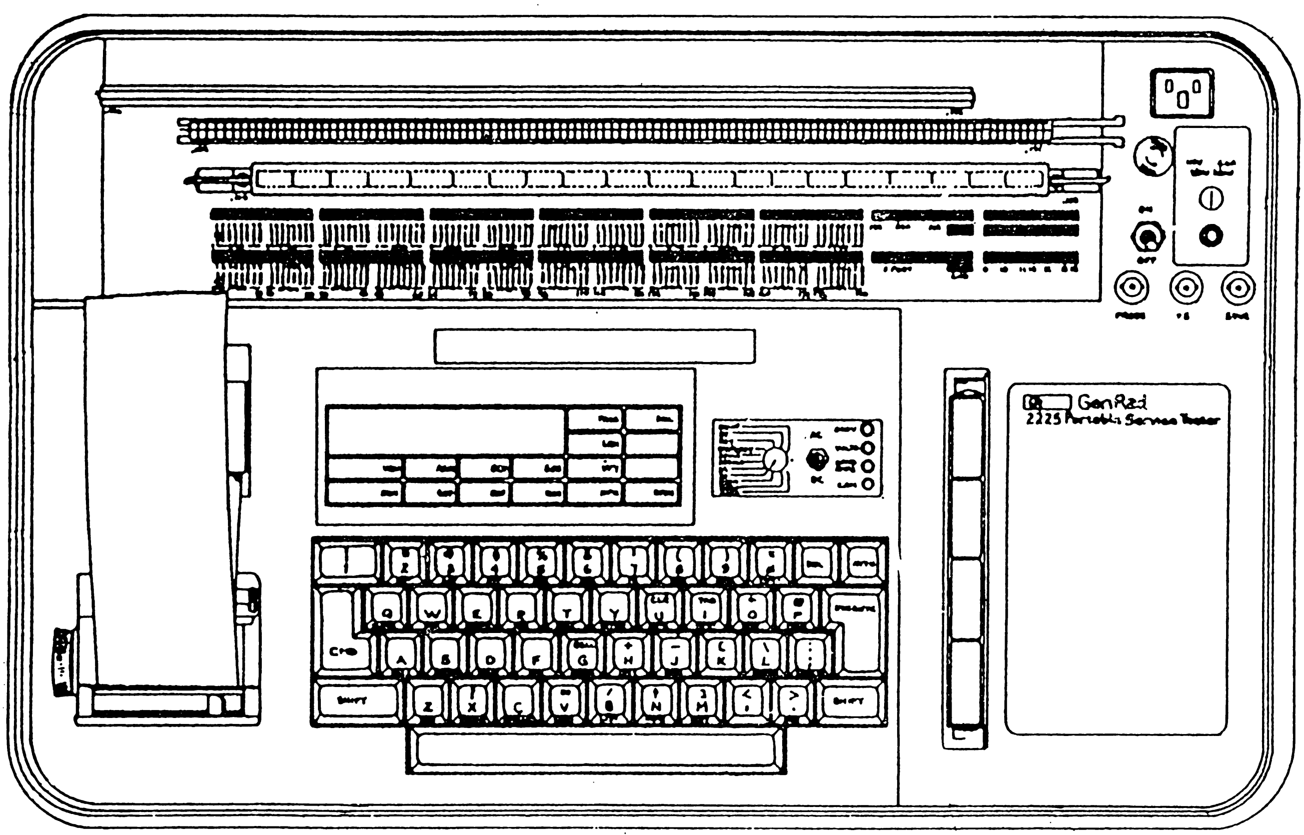

Figure 9-19.–AN/USM-465.

Bus for external instrumentation, and an RS-232 communications interface. In addition, the AN/USM-465 includes four programmable driver/sensor pins that apply power and stimuli to a board under test and measure responses from the board.

Test Program Sets (TPS) are used for programming the AN/USM-465. They consist of cartridge-type magnetic tapes and instructions. The major drawback of the AN/USM-465 is the size and weight of the TPS. TPS are available for many systems and they work well when used properly. For a listing of available TPS, consult the *Catalog of Automatic Testing Capability for Electronic Modules/Printed Circuit Boards*, NAVSEA ST820-AA-010/ATEEM/PCB CAT.

There are various other types of ATE available, all of which will help you achieve self-sustainability. At the IMA, there is ATE that compares known good PCBs/EMs with suspected faulty ones to provide component level fault isolation. Additionally, in the very near future, IMAs will be equipped with an ATE tactical analog test equipment (TAT) capability that will further enhance the maintenance ability of the fleet.

SHIPBOARD TAMS MANAGEMENT

Managing the test equipment aboard ship is a challenge. Many work centers use test equipment, and you, as EMO, will be responsible for seeing that it is all kept aboard, calibrated, and ready for use. You must also be sure that all GPETE allowed in the SPETERL are aboard.

As a new EMO, you should become familiar with the *Electronic Test Equipment Calibration Program Indoctrination Handbook*, NAVMAT P-9491. It is a good source of basic text for information concerning management of test equipment. Also read the *NAVELEX TAMS ACTION NEWS*. It is a good, unofficial source of current information concerning changing policies and procedures. Additionally, keep in touch with the Readiness Support Group (RSG) and the Field Calibration Technical Representative (FCTR).

Your ship should have an instruction that makes the EMO the test equipment manager for the ship. If one doesn't exist, draft one. The instruction must clearly define and assign the responsibilities involved in managing the test equipment. It must also define the specific departmental responsibilities since shipboard management of TMDE will tend to cross the lines of command.

Remember, as the EMO, you must be thoroughly familiar with the latest publications, instructions, and programs that are used in test equipment management. Some of those publications, instructions, and programs are described in the remainder of this chapter.

PEETE INDEX (TEST EQUIPMENT INDEX)

The PEETE Index (NAVSEA ST000-AA-IDX-010/PEETE), also called the Test Equipment Index, identifies portable electrical and electronic test equipment (PEETE) required to support prime electronic, electrical, IC, weapons, and reactor instrumentation systems throughout the Navy. Its various sections provide several different ways to cross reference primary systems and their associated test equipment. You will use it with the Ships Portable Electrical\Electronic Test Equipment Requirements List (SPETERL), outlined later in this chapter, to be sure that your ship's PEETE satisfies current test equipment requirements. Data in the Index is subject to revision periodically as new equipment and systems become available, and new requirements are generated. Therefore, you may find differences between data in the Index and data in the SPETERL, depending upon issue date of the SPETERL. Under present procedures, these differences will be eliminated automatically in later issues of the SPETERL. The Index does NOT, in any way, supersede or change the SPETERL, nor does it authorize procurement of, or requisition of, items not listed on the SPETERL. The Index is published on an annual basis in the spring of each year and you, as EMO, must keep a copy in the work center.

The Test Equipment Index is divided into six sections and five appendices, as outlined in the following paragraphs.

Section I–SCAT Code by Prime Electronic Equipment Requirements

This section is based on "prime" electronic equipment (AN/SPS-65, AN/SPS-48, and so forth). It is arranged in alphanumeric sequence by the approved nomenclature of the prime electronic equipment, and indicates the SCAT codes and quantities of test equipment required to support the prime equipment.

Section II–SCAT Codes by Fleet Supplemental Test Equipment Requirements (FSTER) Code

This section is based on FSTER codes. A FSTER code is a three-digit alphanumeric code. It specifies the SCAT codes and quantities of test equipment required to support electrical, IC, weapons, reactor instrumentation, workshops, and other "special" electronic and nonelectronic systems on either a particular hull or in a particular class of ships. Test equipment specified in this section is in addition to test equipment specified in section I.

Section III–Applications by SCAT Codes

This section is arranged in sequence by test equipment SCAT code, and shows the prime electronic equipment and FSTER codes associated with the SCAT codes.

Section IV–FSTER Codes by Ship Type/Fleet Activity Ashore

This section is organized by ship type and hull. It is arranged in order of ship type and hull number, and shows the FSTER codes that apply to a particular hull or fleet activity ashore.

Section V–Test Equipment Models by SCAT Codes

This section is arranged in numerical sequence by SCAT code, and shows the acceptable substitutes for test equipment models assigned to each SCAT code.

Section VI–SCAT Codes by Test Equipment Models

This section is arranged in alphanumeric sequence by test equipment model number, and shows the SCAT code grouping to which each piece of test equipment is assigned.

Appendix A–CAGE by Manufacturer Name

This appendix is arranged in sequence by the name of the commercial manufacturer of test equipment, and provides a cross-reference to the COMMERCIAL AND GOVERNMENT ENTITY CODE (CAGE).

Appendix B–Manufacturer Name by CAGE

This appendix is arranged in sequence by CAGE, and provides a cross-reference to manufacturer name.

Appendix C–Footnote Narratives by Footnote Number

This appendix is arranged in sequence by footnotes, and provides a cross-reference to footnotes listed in Sections I and II.

Appendix D–National Stock Numbers by SCAT Code

This appendix is arranged in sequence by SCAT codes, and provides the National Stock Number and cognizance symbol for selected test equipment models (usually the most preferred or recently obtained item) within each SCAT code. This data is provided to help fleet personnel identify test equipment stock numbers for GPETE end-item replacement (GEIR) or other supply actions.

APPENDIX E–SCAT Codes by Functional Description

This appendix is arranged in sequence by functional description, and provides a cross-reference to the SCAT code having that functional capability.

As you can see, the Test Equipment Index contains a large amount of information that can be invaluable to you in managing your test equipment.

SHIPS PORTABLE ELECTRICAL/ ELECTRONIC TEST EQUIPMENT REQUIREMENTS LIST (SPETERL)

The SPETERL is an authoritative document generated by NAVSEA and is specifically tailored for each ship. It lists the latest known requirements for Portable Electrical/Electronic Test Equipment (PEETE) based on the current SCLSIS information. The type of PEETE is determined by the corrective and preventive maintenance measurement specifications for installed prime equipments and systems, and is identified by SCAT code. The quantity of each type of test equipment allowed on board is based on many factors. These factors are as follows:

1. Location and number of prime equipments and systems installed on board
2. Portability of the test equipment
3. Number of maintenance personnel that use the test equipment
4. Frequency of use

5. The ability to share test equipment among different divisions

The SPETERL contains a wealth of information and is the best tool available for identifying your ship's test equipment requirements, if your ship's SCLSIS is up to date. The SPETERL has three sections and a cover letter, each providing necessary information on the ship's test equipment allowance. The cover letter provides the date that the SCLSIS information was processed, any planned or new requirements, and points of contact at NAVSEA.

The general information section explains the preparation of the SPETERL, how to request modifications, how to address Allowance Change Requests (ACRs), how to order or get test equipment to correct GEPETE deficiencies, and how to read the information in the second section.

The second section is the computer generated list of the ship's test equipment allowance.

The third section lists test equipment on board that does not support any installed prime equipments or systems; these items are not allowed. Like the SCLSIS Index that was discussed in a previous chapter, you must keep the SPETERL up to date with pen and ink changes. A new SPETREL will normally be issued 2 to 3 months before the beginning of an overhaul or SRA, when major changes are to be made to the ship. The revised SPETERL will take into account new equipment and systems to be installed and old equipment that will be removed due to SHIPALTs.

GENERAL-PURPOSE ELECTRONIC TEST EQUIPMENT (GPETE)

All GPETE should appear on the MEASURE inventory (explained later in this chapter), even if it is classified as NCR (no calibration required). It should also appear in the Ship Configuration Logistics Information System Index (SCLSIS) to ensure that it will appear in the ship's COSAL for parts support (both APLs and AELs). Most EMOs assign the maintenance responsibility for GPETE to the work center that has subcustody. This allows each work center to use its JSN (Job Sequence Number) should the equipment require off-ship repair. When such repairs are requested, you must remain aware of their status. For this reason, OPNAV 4790/2Ks will normally go via your office to the RSG.

You can manage calibration more easily if you have your test equipment petty officer prepare all documentation for submission to the RSG and notify subcustodians to deliver GPETE to the calibration lab assigned (or to the ship's test equipment work center for delivery to the cal lab). While procedures will vary from ship to ship, your representative must maintain very close liaison with the cal lab. In general, the RSG expects to receive your ship's calibration package, containing whatever needs to be calibrated, once each month. Use the MEASURE recall schedule to assemble the package and submit the package with a 4790/2L. But remember, all test equipment in this package must be in working order. If any piece of test equipment that is scheduled for calibration is inoperable or needs repairs, send it in with a 4790/2K. Otherwise it will be rejected. Be reasonable, though, as many minor repairs (broken knobs, broken meter faces, dead batteries, and so on) should be repaired aboard the ship.

One major problem you will have is accountability for GPETE. Be sure you get a responsible person's signature (preferably a division officer) for subcustody of GPETE. Conduct periodic inventories and forward the results to the commanding officer. When GPETE is missing, the division officer having subcustody should begin the survey request, although you should order the replacement GPETE. If you are the only one aboard ship allowed to order GPETE, keeping track of the status of the ship's allowance will be simpler. In short, you should "take charge" of GPETE rather than being faulted for not having a vital piece of GPETE available where it is needed for a ship's mission.

SPECIAL-PURPOSE ELECTRONIC TEST EQUIPMENT (SPETE)

SPETE is procured by the SYSCOM that has the acquisition responsibility for the system or equipment that requires the SPETE for maintenance.

SPETE includes items such as the TS-2232A/UCC-1C(V) test set and BITE (Built-In Test Equipment). This type of equipment aboard ship must be included in the ship's TAMS program. It should be reported in SCLSIS as a component of a prime equipment. In MEASURE, however, it should appear with GPETE to ensure that it is in the calibration program. Obviously, the maintenance responsibility belongs to the work center that maintains the prime equipment. You should, however, include SPETE on the monthly calibration delivery when it is due for calibration.

EQUIPMENT REVIEWS

There are three primary equipment reviews associated with electronic test equipment. They are the type commander review, the Test Equipment Calibration Readiness review (TECRR)–CINCLANTFLT, and the Fleet Test Equipment Allowance Program–CINCPACFLT.

Type Commander Reviews

The Combat System Readiness Review (CSRR)–SURFLANT, Combat System Readiness Test (CSRT)–SURFPAC, the Electronics Examining Board (EEB)–AIRLANT, and Electronics Systems Review–SUBLANT are programs that look at all of the electronics installations aboard their respective ships. Test equipment is inventoried and inspected to determine its operability and calibration status. Representatives from NAVSEACENLANT usually conduct this part of the review and report their findings to cognizant commands. The information they gather is used to update SCLSIS, to determine excess and obsolete equipment to be off-loaded, and to identify the SPETERL deficiencies. Comments on GPETE management often identify calibration and repair problems aboard the ship.

Test Equipment Calibration Readiness Review (TECRR)

The TECRR is a CINCLANTFLT program that deals with test equipment excesses and deficiencies of the Atlantic fleet. Under this program, ships that have excess GPETE turn it in to the Redistribution Center in Chesapeake, Va. In turn, ships that have a deficiency of GPETE check first with the Redistribution Center to fill that deficiency. The redistribution center has the equipment calibrated, repaired, and made ready for issue. Any equipment not economically repairable is turned in to supply for disposition. A word to the wise, however, don't go shopping for GPETE at salvage since you will just start the cycle again.

Fleet Test Equipment Allowance Program (FTEAP)

The FTEAP is a CINCPACFLT program similar to the TECRR program. The FTEAP has two redistribution centers, one in Pearl Harbor, Hawaii, and the other in San Diego, Calif. The FTEAP differs from the TECRR program in that FTEAP teams do not do on site reviews and do not have calibration capability. For further information about TECRR/FTEAP, including what is available, consult the applicable type commander instructions.

All excess test equipment must be turned in to the appropriate redistribution center. This is a simple process that only requires a DD Form 1149 for transfer of custody. Be sure to include all technical manuals and accessories.

FILLING GPETE DEFICIENCIES

Drawing test equipment to fill GPETE deficiencies is a little more complicated than turning in excess equipment because there are different actions you need to take, depending on the classification of equipment that you need. There are two classifications of test equipment for filling GPETE deficiencies:

- GPETE Initial Outfitting (GINO). This is high value test equipment that is procured by NAVSEA for new systems/equipments being installed in the fleet.
- GPETE End Item Replacement (GEIR). This is replacement equipment for test equipment that has been surveyed due to loss or damage or that is beyond economical repair (BER).

Deficiencies of GINO require no requesting action on your part. These items are automatically "pushed" to the ship by NAVSEA. Any requisitions that you submit to the supply system for these items will be rejected or canceled. The only action you must take is to track shipping information for the new test equipment through the point of contact listed on the cover letter of the SPETERL. Contact TECRR or FTEAP, as appropriate, if the lead time is excessive. They can then ship the item, provided the GINO is redirected to them. GINO is provided at no cost to the ship.

GEIR is a different matter, as it must be requisitioned and paid for by the ship and can be quite costly. The first point of contact is TECRR or FTEAP. If the item is available at the redistribution center, it will be provided at no cost. If the item is not available at the redistribution center, refer to the guidelines set forth in *Afloat Supply Procedures*, NAVSUP P-485, and in the general information section of your ship's SPETERL.

GPETE Loan Pools

The purpose of GPETE loan pools is to provide a broad range of ready-for-issue GPETE for short term use. Equipment depth in the various pools is adjusted, based upon demand, to provide continuous availability for fleet units. GPETE from the pools is checked out for specific purposes (i.e., PMS for the AN/SPS-49 radar or corrective maintenance for the AN/WSC-3) when the GPETE is, for some reason, unavailable aboard ship. The GPETE pools are not intended to supplement your ship's allowance, and if you borrow pool equipment, you must return it to the pool as soon as possible to assure its availability to other users. In no instance may you keep pool equipment for more than 10 days without specific TYCOM approval. Loan pools are located at SIMAs; however you may be able to borrow the test equipment from other ships on the waterfront.

TEST EQUIPMENT STOWAGE

One of the biggest problems concerning shipboard test equipment is stowage. Reports prepared by the Board of Inspection and Survey (INSURV) indicate that inadequate stowage facilities for portable test equipment continues to be a problem on board ships. Factors contributing to the degradation of stowage facilities are the unofficial rearrangement of stowage for portable test equipment by fleet personnel and inadequate provision of proper stowage following the installation of ship alterations.

To aid in correcting this deficiency, NAVSEA has developed the *Stowage Guide for Portable Electrical/Electronic Test Equipment (PEETE)*, NAVSEA ST000-AB-010/PEETE. This guide contains information about the availability and the use of stowage equipment and aids; such as shelving, shock absorbent materials, tiedowns, brackets, cabinets, workbenches, and other material required for the construction of shipboard stowage facilities. The guide is easy to use and has three chapters that provide information to help you resolve test equipment stowage problems.

To use the test equipment stowage facilities listed in the stowage guide effectively, there are two things that you must do:

1. Ensure that stowage facilities are not used for purposes other than stowage of test equipment. This includes the removal of personal items from stowage facilities.
2. Expedite the removal of test equipment that is identified as excess.

NAVY CALIBRATION PROGRAM

All TMDE must be periodically calibrated to ensure its accuracy. Calibration is defined as:

> The comparison of a measurement system or device of unverified accuracy to a measurement system or device of known and greater accuracy to detect and correct any variation from required performance specifications of the unverified measurement system or device.

The Navy Calibration Program includes facilities ashore and afloat whose prime function is calibration of test and measuring equipment. Shore laboratories are under the management control of the systems commands. The systems commands have also established fleet calibration laboratories afloat and at all IMAs.

Calibration is performed at the lowest echelon possible, depending on the availability of standards and qualified personnel. These echelons are depicted in figure 9-20 and described below.

The first echelon of service for fleet-held test equipment in the Navy Calibration Program is the organizational activity (ship) through the Field Calibration Activity (FCA). The FCA will calibrate test equipment that is within the capability of its calibration packages. Instructions for establishing and operating an FCA are given in *Shipboard Gage Calibration Program; Guidance and Requirements for*, NAVSEAINST 4734.1.

The second echelon is the applicable Fleet Electronic Calibration Laboratory (FECL) and Mechanical Instrument Repair and Calibration (MIRCS) located at each IMA. These facilities can calibrate a large variety of equipment and provide routine services to the Force.

The third echelon is the Navy Calibration Laboratory/Navy Standards Laboratory (NCL/NSL), located at various activities ashore. Equipment that is beyond the calibration capability of the ship and FECL/MIRCS is sent to these facilities by the Readiness Support Group (RSG) and the METCAL overflow coordinator.

FIELD CALIBRATION ACTIVITY (FCA)

The Field Calibration Activity (FCA) was introduced into the fleet at the organizational (ship) level to provide calibration support for high volume workload items within the user's facility. Field calibration is the term given to the calibration process performed by authorized Navy activities other than Navy calibration or standards laboratories. These calibrations are considered valid when done by personnel trained to use

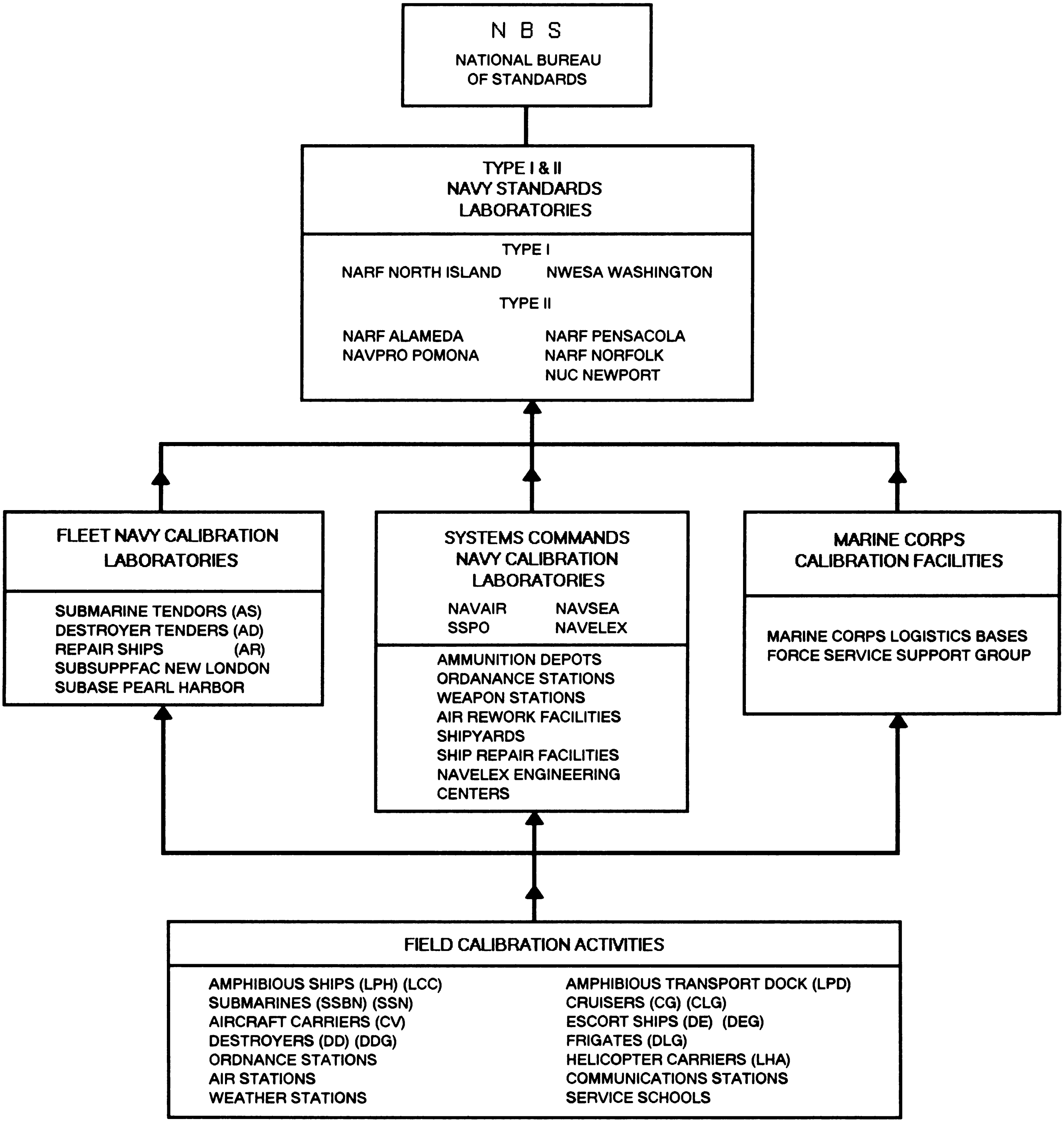

Figure 9-20.–Hierarchy of Navy/Marine Corps Calibration/Standards Facilities.

specific standards and procedures. The measurement standards must be calibrated periodically by a Navy calibration or standards laboratory. Four basic equipment packages have been developed for field calibration use. They are designated Phase A, B, C, and D. Phase A is intended to support electrical and electronic meters of various types. Phase B supports pressure gauges and pressure devices. Phase C supports electronic instruments such as signal generators, oscilloscopes, oscillators, and frequency counters and meters. Phase D supports torque wrenches and tools. Additional packages have been developed to expand the capability of each phase and to support specific or unique equipment. For example, the phase F series have been developed to support various aircraft systems.

The FCA must meet certain criteria to be certified, and then must be recertified as directed by NAVSEA. These criteria include requirements such as properly trained calibration technicians and environmental and safety conditions.

The Navy has published three different Calibration Facility Requirements documents: for Navy Field Calibration Activities–NAVAIR 17-35FR-01, NAVELEX 0967-LP-1010, and NAVSEA OD 45843; for Shorebased Navy Calibration Laboratories– NAVAIR 17-35FR-02, NAVELEX 0967-LP-465-8010, and NAVSEA OD 45842; and for Shipboard Navy Calibration Activities–NAVAIR 17-35FR-03, NAVELEX 0967-LP-465-8020, and NAVSEA OD 45844. These publications define the facility and environmental requirements for the various types of calibration laboratories.

NAVY CALIBRATION LABORATORY

The prime function of a calibration laboratory is to calibrate test and measurement equipment obtained from field activities, both ashore and afloat. In most cases, incidental repairs and adjustments are made to obtain the required accuracies. Some calibration laboratories are also required to provide calibration teams for performing on-site calibration for certain selected, non-portable, and critically sensitive test equipment.

Calibration laboratories are located at air stations and air rework facilities under NAVAIR, at ordnance and weapon stations under NAVSEA, at shipyards and ship repair facilities under NAVSEA and NAVELEX (Naval Electronic Systems Command) and at NAVELEX engineering centers.

Fleet electronic calibration laboratories are located aboard fleet submarine tenders, destroyer tenders, repair ships, and at shore intermediate maintenance activities (SIMAs). The various calibration laboratories do not have the same geographic area or coverage or weapon system support mission; therefore, their equipage may not be the same. For example, calibration laboratories located on board destroyer tenders (AD) and repair ships (AR) might be required to support LAMPS weapon system test equipment; whereas certain submarine tenders (AS) handle fleet ballistic missile (FBM) support requirements. The equipage will vary accordingly. Similarly, calibration laboratory equipment at naval air stations will generally differ from that found at naval shipyards or ship repair facilities.

Further details about specific responsibilities and missions of Navy calibration laboratories are given in instructions issued by the various systems commands. Authorized Navy calibration laboratories are listed in the *Navy Calibration Activities List*, NAVAIR 17-35NCA-1. You may wish to review the instructions that pertain to the laboratories servicing your equipment to find out what you may expect of them.

FIELD CALIBRATION TECHNICAL REPRESENTATIVE (FCTR)

Field calibration technical representatives direct the NAVELEX Calibration Program within their assigned areas of responsibility. You will find consulting with the FCTR helpful in answering many of the calibration questions that may arise. The FCTRs have responsibilities up and down the chain of command, but some of them work directly with the fleet. Ships that have a field calibration activity (FCA) aboard should stay in touch with the FCTR for advice on operating the FTC and for comments on any local calibration procedure. The addresses of Naval Space and Warfare Systems Command (SPAWARS) FCTRs are listed below.

NAVELEXCEN Charleston–Commanding Officer, Naval Electronics System Engineering Center, Charleston; ATTENTION: Field Calibration Technical Representative, 4600 Goer Road, North Charleston, SC 29406.

NAVELEXCEN Portsmouth–Commanding Officer, Naval Electronic Systems Engineering Center, Portsmouth; ATTENTION: Field Calibration Technical Representative, P.O. Box 55, Portsmouth, VA 23705.

NAVELEXCEN San Diego–Commanding Officer, Naval Electronic Systems Engineering Center, San Diego; ATTENTION: Field Calibration Technical Representative, P.O. Box 80337, San Diego, CA 92138.

NAVELEXCEN Vallejo–Commanding Officer, Naval Electronics Systems Engineering Center, Vallejo, Mare Island Naval Shipyard, Vallejo, CA 94592.

NAVSEEACT Pacific–Commanding Officer, Naval Shore Electronics Engineering Activity, Pacific; ATTENTION: Field Calibration Technical Representative, Box 130, FPO San Francisco, CA 96610.

CALIBRATION INTERVALS

Test and monitoring equipment and calibration standards should be calibrated as often as necessary to maintain the prescribed accuracy with an acceptable level of confidence. The Navy's Metrology Engineering Center is responsible for designating and revising calibration intervals for Navy TAMS and standards, and for publishing the intervals in the Metrology Requirements List (NAVAIR 17-35MTL, NAVELEX 0969-LP-133-2010, NAVSEA OD 45845), commonly referred to as METRL. NAVMATINST 4355.67B specifies that calibrations must be performed at the intervals listed in the METRL.

The METRL lists all TAMS known to exist in the Navy and includes equipment that has been identified as "calibration not required," as well as equipment that can be used to take quantitative measurements. Note, however, that you should not base a requirement for calibration on the fact that an interval is shown in METRL, but rather on the fact that the instrument is being used to take quantitative measurements. Equipment that is normally calibrated but used in a non-quantitative situations does not require calibration. Section 1 of the METRL provides criteria for designating equipment as NCR (No Calibration Required).

The METRL is updated every 6 months with respect to calibration intervals. MEC also identifies significant interval changes monthly in the Metrology Bulletin.

CALIBRATION PROCEDURES

Written uniform methods or procedures for calibrating TAMS and standards help to prevent measurement inaccuracies due to differences in calibration techniques, environmental conditions, choice of standards, and so on. NAVMATINST 4355.67B states that, "calibrations shall be performed in accordance with the procedures listed in the current issue of METRL." It further assigns to MEC the responsibility to "Develop and provide for uniform metrology and calibration procedures and documentation for use at all Navy calibration activities."

For equipment not listed in the METRL, calibration activities document the calibration requirement and prepare Local Calibration Procedures (LCPs).

If you have a calibration facility under your supervision, be sure that all appropriate calibration procedures are readily available to the calibration technician and used in the performance of each calibration. Do not allow a technician to perform calibrations from memory. Even the technician who calibrates one type of instrument daily should have the procedure at hand and, as a minimum, use the procedure checklist to remind him of each step.

METROLOGY AUTOMATED SYSTEM FOR UNIFORM RECALL AND REPORTING (MEASURE)

MEASURE is a data processing system designed to provide participating activities with a standardized system for the recall and scheduling of Test, Measurement, and Diagnostic Equipment (TMDE) into calibration facilities. Additionally, MEASURE provides for the documenting and reporting of all calibration actions. MEASURE also provides for the collection, correction, analysis and collation of data as well as the distribution of data and products and formats to requesting activities. In short, MEASURE's goal is to provide a single, uniform management information system throughout the Navy. At the ship level, MEASURE is the approved method of managing test equipment. Since it is an information system, the "garbage in- garbage out" rule applies. Therefore, you, as EMO, **must** closely monitor all the MEASURE documentation for correctness.

Keep on the lookout for available training on MEASURE documentation to ensure that supervisory personnel using TMDE can receive periodic training. Assistance in processing MEASURE documents and general TMDE management is available at the local Readiness Support Group (RSG), so don't hesitate to use this assistance. MEASURE, itself, will not keep all of the TMDE calibrated and repaired, but it certainly helps. A closely supervised program should be one of your high priority items.

The primary source for system operation is the *Metrology Automated System for Uniform Recall and Reporting (MEASURE) Users Manual*, OPNAV 43P6A.

As the EMO, you must ensure that the test equipment for which your ship has been assigned primary responsibility, is submitted on schedule to the proper calibration activity for required calibration.

The MEASURE Program is designed, among other things, to help you fulfill this responsibility. It does this by providing for the automatic scheduling and recall of all test equipment that requires calibration. The MEASURE Operational Control Center (MOCC), based upon the information contained on your ship's inventory, will provide the necessary preprinted MEASURE METER Cards (fig. 9-21), computer printouts of your inventory (format 310), and equipment recall schedules (format 800). You will find Format 350, sequenced by 3-M work centers, very useful in helping you manage your ship's equipment. You can pass it to each work center supervisor as an accurate monthly inventory annotated with the calibration status of each piece of test equipment. You will receive updated versions of Formats 310, 350, and 800 each month.

METER Card

The Metrology Equipment Recall and Report (METER) Card (fig. 9-21) is your primary means of providing input to MEASURE, on an "as required" basis. Each piece of test equipment has its own METER card, preprinted by the MOCC with information taken from your ship's initial Inventory Report Forms, updated to reflect data from all prior METER cards. If any additional information is needed on a METER card, either you or the calibration activity, as appropriate, must provide it. You will use the METER card to report additions and deletions to your ship's inventory; to report changes in subcustodianship and equipment status; and to correct errors in the inventory data file. You will also use the METER card to report changes in the scheduled laboratory–the calibration activity to which you submit equipment for calibration. For METER card procedures, see *MEASURE USER'S MANUAL*, OPNAV 43P6. You can get blank METER Cards from your METCALREP.

Recall Schedules

The purpose of the MEASURE recall schedules is to list items of equipment that are due at a laboratory for calibration. It serves as a reminder and a planning document for you, the subcustodian, and the laboratory performing the calibration. MEASURE recall schedules for equipments, other than those that are either inactive or classified as No Calibration Required (NCR), are generated by the MEASURE Operation Control Center and sent to your ship, with copies to the proper calibration activities. Separate schedules are printed, showing the equipment that is due for calibration during the scheduled period by Intermediate Level/Field Calibration Activities, calibration laboratories, and calibration teams "on-site." Each Recall Schedule is a set of four identical copies. One set is provided to the supporting calibration activity as an aid to work load planning, and a second set is sent to your ship.

Your ship will receive two sets of MEASURE documents. One set, marked E, will be for you. The other set, marked S, will be for the Chief Engineer. The E set will list NAVELEX equipment, while the S set will list NAVSEA equipment. This arrangement allows the two commands to pay their share of the calibration costs. Both you and the Chief Engineer maintain both SPAWARS and NAVSEA prime equipment and TAMS. As you can see, assigning responsibility for TAMS aboard ship leaves room for controversy. We recommend that GPETE (p/o TAMS) be assigned to you for management. GPETE should then appear on the E documents regardless of whether NAVELEX or NAVSEA controls it.

The Format 310 is, by far, the best management tool of the MEASURE Program for you to use in managing your command's test equipment inventory. To make full use of this tool, you should take the following actions:

1. Thoroughly review the Format 310 monthly.
2. Annotate the Format 310 as status changes occur during the month for equipments that have been calibrated, deleted, sent in for repair, added to inventory, delayed, surveyed, inactivated, and so on, during the month.
3. Carry these annotations forward to the next monthly Format 310, until the change is reflected on a new Format 310.
4. If changes in equipment status are not reflected on the new monthly Format 310 within 60 days of the transaction date, resubmit necessary MEASURE METER cards (hand scribed) to correct the discrepancy or contact your RSG MEASURE coordinator for help.

At the time of this printing, replacement systems for MEASURE were being investigated. Those being considered are onboard PC-based systems that will be managed by the local RSG to decrease the amount of paperwork required and provide more timely information.

GENERAL TEST EQUIPMENT RESOURCES/INFORMATION

As the EMO, you should be thoroughly familiar with the following publications to assure optimum test equipment readiness:

- *Measure Users Manual*, OPNAV 43P6
- *Electronic Test Equipment Calibration Program Indoctrination Handbook*, NAVMAT P9491

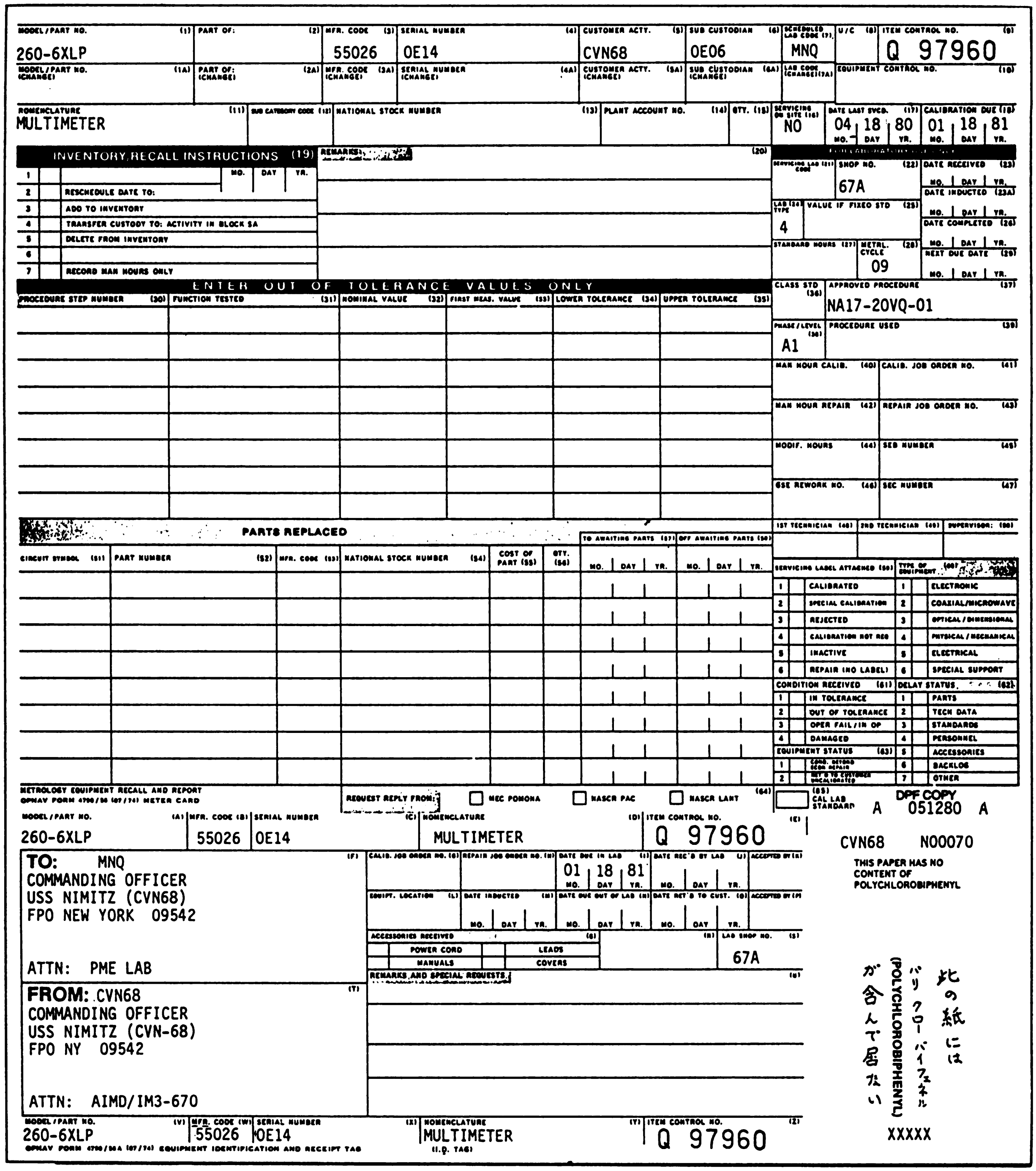

Figure 9-21.–MEASURE METER Card.

- *Electrical/Electronic Test Equipment Index For Support Requirements of Shipboard Electronic, Electrical, IC, Weapons and Reactor Systems,* NAVSEA ST000-AA-IDX-010/PEETE
- *Standard General-Purpose Electronic Test Equipment,* MIL-STD-1364 Series (Navy)
- *Metrology Requirements List,* 0969-LP-133-2010
- *Metrology Requirements List for Field Calibration Activities (FCA),* 0969-LP-133- 2020
- *Test Equipment Stowage Guide,* NAVSEA ST000-AB-GYD-001/PEETE

SUMMARY

We cannot say enough about test equipment. It is the heart and soul of the technician's work. You, as EMO, must provide your technicians with the latest and best test equipment. Remember, a piece of test equipment out of calibration renders any adjustment out of specifications. The equipment affected will never operate as designed. It also **GUNDECKS** your PMS and will most assuredly fail you during a PMS inspection. Keep abreast of the latest in test equipment; it will make your job much easier to do. Use GPETE loan pools and TECRR assets as much as possible. Turn in your excess GPETE so that others, as well as you, can benefit from it.

REFERENCES

Guide for Establishment of a Local Calibration Program, NAVAIR 35HBK-3-1, NAVMETCAL, Metrology Engineering Center, Naval Weapons Station, Seal Beach, Pomona Annex, Pomona, Calif., 1982.

Maintenance Manual, COMNAVSURFLANT 9000.1C, Naval Surface Forces Atlantic, 1989.

Metrology Requirements List, NAVSEA OD45845, Naval Sea Systems Command, Washington, D.C., 1991.

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OP 43P6 MEASURE, Office of the Chief of Naval Operations, Washington D.C., 1984.

Shipboard Gage Calibration Program; Guidance and Requirements for, NAVSEAINST 4734.1, Naval Sea Systems Command, Washington, D.C., 1982.

Stowage Guide For Portable Electrical/Electronic Test Equipment (PEETE), NAVSEA ST000-AB-GYD-010/PEETE, Naval Sea Systems Commands, Washington, D.C., 1987.

Training Manual US Navy Metrology and Calibration Program Indoctrination, NAVAIR 17-35QAL-13, NAVMETCAL, Metrology Engineering Center, Naval Weapons Station, Seal Beach, Pomona Annex, Pomona, Calif., 1982.

CHAPTER 10

COMMUNICATIONS THEORY AND EQUIPMENT

OVERVIEW

The EMO must have a good understanding in the basics of communications to effectively maintain his radios.

OUTLINE

Equipment categories

Frequency spectrum

Propagation

Atmospherics

Frequency selection

Antenna characteristics

Couplers

Modulation

Receivers

Ancillary comm equipment

Frequency ranges

Portable and pack radios

Multiplexing

SAS

Satellite fundamentals

QMCS

EMI

INTRODUCTION

Regardless of the size of a unit–branch, division, squadron, or fleet–members of the unit have to be able to communicate to complete their missions. The primary means of communicating within and between ships and between ships and stations is known as *telecommunications*. Telecommunications refers to communications over a distance and includes any transmission, emission, or reception of signs, signals, writings, images, and sounds. Intelligence produced by visual or oral means, and by wire, radio, or other electromagnetic systems is also included. Electrical, visual, and sound telecommunications are all used in the Navy. In this chapter we will only discuss electrical types of telecommunications.

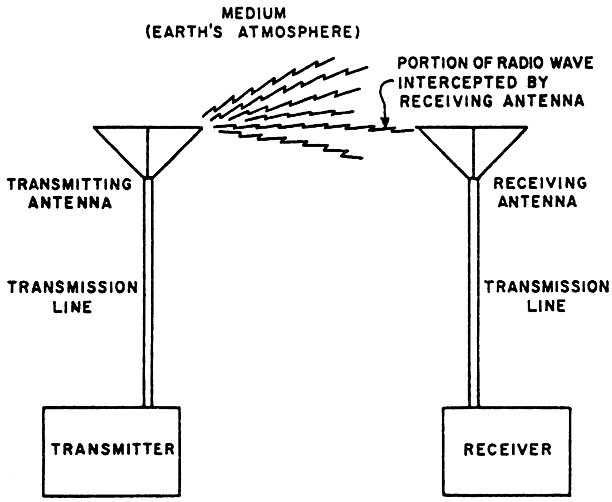


Figure 10-1.–Basic radio communication system.

EQUIPMENT CATEGORIES

Radio equipment can be divided into three broad categories: transmitting equipment, receiving equipment, and terminal equipment. Transmitting equipment generates, amplifies, and modulates a transmitted signal. Receiving equipment receives a radio wave, then amplifies and demodulates it to extract the original intelligence. Terminal equipment is used primarily to convert the audio signals of encoded or data transmissions into the original intelligence.

A basic radio communication system consists of a transmitter and a receiver connected by electromagnetic waves (fig. 10-1). The transmitting equipment creates a radio-frequency (rf) carrier and modulates it with audio intelligence to produce an rf signal. This rf signal is amplified and fed to the transmitting antenna, which converts it to electromagnetic energy for propagation.

The receiving antenna converts the portion of the transmitted electromagnetic energy it receives into a flow of alternating radio-frequency currents (rf signal). The receiver then converts this rf signal back into intelligence.

THE FREQUENCY SPECTRUM

Figure 10-2 shows the overall electromagnetic frequency spectrum as defined by the International Telegraph Union.

Rapid growth in the quantity and complexity of communications equipment and increased worldwide international requirements for radio frequencies have placed large demands upon the radio-frequency spectrum. These demands include military and civilian applications, such as communications, location and ranging, identification, standard time, and frequency transmission, and industrial, medical, and other scientific uses.

The military has modified the frequency spectrum for its use, as shown in Table 10-1.

NAVY FREQUENCY BAND USE

The allocation, assignment, and protection of all frequencies used by Navy components are the responsibility of Commander Naval Telecommunications Command (COMNAVTELCOM). Propagation of radio waves varies widely at different frequencies. Frequencies and equipment are chosen to meet the communications application desired. The following paragraphs discuss the radio-frequency spectrum.

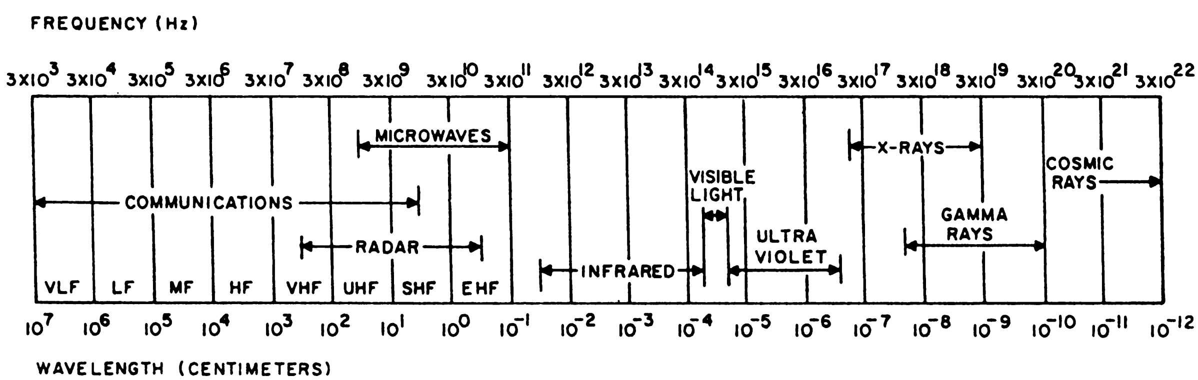


Figure 10-2.–Frequency spectrum.

Table 10-1.–Radio-Frequency Spectrum

FREQUENCY	DESCRIPTION
30 GHZ – 300 GHZ	extremely high frequency
3 GHZ – 30 GHZ	superhigh frequency
300 MHZ – 3 GHZ	ultrahigh frequency
30 MHZ – 300 MHZ	very high frequency
3 MHZ – 30 MHZ	high frequency
300 KHZ – 3 MHZ	medium frequency
30 KHZ – 300 KHZ	low frequency
3 KHZ – 30 KHZ	very low frequency
300 HZ – 3 KHZ	voice frequency
up to 300 HZ	extremely low frequency

EXTREMELY-LOW-FREQUENCY COMMUNICATIONS

The extremely-low-frequency (elf) communications system is a one-way system, used to send short "phonetic letter spelled out" (PLSO) messages from operating authorities in the continental United States (CONUS) to submarines operating at normal mission speeds and depths. Elf has the ability to penetrate ocean depths to several hundred feet with little signal loss. This ability allows submarines to operate well below the immediate surface and enhances submarine survivability by making detection more difficult.

The self-system transmits only from shore to ship because the large size of elf transmitters and antennas makes elf transmission from submarines impractical.

VERY-LOW-FREQUENCY COMMUNICATIONS

As new sea frontiers open, our Navy must maintain control of its operating forces in an ever expanding coverage area. This additional area requires changes in communications capacity, range, and reliability. Additional needs have been particularly great in the North Atlantic and the newly opened Arctic Ocean. High-frequency circuits are too unreliable in these areas because of local atmospheric disturbances.

Very-low-frequency (vlf) transmissions provide a highly reliable path for communications in these northern latitudes, as well as over and under all oceans and seas of the world. At present, practically all Navy vlf transmitters are used for fleet communications or navigation. The vlf transmission is normally considered a broadcast; that is, a one-way transmission with no reply required.

Vlf is currently used for communications to large numbers of satellites and as a backup to shortwave communications blacked out by nuclear activity. Our Navy depends on vlf for crucial communications during hostilities.

Secondary applications of vlf include worldwide transmission of standard frequency and time signals. Standard frequency and time signals with high accuracy over long distances have become increasingly important in many fields of science. It is essential for tracking space vehicles, worldwide clock synchronization and oscillator calibration, international comparisons of atomic frequency standards, radio navigational aids, astronomy, national standardizing laboratories, and communications systems.

A vlf broadcast of standard time and frequency signals has more than adequate precision for the operation of synchronous cryptographic devices, decoding devices, and single-sideband transmissions.

LOW-FREQUENCY COMMUNICATIONS

The low-frequency (lf) band occupies only a very small part of the radio-frequency spectrum. This small band of frequencies has been used for communications since the advent of radio.

Low-frequency transmitting installations are characterized by their large physical size and by their high construction and maintenance costs. Over the years, propagation factors peculiar to the low-frequency band have resulted in their continued use for radio communications. Low-frequency waves are not seriously affected during periods of ionospheric disturbance when communications at the high frequencies are disrupted. Because of this, the Navy has a particular interest in the application of low frequencies at northern latitudes. However, the use of low frequencies at latitudes near the equator is sometime limited by atmospheric noise.

The Navy's requirements to provide the best possible communications to the fleet require operation on all frequency bands. Constant research is being done to improve existing capabilities and to use new systems and developments as they become operationally reliable.

In the past, the fleet broadcast system provided ships at sea with low-frequency communications via cw telegraph transmissions. As technology advanced, the system was converted to single-channel radio teletypewriter (rtty) transmission. Today, lf communications is used to provide eight channels of frequency-division multiplex rtty traffic on each transmission of the fleet multichannel broadcast system.

MEDIUM-FREQUENCY COMMUNICATIONS

The medium-frequency (mf) band of the radio-frequency spectrum includes the international distress frequencies (500 kilohertz and approximately 484 kilohertz). Some ships have mf equipment and can, if they desire, monitor the distress frequencies. When they do so, they usually keep the transmitter in the stand-by position. Ashore, the mf receiver and transmitter equipment is usually affiliated with search and rescue organizations, which are generally located near the coast.

Only the upper and lower ends of the mf band have naval use because the commercial broadcast band (AM) extends from 535 to 1,605 kilohertz. Frequencies in the lower portion of the mf band (300 to 500 kilohertz) are used primarily for ground-wave transmission for moderately long distances over land. Transmission in the upper mf band is generally limited to short-haul communications (400 miles or less).

HIGH-FREQUENCY COMMUNICATIONS

The Navy began using high-frequencies for radio communications around World War I when only a few communications systems were operated on frequencies near 3 megahertz. When we look at the extensive present-day use of high frequencies for long-distance communications, the fact that those Navy systems were intended for very short-range communications of a few miles seems curious. The general belief at the time was that frequencies above 1.5 megahertz were useless for communications purposes. The military hf band has been expanded to include frequencies from 2 megahertz through 32 megahertz.

One of the prominent features of high-frequency, long-distance communications is changes in signal strength due to changes in the propagation medium. High-frequency radio waves are transmitted over long distances by being "bounced" off of the ionosphere, like light waves are bounced off of mirrors. The ground distance a radio wave travels and the strength it has when it gets to the receiver depend on how dense the ionosphere is and how far it is from the Earth. High and dense ionosphere layers tend to produce longer and stronger signals than lower and less dense ionosphere layers. The height and density of the ionosphere are determined primarily by ultraviolet radiation from the Sun. Both the height and density vary significantly with the time of day, season of the year, and the 11-year cycle of sunspot activity. As the height and density of the ionosphere change, the strength of the radio signal will change, sometimes fading or disappearing completely. Therefore, you must generally use more than a single frequency, sometimes up to four or five, to maintain communications on a circuit.

In spite of the difficulties we encounter with hf propagation, the economic and technical advantages of using high frequencies have led to a rapid expansion in the use of the hf band. Because the number of users has increased, the hf spectrum is approaching saturation.

The hf band is shared by many domestic and foreign users, and only portions scattered throughout the band are allocated to the military services. As for other agencies, Navy requirements have grown; the capacity of the Navy's assigned portion of the hf spectrum has become severely taxed. The use of single-sideband equipment and the application of independent sideband techniques have increased the capacity, but not enough to catch up with the demand. Some predict that satellite communications will eventually relieve congestion in the hf band and that, for some types of service, it will replace hf for long-distance communications. We will present more information to you concerning satellite communications later in this chapter. Even with new technology, the hf spectrum most likely will continue to be in high demand for some time.

Naval communications within the hf band can be grouped into four general types of systems: point-to-point, ship-to-shore, ground-to-air, and fleet broadcast. All but the fleet broadcast are normally operated with two-way communications. Some of these systems involve ships and aircraft that present special problems because of their physical characteristics and mobility. Generally, the less than optimum hf performance of this shipboard equipment is at least partially offset by powerful transmitters and sensitive receiving systems at the shore terminals.

Point-to-Point

Point-to-point systems are established to communicate over long-distance trunks or links between fixed terminals. A trunk is normally a message circuit between two points that are both switching centers or individual message distribution points. A link is a transmitter-receiver system connecting two locations. Generally, enough real estate is acquired at the terminals to permit the use of large, high-grain antennas aimed at opposite terminals of each link. This increases the effective power and sensitivity of the receiving system; it also reduces susceptibility of a circuit to interference. With the path length and direction fixed, other propagation factors are simplified and highly reliable communications can be achieved.

Ship-to-Shore

This application of the hf band is more difficult than point-to-point since the ship is moving and constantly changing its position. In ship-to-shore, the path length and direction are variable. Aboard ship, limited space and other restrictions prohibit installation of large, efficient hf antennas. Because of the mobility of ships, shipboard antennas are designed to be as nearly omnidirectional as possible.

The problems are not as severe at the shore terminal where there is sufficient space for efficient omnidirectional antennas or arrays designed for coverage of large areas of the earth. At shore stations, rotatable high-gain antennas or fixed point-to-point antennas are used.

Several frequencies are usually assigned for each circuit. This allows the selection of a frequency that best matches the propagation path conditions between the shore terminal and the ship.

Ground-to-Air

The use of hf radio for ground-to-air communications is similar to ship-to-shore use. The only difference is that an aircraft moves more rapidly than a ship. All major circuit improvements must be made at the ground station. For example, higher powered transmitters, lower noise receivers, and more efficient antennas must be used on the ground.

Fleet Broadcasts

As the name implies, this service involves broadcast area coverage from shorebased transmitters to ships at sea. Messages to be sent to ships are delivered by various means to the proper broadcast station. They are then broadcast for shipboard reception. To overcome propagation problems, naval communicators send their messages on several frequencies at once. This is known as frequency-diversity transmission. This type of transmission allows the ship to choose the best frequency for reception. Space-diversity, with physically separated receiving antennas, also helps to overcome this problem.

VERY-HIGH-FREQUENCY AND ABOVE COMMUNICATIONS

Frequencies above 30 megahertz are not normally refracted by the atmosphere and groundwave range is minimal. This normally limits our use of this frequency spectrum to line-of-sight. The exception is increased range through the use of tropospheric scatter techniques. Some communications using vhf and above frequencies use a technique called forward propagation by tropospheric scatter (fpts).

Certain atmospheric and ionospheric conditions can also cause the normal line-of-sight range to be extended. Frequencies at the lower end of this band can overcome the shielding effects of hills and structures to some degree; but as the frequency is increased, the problem becomes more pronounced. Reception is notably free from atmospheric and man-made static. (The very high-frequency (vhf) and ultrahigh-frequency (uhf) bands are known as line-of-sight transmission bands.) Because this is line-of-sight communications, the transmitting antenna is in a direct line with the receiving antenna and not over the horizon. The line-of-sight characteristic makes the vhf band ideal for amphibious operations (beach landing from sea craft) and the uhf band well suited for tactical voice transmissions (maneuvering of ships traveling together).

A large portion of the lower end of the vhf band is assigned to the commercial television industry and is used by the Navy in amphibious operations and in special instances. The upper portion of the vhf band (225 MHz to 300 MHz) and the lower portion of the uhf band (300 MHz to 400 MHz) are used extensively by the Navy for short range and aircraft communications. The super high-frequency (shf) band is used for radar and satellite communications, whereas the extremely

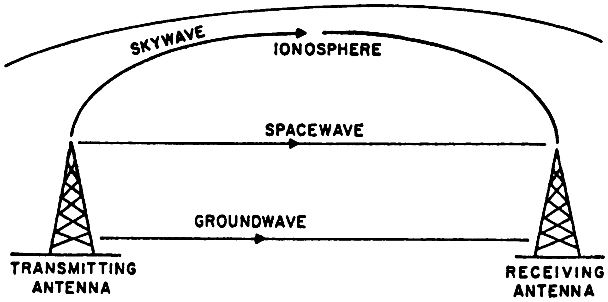


Figure 10-3.–Divisions of the transmitted electromagnetic wave.

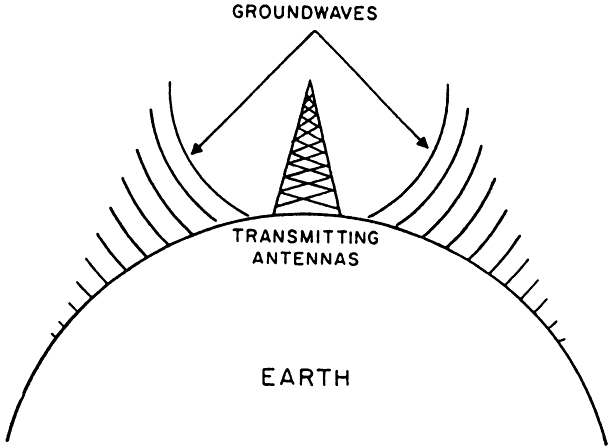


Figure 10-4.–Groundwave component of the transmitted electromagnetic wave.

high-frequency (ehf) band is used only for experimental purposes.

PROPAGATION

When rf currents flow through a transmitting antenna, they produce electromagnetic waves. These waves (radio waves) radiate from the antenna in a manner similar to the way waves radiate on the surface of a pond when a rock is thrown into the water. However, electromagnetic waves may travel either parallel to the surface of the earth (horizontally polarized) or perpendicular to the surface of the earth (vertically polarized). Transmitted waves travel toward receiving antennas by a means known as *propagation.*

Figure 10-3 illustrates transmitting and receiving antennas and their associated electromagnetic waves. The electromagnetic waves are divided into three components according to propagation characteristics: groundwaves, skywaves, and spacewaves.

GROUNDWAVE PROPAGATION

The groundwave (fig. 10-4) is the portion of the radiated wave that moves along the surface of the earth. The field strength of the groundwave diminishes with distance much more rapidly than the waves that move through free space. There are many complex factors contributing to this, several of which are briefly described below.

Absorption by the earth increases with an increase in frequency, so long-distance communications by groundwaves are limited to low frequencies at very high power. Daytime reception of the Standard Broadcast Band (AM) is an example. The type of soil near the antenna site is also a factor in attenuation of the groundwave. Clay or loam will attenuate the signal less than sand or rock. However, salt water will propagate the signal better than either type of soil. The horizontally polarized wave is short-circuited by the earth and is attenuated much more rapidly than the vertically polarized wave. Thus, to gain maximum advantage, the groundwave must be transmitted and received using vertically polarized antennas. Despite these limiting factors, the groundwave remains the most reliable means of radio communications because most of the restricting factors do not vary with time of day or weather conditions.

SKYWAVE PROPAGATION

The skywave (fig. 10-5) is the portion of the electromagnetic signal radiated upward that may or may not be refracted back to earth by the ionosphere (the upper atmosphere beginning 40 to 50 miles above the earth). Skywave propagation is not as reliable as groundwave propagation; however, much greater distances may be covered by this means because the radiated electromagnetic field directed toward the ionosphere is refracted (bent and reflected) back by the denser ionosphere at distances of hundreds or even thousands of miles.

The angle at which the energy is refracted depends on many variables, the major ones being the frequency and angle of the radiation, and the height and density of the ionospheric layers. There is an angle at which the electromagnetic waves that enter the ionosphere will be refracted, but not enough to return to earth. This angle is called the *critical angle.* Any transmitted energy entering the ionosphere beyond this angle continues into free space.

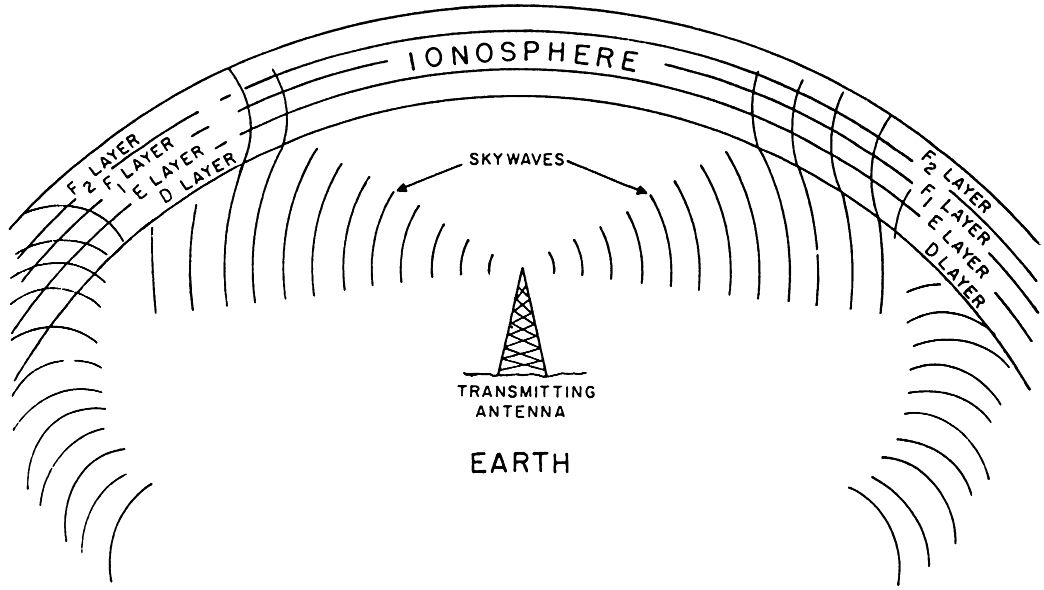


Figure 10-5.–Refraction of the skywave component during daylight hours.

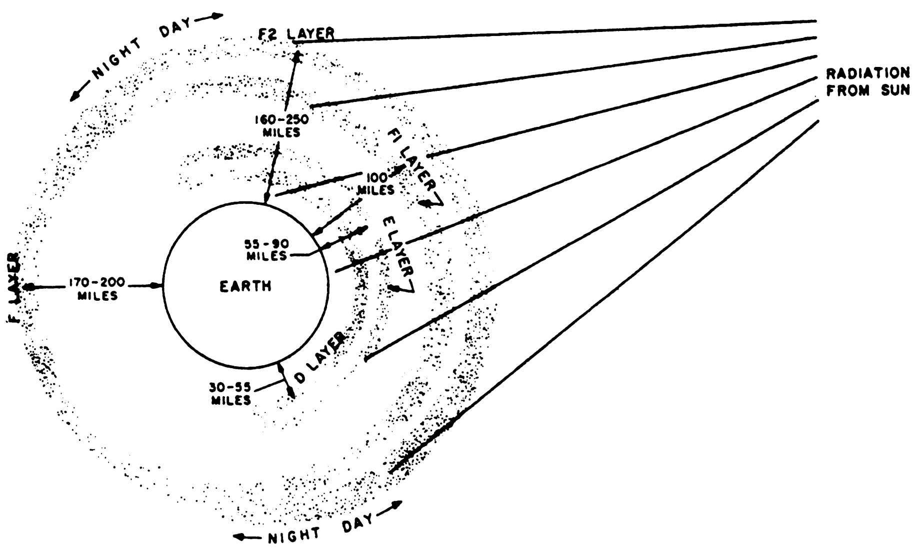


Figure 10-6.–Layers of the ionosphere.

The ionosphere differs from other atmospheric layers because it contains a much higher number of positive and negative ions. The negative ions are believed to have energy levels that have been increased greatly by solar bombardment of ultraviolet and particle radiation. Extending from about 30 miles to 250 miles in the ionosphere are four layers of ionization: D, E, F1, and F2, as shown in figure 10-5. Although ionization appears in distinguishable layers, the intensity and height of ionized layers in any given region depend on many factors including season, sunspot cycle, and most readily apparent, the time of day. The D layer is present only during daylight and has little effect on refraction, but it is a factor in absorbing energy from the electromagnetic fields that pass through it. The E layer is much stronger during the day than at night and can refract frequencies up to approximately 20 MHz during the daylight hours. The F layers have the most effect on the refraction of electromagnetic energy. During the night the D layer fades, the E layer becomes much weaker, and the F1 and F2 layers combine into a single F layer. The reduction in absorption losses because of the fading of the D and E layers can cause the electromagnetic energy to cover greater distances at night. Additionally the combined F1 and F2 layers refract higher energy level signals at greater angles. Figure 10-6 depicts a comparison of day and night ionospheric layers.

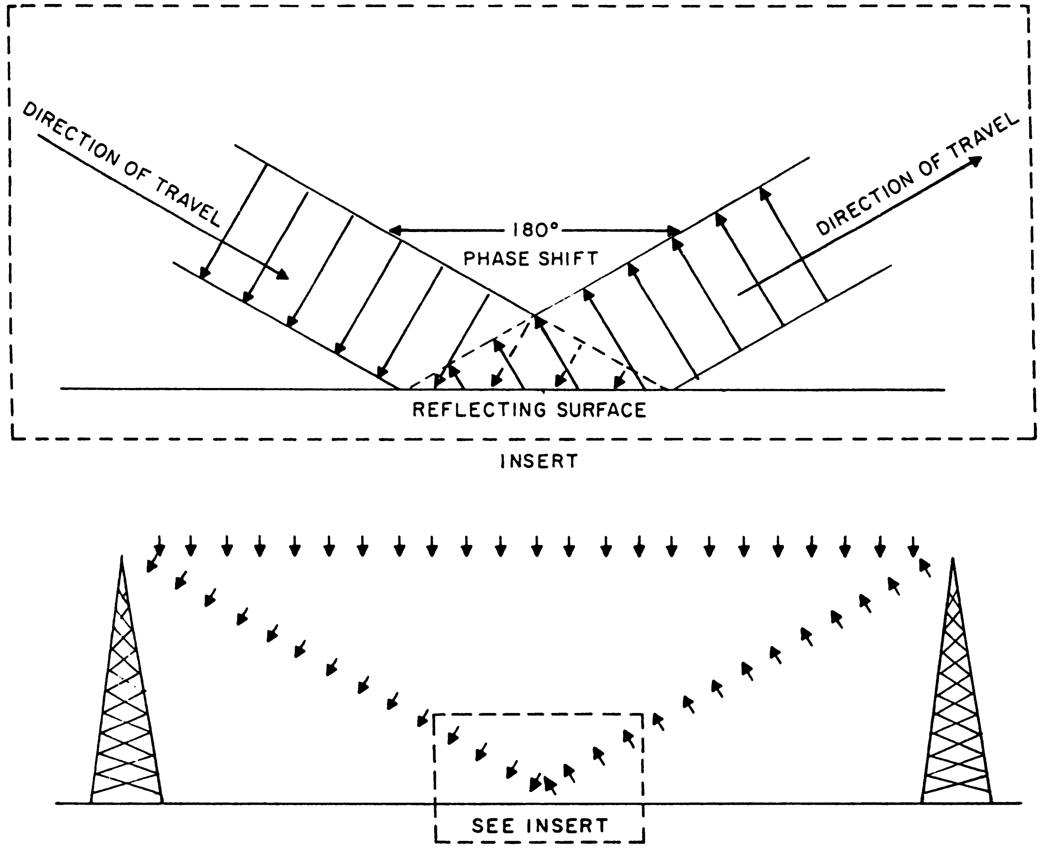


Figure 10-7.–Spacewave component of the transmitted electromagnetic wave.

Long-distance radio communications may be conducted by using multihop transmissions. During these transmissions, a sequence of refractions in the ionosphere and reflections from the earth occur, causing the electromagnetic energy to "bounce" several times over the distance covered. The complete effects of all the variables on skywave propagation are not fully understood. Researchers are continuously searching for means to improve the reliability of long-distance skywave communications.

SPACEWAVE PROPAGATION

The spacewave (fig. 10-7), sometimes referred to as the direct ground wave, is the part of the total wavefront that travels directly, or is reflected by the earth from the transmitting antenna, to the receiving antenna. The spacewave is limited to line-of-sight distances plus the additional small distance created as atmospheric diffraction bends the wave a slight amount around the curvature of the earth. Naturally, line-of-sight distance can be increased by increasing either one or both of the heights of the transmitting and receiving antennas.

The reflected spacewave is "bounced" off of the earth at some distance between the transmitting and receiving antennas. When the transmitted wave strikes the surface of the earth, a part of the energy is lost in the form of heat dissipation. The balance is reflected at the same angle at which it arrived. When the wave is reflected from the surface of the earth, it undergoes a phase reversal of 180 degrees (See insert, fig. 10-7.). Also, since the reflected wave travels a somewhat longer distance than the line-of-sight spacewave, it arrives at the point of reception later than the line-of-sight spacewave. These two factors are important, since the 180-degree phase shift plus the longer route may cause the reflected wave to be out of phase with the line-of-sight wave at the point of reception. In other words, the two waves may have a tendency to cancel one another at the receiving antenna.

ATMOSPHERIC EFFECTS ON PROPAGATION

As previously mentioned, variations in the earth's atmosphere have a direct effect on wave propagation. Some of those factors are briefly described below.

The factor that has the greatest effect on radio communications is *absorption*. Absorption decreases the energy of a radio wave and has a pronounced effect on both the strength of received signals and the ability to communicate over long distances.

FADING

The most troublesome and frustrating problem in receiving radio signals is variations in signal strength, most commonly known as *fading*. There are several conditions that can produce fading. When a radio wave is refracted by the ionosphere or reflected from the earth's surface, random changes in the wave's polarization may occur. This change in polarization may adversely affect reception, depending on the polarization of the receiving antenna. An antenna, depending on how it is designed and mounted, will receive either vertically polarized or horizontally polarized signals at full strength, but not both. If an antenna meant to receive vertically polarized signals receives a horizontally polarized signal, or vice versa, it will pass only a small portion of the signal to the receiver. This decrease in signal passed to the receiver will be indicated by a decrease in receiver output.

Fading also results from absorption of the rf energy in the ionosphere. Absorption fading occurs for a longer period of time than other types of fading since absorption takes place slowly. For the most part, however, fading on ionospheric circuits is mainly a result of multipath propagation.

Multipath Fading

Multipath is simply a term used to describe the multiple paths a radio wave may follow between a transmitter and a receiver. Propagation paths include the ground wave, ionospheric refraction, reradiation by the ionospheric layers, reflection from the earth's surface, or from more than one ionospheric layer, and so on.

Multipath fading may be minimized by practices called *space diversity and frequency diversity.* In space diversity, two or more receiving antennas are spaced some distance apart. Fading does not occur at the same time at both antennas; therefore, sufficient output is almost always available from one of the antennas to provide a useful signal. In frequency diversity, two transmitters and two receivers are used, each pair tuned to a different frequency, with the same information being transmitted at the same time over both frequencies. One of the two receivers will almost always provide a useful signal.

Selective Fading

Fading resulting from multipath propagation varies with frequency since signals of different frequencies arrive at the receiving point via a different radio paths. When a wide band of frequencies is transmitted at the same time, each frequency will vary in the amount of fading. This variation is called *selective fading*. When selective fading occurs, all frequencies of the transmitted signal do not retain their original phases and relative amplitudes. This fading causes severe distortion of the signal and limits the total signal transmitted.

Transmission Losses

All radio waves propagated over ionospheric paths undergo energy losses on their way to the receiving site. As discussed earlier, absorption in the ionosphere and lower atmospheric levels account for a large part of these energy losses. There are two other types of losses that also significantly affect the ionospheric propagation of radio waves. These losses are known as *ground reflection loss and freespace loss*. The combined effects of absorption, ground reflection loss, and freespace loss account for almost all the energy losses of radio transmissions propagated by the ionosphere.

VARIATIONS IN THE IONOSPHERE

Because the existence of the ionosphere is directly related to radiations from the sun, the movement of the earth about the sun or changes in the sun's activity will result in variations in the ionosphere. These variations are of two general types: (1) those that are more or less regular and occur in cycles and (2) those that are irregular as a result of abnormal behavior of the sun. Regular variations can be predicted and planned for in advance, whereas irregular variations cannot. Both regular and irregular variations have important effects on radio wave propagation.

Regular Variations

The regular variations that affect the extent of ionization in the ionosphere can be divided into four main classes: daily, seasonal, 11-year, and 27-day variations.

DAILY.–Daily variations in the ionosphere result from the 24-hour rotation of the earth about its axis. Daily variations of the different ionospheric layers were discussed previously.

SEASONAL.–Seasonal variations result from the earth revolving around the sun; the relative position of the sun moves from one hemisphere to the other with changes in seasons. Seasonal variations of the D, E, and F1 layers correspond to the highest angle of the sun; thus the ionization density of these layers is greatest during the summer. The F2 layer, however, does not follow this pattern; its ionization is greatest in winter and least in summer, the reverse of what might be expected. As a consequence, operating frequencies for F2 layer propagation are higher in the winter than in the summer.

ELEVEN-YEAR SUNSPOT CYCLE.–One of the most notable phenomena on the surface of the sun is the appearance and disappearance of dark, irregularly shaped areas known as sunspots. The exact nature of sunspots is not known, but scientists believe they are caused by violent eruptions on the sun and are characterized by unusually strong magnetic fields. These sunspots are responsible for variations in the ionization level of the ionosphere. Sunspots can, of course, occur unexpectedly. The lifespan of individual sunspots is variable; however, a regular cycle of sunspot activity has also been observed. This cycle has both a minimum and maximum level of sunspot activity that occur approximately every 11 years.

During periods of maximum sunspot activity, the ionization density of all layers increases. Because of this, absorption in the D layer increases and the critical frequencies for the E, F1, and F2 layers are higher. At these times, higher operating frequencies must be used for long-distance communications.

TWENTY-SEVEN DAY SUNSPOT CYCLE.–The number of sunspots in existence at any one time is continually subject to change as some disappear and new ones emerge. As the sun rotates on its axis, these sunspots are visible at 27-day intervals, which is the approximate period required for the sun to make one complete rotation.

The 27th-day sunspot cycle causes variations in the ionization density of the layers on a day-to-day basis. The fluctuations in the F2 layer are greater than for any other layer. For this reason, precise predictions on a day-to-day basis of the critical frequency of the F2 layer are not possible. In calculating frequencies for long-distance communications, allowances for the fluctuations of the F2 layer must be made.

Irregular Variations

Irregular variations in ionospheric conditions also have an important effect on radio wave propagation. Because these variations are irregular and unpredictable, they can drastically affect communication capabilities without any advanced warning.

The more common irregular variations are sporadic E, sudden ionospheric disturbances, and ionospheric storms.

SPORADIC E.–Irregular cloudlike patches of unusually high ionization, called sporadic E, often form at heights near the normal E layer. Exactly what causes this phenomenon is not known, nor can its occurrence be predicted. It is known to vary significantly with latitude. In the northern latitudes, it appears to be closely related to the aurora or polar lights.

SUDDEN IONOSPHERIC DISTURBANCE.–The most startling of the ionospheric irregularities is known as a *sudden ionospheric disturbance (sid)*. These disturbances may occur without warning and may prevail for any length of time, from a few minutes to several hours. When sid occurs, long-distance propagation of hf radio waves is almost totally blanked out. The immediate effect is that radio operators listening on normal frequencies are inclined to believe their receivers have gone dead.

IONOSPHERIC STORMS.–Ionospheric storms are disturbances in the earth's magnetic field. They are associated, in a manner not fully understood, with both solar eruptions and the 27-day intervals, thus corresponding to the rotation of the sum.

WEATHER VERSUS PROPAGATION

Weather is an additional factor that affects the propagation of radio waves. In this section, we explain how and to what extent the various weather phenomena affect wave propagation.

Wind, air temperature, and water content of the atmosphere can combine in many ways. Certain combinations can cause radio signals to be heard hundreds of miles beyond the ordinary range of radio communications. Conversely, a different combination can attenuate the signal to the extent that it may not be heard even over a normally satisfactory path. Unfortunately, there are no hard and fast rules concerning the effects of weather on radio transmissions since the weather is extremely complex and subject to frequent change. Therefore, the following discussion of the effects of weather on radio waves is limited to general terms.

Precipitation Attenuation

Calculating the effect of weather on radio wave propagation would be comparatively simple if there were neither water nor water vapor in the atmosphere. However, some form of water (vapor, liquid, or solid) is always present and must be considered in all calculations. Before we discuss the specific effects that individual forms of precipitation (rain, snow, fog) have on radio waves, you should note that the attenuation effects of precipitation are generally proportionate to the frequency and wavelength of the radio wave. For example, rain has a pronounced effect on microwave frequencies. You can assume, then, that as the wavelength becomes smaller with increases in frequency, precipitation causes a greater attenuation of the radio waves. Conversely, you can assume that as the frequency is reduced and the wavelength increased, precipitation has little effect on radio waves in the hf range and below.

Rain

Attenuation because of raindrops is greater than attenuation because of other forms of precipitation. Attenuation may be caused by absorption, whereby the raindrop, acting as a poor dielectric, absorbs power from the radio wave and dissipates the power by heat loss. Attenuation may also be caused by scattering. Raindrops cause greater attenuation by scattering than by absorption at frequencies above 100 megahertz. At frequencies above 6 gigahertz, attenuation by raindrop scatter is even greater.

Fog

Fog may be considered another form of rain. Since fog remains suspended in the atmosphere, the amount of attenuation is determined by the quantity of water per unit volume and by the size of the droplets. Attenuation due to fog is of minor importance at frequencies lower than 2 gigahertz. However, above 2 gigahertz fog can cause serious attenuation by absorption.

Snow

Scattering because of snow is difficult to compute because of the irregular sizes and shapes of the flakes. While information on the attenuating effect of snow is limited, scientists assume that attenuation from snow is less than from rain falling at an equal rate. This assumption is borne out by the fact that the density of the rain is eight times the density of snow. As a result, rain falling at the rate of 1 inch per hour would have more water per cubic inch than snow falling at the same rate.

Hail

Attenuation by hail is determined by the size of the stones and their density. Attenuation of radio waves by scattering because of hailstones is considerably less than by rain.

FREQUENCY SELECTION CONSIDERATIONS

Up to this point, we have discussed the numerous factors that control the propagation of radio waves through the ionosphere, such as the structure of the ionosphere, the incidence angle of radio waves, and operating frequencies. You must have a thorough knowledge of radio wave propagation to exercise good judgment when you deal with communication factors over which you have control. These factors include the proper selection of transmitting and receiving antennas and the very important aspect of frequency selection. Selection of a suitable operating frequency (within the bounds of frequency allocations and availability) is of prime importance in maintaining reliable communications.

For successful communications between any two specified locations at any given time of the day, there is a maximum frequency, a lowest frequency, and an optimum frequency that can be used.

Maximum Usable Frequency

As discussed earlier, higher frequency radio waves are refracted (and reflected) less by ionized layers of the atmosphere than are lower frequency radio waves. Therefore, for a given angle of incidence and time of day, there is a maximum frequency that can be used for communications between given locations. This frequency is known as the *maximum usable frequency* (muf).

Frequencies above the muf are normally refracted so slowly that they return to earth beyond the desired location, or pass on through the ionosphere and are lost. You should understand, however, that use of an established muf certainly does not guarantee successful communications between a transmitting site and a receiving site. Variations in the ionosphere may occur at any time and consequently raise or lower the predetermined muf. This is particularly true for radio waves being refracted by the highly variable F2 layer.

The muf is highest around noon when ultraviolet light waves from the sun are the most intense. It then drops rather sharply as recombination begins to take place.

Lowest Usable Frequency

Just as there is a maximum operating frequency that can be used for communications between two points, there is also a minimum operating frequency. This is known as the *lowest usable frequency (luf)*.

As the frequency of a radio wave is lowered, the rate of refraction increases. Consequently, a wave whose frequency is below the established luf is refracted back to earth at a shorter distance than desired.

The transmission path that results from the rate of refraction is not the only factor that determines the luf. As a frequency is lowered, absorption of the radio wave increases. A frequency that is too low is absorbed to such an extent that it is too weak for reception. Likewise, atmospheric noise is greater at lower frequencies; thus, a low-frequency radio wave may have an unacceptable signal-to-noise ratio.

For a given angle of incidence and set of ionospheric conditions, the luf for successful communications between two locations depends on the refraction properties of the ionosphere, absorption considerations, and the amount of atmospheric noise present.

Optimum Working Frequency

Neither the muf nor the luf is a practical operating frequency. While the luf can be refracted back to earth at the desired location, the signal-to-noise ratio is still much lower than at the higher frequencies, and the probability of multipath propagation is much greater. Operating at or near the muf can result in frequent signal fading and dropouts when ionospheric variations alter the length of the transmission path.

The most practical operating frequency is one that you can rely on with the least amount of problems. It should be high enough to avoid the problems of multipath, absorption, and noise encountered at the lower frequencies; but not so high as to experience the adverse effects of rapid changes in the ionosphere.

A frequency that meets the above criteria is known as the *optimum working frequency*. It is abbreviated "fot" from the initial letters of the French words for optimum working frequency, "frequency optimum de travail." The fot is roughly about 85 percent of the muf, but the actual percentage varies and may be either considerably more or less than 85 percent.

ANTENNA CHARACTERISTICS

All antennas have common characteristics. Sometimes, the most difficult problem concerning antennas is the terminology involved. In this section, we will discuss many of the misunderstood terms dealing with the theory of antennas.

WAVELENGTH

Whenever RF current flows through a transmitting antenna, electromagnetic (radio) waves are radiated from the antenna in all directions. These waves travel at approximately the speed of light. The frequency of the radio wave that is radiated by the antenna will be the same as the frequency of the RF current.

The velocity of a radio wave remains the same regardless of the frequency. This is important to remember in computations that concern antenna length. Whenever the length of an antenna is referred to, the term *wavelength* is used. You will hear antennas referred to as "halfwave," "quarterwave," or "fullwave." These terms describe the relative length, electrical or physical, of an antenna.

Simply stated, wavelength is defined as "the distance traveled by the radio wave in the time required for one cycle." This means that wavelength will vary with frequency. If we increase the frequency, the time required to complete one cycle is naturally less. Therefore, the wavelength is shorter. If we decrease the frequency, the time required to complete one cycle is longer. Therefore, the wavelength is longer.

When we *tune* an antenna, we are electrically lengthening or shortening the antenna to achieve resonance at a particular frequency. In doing so, we are actually changing the wavelength of the antenna. To compute the wavelength of the antenna, we can begin with the fact that a radio wave travels at a nearly constant speed of 300,000,000 meters per second (or 186,000 miles per second). To determine the length of 1 cycle

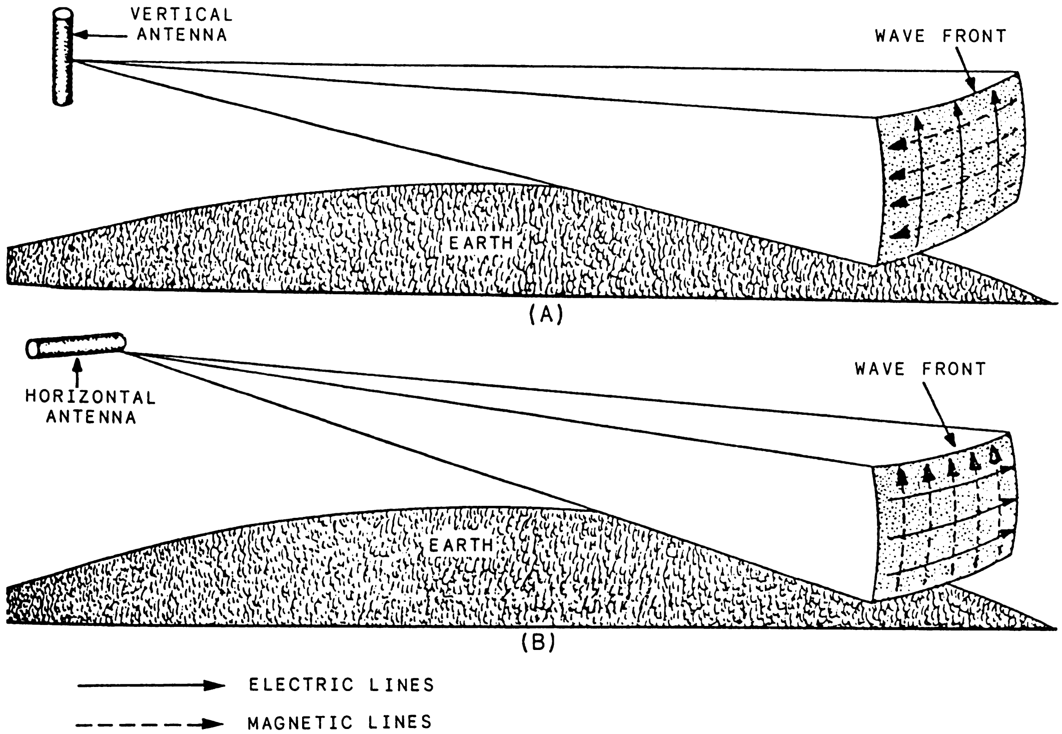


Figure 10-8.–Vertical and horizontal polarization.

(wavelength), we simply divide the velocity of the wave by its frequency. Expressed as a formula:

$$\textit{Wavelength in meters} = \frac{300{,}000{,}000\ m/sec}{\textit{Frequency in hertz}}$$

Because there are 3.28 feet in one meter, we can also compute wavelength in feet. Multiplying 3.28 times 300,000,000 equals 984,000,000 feet. Therefore:

$$\textit{Wavelength in feet} = \frac{984{,}000{,}000\ ft/sec}{\textit{Frequency in hertz}}$$

The electrical length of an antenna is not necessarily the same as its physical length. Radio frequency energy travels at the speed of light in free space. However, it travels at a much slower speed on an antenna. The difference in velocity results in a difference between electrical and physical lengths. Thus, an antenna may be called a half-wave antenna because its electrical length is a half-wave, but its physical length may be much shorter.

WAVE POLARIZATION

The orientation of an antenna in space determines the polarization of the emitted radio wave. An antenna that is oriented vertically with respect to the earth radiates a vertically polarized radio wave, while a horizontally oriented antenna radiates a horizontally polarized wave. Figure 10-8 shows examples of both vertically and horizontally polarized waves. Note that the electric field corresponds to the polarization of the wave. This means that the electric field will have the same polarization as the antenna.

At the lower frequencies, wave polarization will remain fairly constant as it travels through space. At higher frequencies, however, the polarization usually varies, sometimes quite rapidly, because the wavefront splits into several components which follow different paths.

Polarization of a radio wave is a major consideration in efficient transmission and reception of radio signals. For example, if a single-wire antenna is used to extract energy from a passing radio wave, it will extract the most energy (maximum signal) when it lies physically in the same direction as the electric field component. In theory, a vertical antenna should be used for efficient reception of vertically polarized waves. A horizontal antenna should be used for reception of horizontally polarized waves. For this reason,

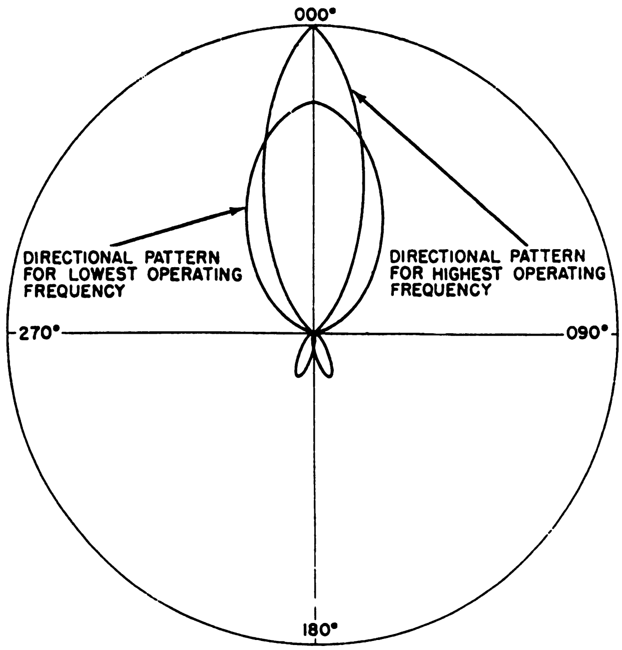


Figure 10-9.–Radiation pattern of an antenna.

shipboard antennas are installed with correct polarization in mind. If antennas require relocation, be sure that the correct polarization is maintained.

DIRECTIVITY

In general, we use three terms to describe the direction or directions in which an antenna can transmit or receive. They are *omnidirectional, bidirectional,* and *unidirectional.* Omnidirectional antennas radiate and receive equally well in all directions, except off of their ends. Bidirectional antennas radiate or receive efficiently in only two directions: for example North or South or East or West. Unidirectional antennas radiate or receive efficiently in one direction only.

Most antennas are either omnidirectional or unidirectional. Bidirectional antennas are rarely used in naval communications. Examples of an omnidirectional antenna are the antennas used to

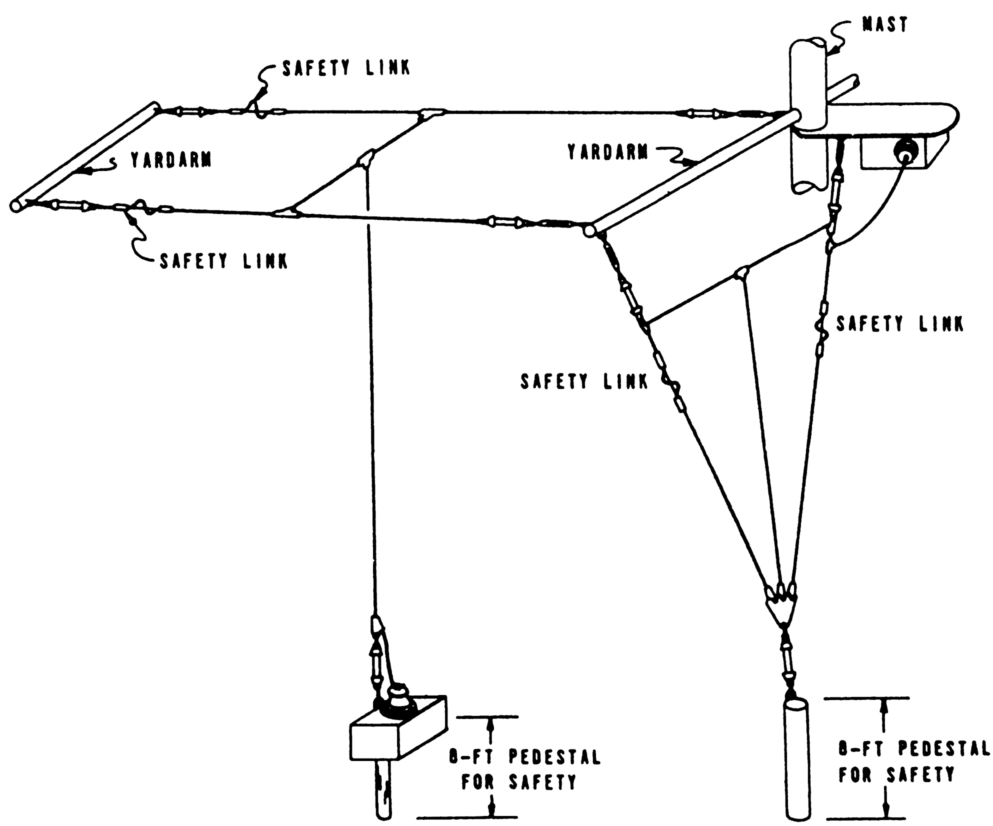


Figure 10-10.–Wire rope antenna.

transmit fleet broadcasts or most medium-to-high frequency antennas used aboard ship. An example of a unidirectional antenna is a parabolic, or "dish," antenna. The directivity of an antenna can be determined by its radiation pattern. In figure 10-9, the rounded projections of the pattern are called lobes and the intended portions, representing minimum energy pick-up, are called nulls. The information contained in the antenna radiation pattern can be used to determine the best operational use for the antenna.

As the EMO, you will be required to maintain a complete set of radiation patterns for each installed transmit antenna.

ANTENNAS

Antenna theory and basic antennas are discussed in NEETS Module 10. This section describes some of the common types of antennas used with shipboard communication systems.

WIRE ANTENNAS

A wire antenna consists of a wire rope suspended either vertically or horizontally from a yardarm or the mast itself to outriggers, to another mast, or to the superstructure. A simplified diagram of a shipboard wire antenna is shown in figure 10-10.

Single-wire antennas are not used aboard ship as extensively now as they were in the past. They have, to a large extent, been replaced by whip, dipole, and other antenna assemblies. In some installations, wire antennas are used only in emergencies.

Because of the frequency range in which these antennas are used, the portion of the ship's structure used to support the wire and other nearby structures are an electrically integral part of the wire antenna. Therefore, wire antennas are usually designed for a particular ship or installation.

Transmitting and receiving antenna wire rope will have a vinyl insulating jacket (as will transceiving wire antennas) to reduce interference from precipitation static (static interference due to the discharge of large charges built up by rain, sleet, snow, or electrically charged clouds).

WHIP ANTENNAS

Whip antennas are essentially self-supporting. Therefore, they may be installed in many locations aboard ship where space is at a premium and in locations that are unsuitable for other antenna types. They may be deck mounted or mounted on brackets on the stacks or superstructure.

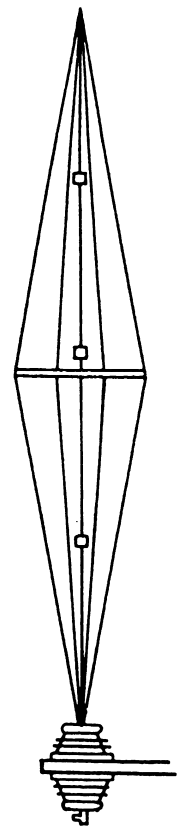


Figure 10-11.–Trussed whip antenna.

Whip antennas that are to be used for receiving only are mounted as far away from the transmitting antennas as possible to minimize the amount of energy they pick up from a local transmitter.

You can distinguish receiving whip antennas from transmitting antennas by the color of the base. Receiving antennas have green bases; transmitting antennas have red bases.

One type of whip antenna commonly used aboard ship is constructed with 7-foot sections of aluminum rod. The lower rod is 3 inches in diameter and the whip tapers to a diameter of 1 inch at the upper section. (Fiberglass whips are replacing the aluminum whips in some installations.) Some whips may be trussed with wire rope (which increases the frequency bandwidth), resulting in better performance (fig. 10-11). The recommended method for mounting a receiving whip

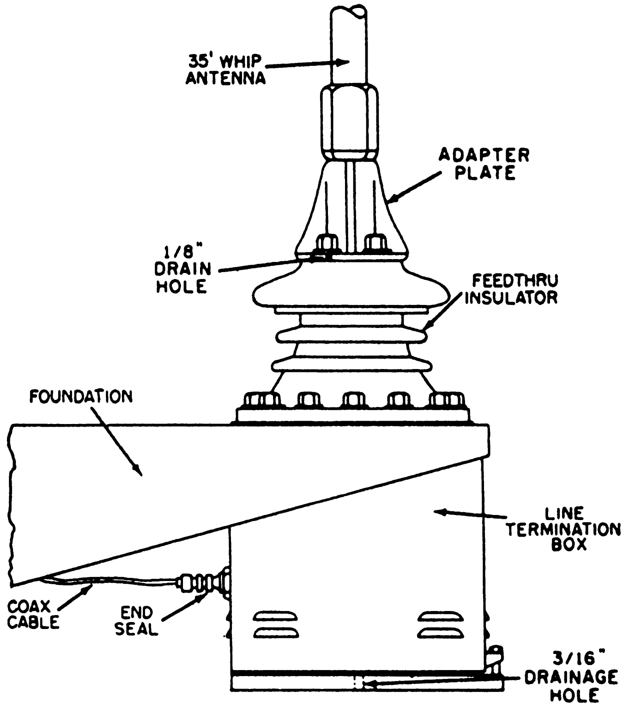


Figure 10-12.–Method of mounting whip antenna of 35 feet or less.

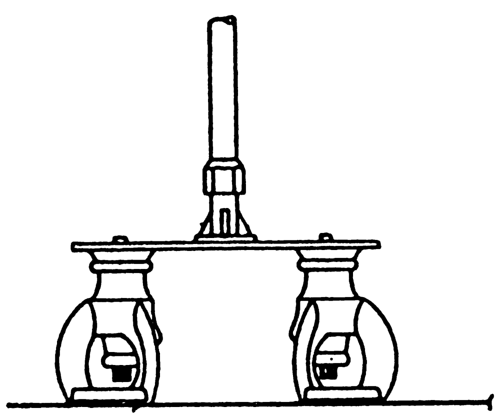


Figure 10-13.–Method of mounting whip antenna over 35 feet.

antenna up to 35 feet in length is shown in figure 10-12. Whip antennas over 35 feet are mounted on a plate supported by three or four insulators (fig. 10-13) for greater strength. Small whip antennas have been mounted horizontally on yardarms or masts in some installations for use as low-frequency probe antennas. Such antennas usually come supplied with a line termination box (fig. 10-14), which is normally mounted to the ship's structure. Some applications use two whips connected as a single antenna for better electrical performance.

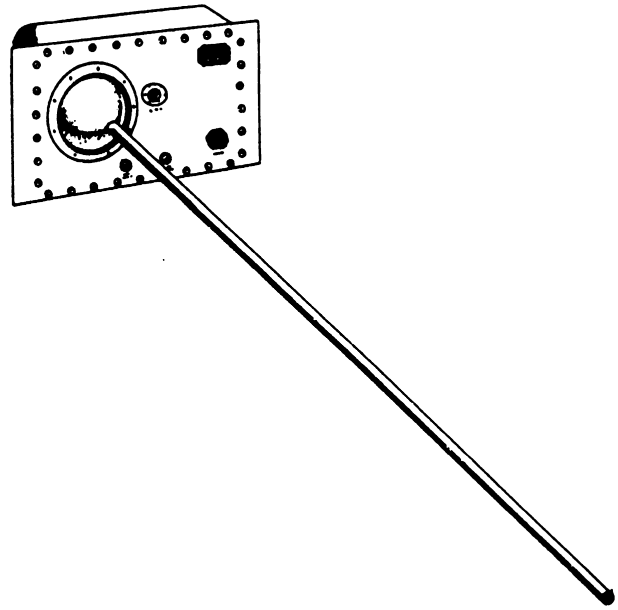


Figure 10-14.–Small whip antenna with line termination box.

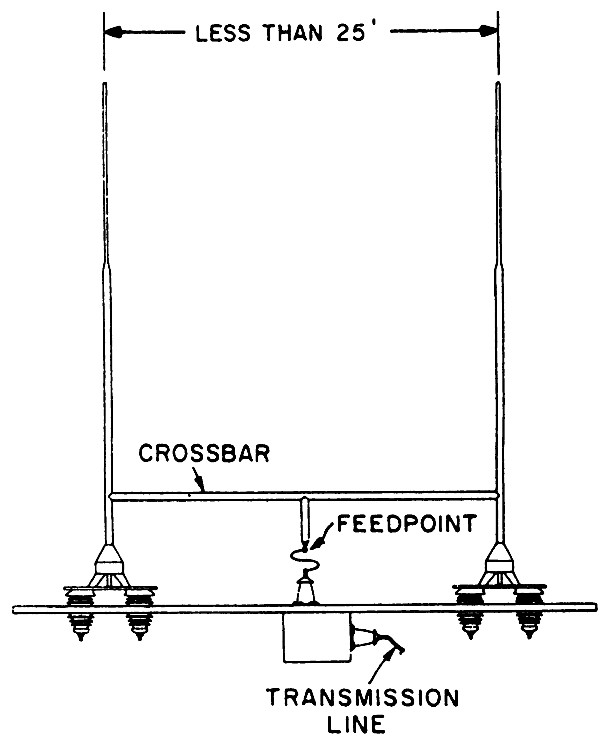


Figure 10-15.–Twin whip antennas with crossbar terminations.

If the antennas are less than 25 feet apart, they are usually connected with a crossbar (fig. 10-15), which has the feedpoint at its center. If the antennas are a considerable distance apart, or for some other reason, a direct connection is not practical, transmission line termination is used. In figure 10-16 the transmission lines (of equal length) are fed to a tee, which is the

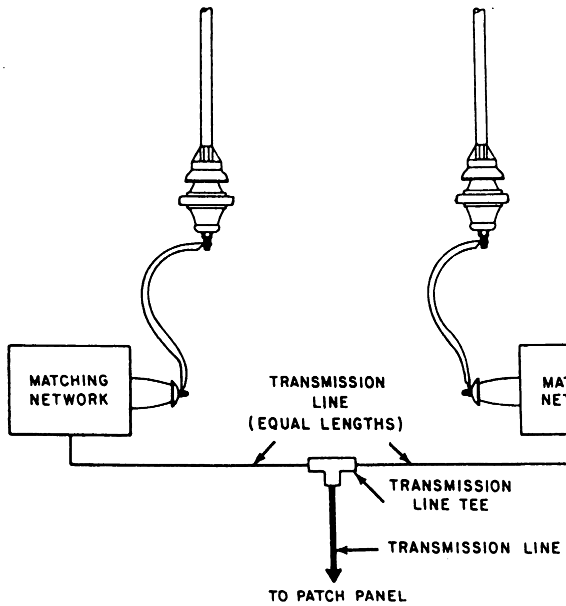


Figure 10-16.–Twin whip antennas with coaxial terminations.

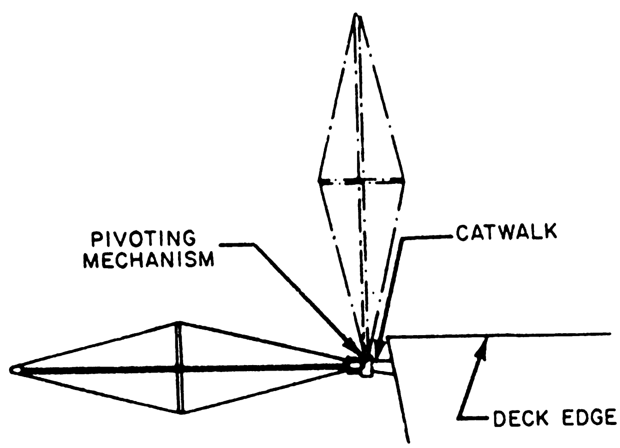


Figure 10-17.–Tilting whip antenna.

assembly feed point. Each whip is usually matched individually to the transmission line by antenna base matching networks. Wire rope is used in place of the whips in some installations.

On aircraft carriers and missile ships, a method of tilting (fig. 10-17) is used for whip antennas installed along the edges of the flight deck or in the missile firing zone.

The tilting mounts may be mechanically or hydraulically operated. Mechanically operated mounts have a counterweight at the base of the antenna heavy enough to balance the antenna in almost any position. The antenna may be locked in either a vertical or horizontal position by positive locking devices in both the operating and stowed positions.

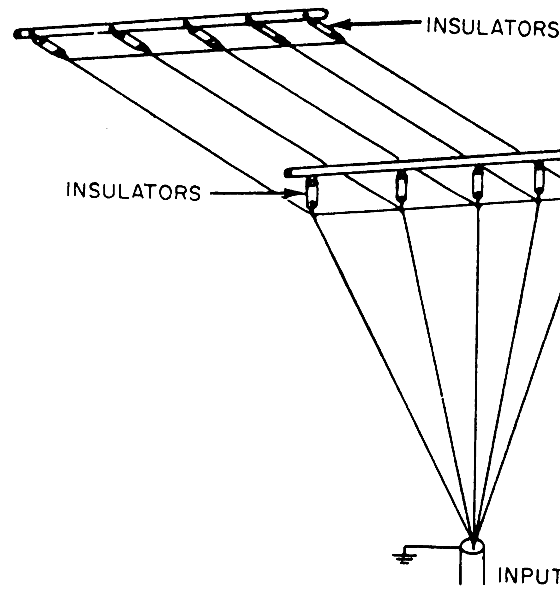


Figure 10-18.–Five-wire vertical fan antenna.

BROADBAND ANTENNAS

Broadband antennas for use in the hf and uhf bands have been developed for use with antenna multicouplers. To be used with a multicoupler, the antenna must be capable of handling simultaneous transmissions from several transmitters without excessive loss of power in the multicoupler equipment. The antenna must, therefore, function satisfactorily over a relatively wide band of frequencies.

The effectiveness of a given antenna depends largely on impedance matching. If a good impedance match exists between the transmission line and the antenna throughout the operating band of frequencies, efficiency and power transfer are improved.

One type of broadband antenna, called a fan, is shown in figure 10-18. Effectively, this is a V-shaped plane radiator. Physically, it is composed of five wires cut for one-quarter wavelength at the lowest frequency to be used. The wires are fanned approximately 30 degrees between adjacent wires. On small ships, the fan antenna may consist of only three or four wires. Ships may have two fan antennas, one vertical fan and the other horizontal.

UHF ANTENNAS

A large variety of uhf antennas have been developed for shipboard use. Two of these antennas (AT-150/SRC

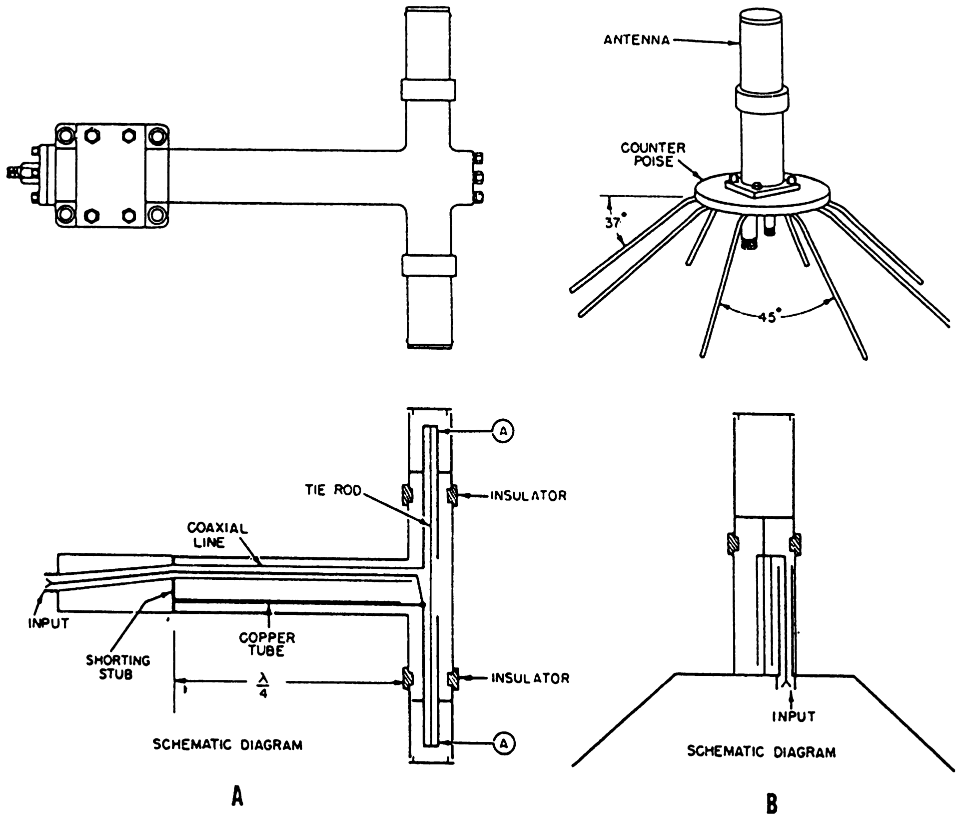


Figure 10-19.–UHF antennas.

and AS-390/SRC) are shown in figure 10-19. They are used for transmitting or receiving vertically polarized waves in the 220- and 400-MHz range.

ANTENNA FEED POINT

The term *feed point* indicates the point at which the rf cable that carries the signal from the transmitter is connected to the antenna. The type of antenna being used and the desired operating characteristics determine the feed point. If the rf transmission line is connected to the base of the antenna, the antenna is said to be *end-fed.* If the rf transmission line is connected at the center of the antenna, the antenna is said to be *midfed* or *center fed.*

MATCHING NETWORKS

An antenna matching network consists of one or more parts (such as coils, capacitors, and lengths of transmission line) connected in series or parallel with the transmission line to reduce the standing wave ratio on the line. Matching networks are usually adjusted when they are installed and require no further adjustment for proper operation. Figure 10-20 shows a matching network outside of the antenna feedbox with a sample matching network schematic.

Matching networks can also be built with variable components so they can be used for impedance matching over a band of frequencies. These networks are called antenna tuners.

Antenna tuners are usually adjusted automatically or manually each time the operating frequency is changed. Standard tuners are made with integral enclosures so that installation consists simply of mounting the tuner, assembling the connections with the antenna and transmission line, and pressurizing if required. Access must be provided to the pressure gauge and pressurizing and purging connections.

ANTENNA TUNING

For every frequency in the frequency spectrum, there is an antenna that is perfect for radiating at that frequency. By that we mean that all of the power being transmitted from the transmitter to the antenna will be radiated into space. Unfortunately, this is the ideal and not the rule. Normally, some power is lost between the transmitter and the antenna. This power loss is the result

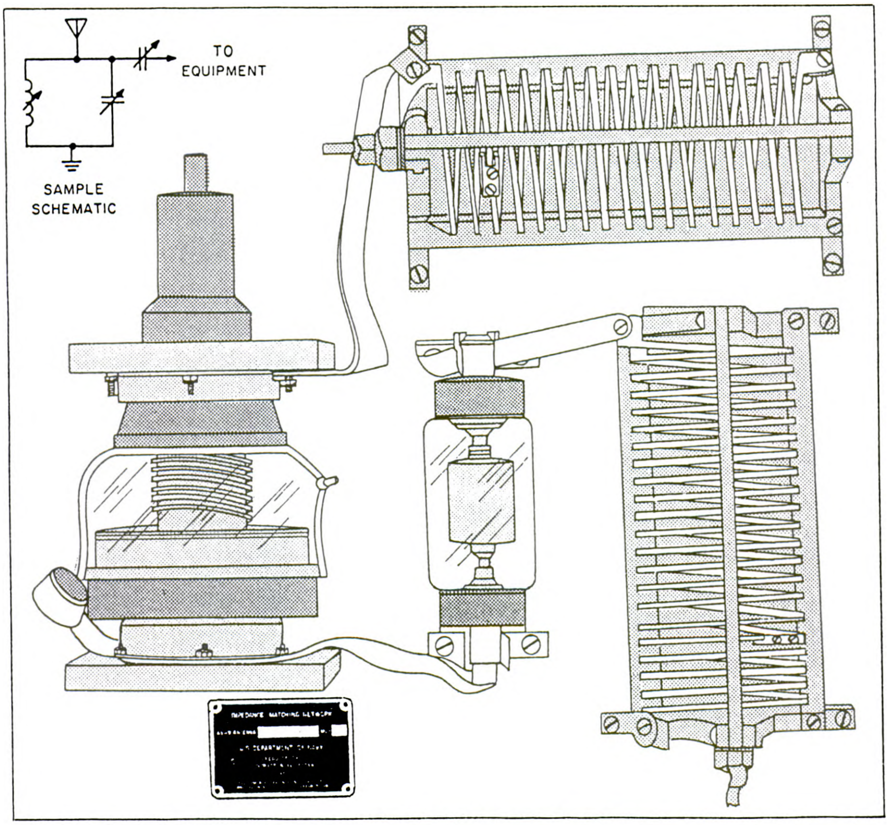


Figure 10-20.–Matching network.

of the antenna not having the perfect dimensions and size to radiate perfectly all of the power delivered to it from the transmitter. Naturally, it would be unrealistic to carry a separate antenna for every frequency that a communications center is capable of radiating; a ship would have to have millions of antennas on board, and that would be impossible.

To overcome this problem, we use *antenna tuning* to electrically lengthen and shorten antennas to better match the frequency on which we want to transmit. The RF tuner is electrically connected to the antenna and is used to adjust the apparent physical length of the antenna by electrical means. This simply means that the antenna does not physically change length; instead, the antenna is electrically adapted to the output frequency of the transmitter and "appears" to change its physical length. Antenna tuning is done by using antenna *couplers, tuners*, and *multicouplers.*

Antenna couplers and tuners are used to match a single transmitter or recover to one antenna.

Antenna multicouplers are used to match more than one transmitter or receiver to one antenna for simultaneous operation. Some of the many antenna couplers are addressed in the following paragraphs. For specific information, refer to the appropriate equipment technical manual.

Antenna Coupler Group AN/URA-38

Antenna Coupler Group AN/URA-38 is an automatic antenna tuning system intended primarily for use with the AN/URT-23(V) operating in the high-frequency range. The equipment also includes provisions for manual and semiautomatic tuning, making the system readily adaptable for use with other radio transmitters. The manual tuning feature is useful when a failure occurs in the automatic tuning circuitry. Tuning can also be done without the use of rf power (silent tuning). This method is useful in installations where radio silence must be maintained except for brief transmission periods.

The antenna coupler matches the impedance of a 15-, 25-, 28-, or 35-foot whip antenna to a 50-ohm transmission line, at any frequency in the 2- to 30-MHz range. When the coupler is used with the AN/URT-23(V), control signals from the associated antenna coupler control unit automatically tune the coupler's matching network in less than 5 seconds. During manual and silent operation, the operator uses the controls mounted on the antenna coupler control unit to tune the antenna. A low power (not to exceed 250 watts) cw signal is required for tuning. Once tuned, the CU 938A/URA-38 is capable of handling 1000 watts of peak envelope power (PEP).

Antenna Coupler Groups AN/SRA-56,-57, and -58

Antenna Coupler Groups AN/SRA-56, -57, and -58 are designed primarily for shipboard use. Each coupler group permits several transmitters to operate simultaneously into a single, associated, broadband antenna, thus reducing the total number of antennas required in the limited space aboard ship.

These antenna coupler groups provide a coupling path of prescribed efficiency between each transmitter and the associated antenna. They also provide isolation between transmitters, tunable bandpass filters to suppress harmonic and spurious transmitter outputs, and matching networks to reduce antenna impedances.

The three antenna coupler groups (AN/SRA-56, -57, -58) are similar in appearance and function, but they differ in frequency ranges. Antenna Coupler Group AN/SRA-56 operates in the frequency range from 2 to 6 MHz. The AN/SRA-57, operates from 4 to 12 MHz, and the AN/SRA-58 operates in the 10- to 30-MHz range. When more than one coupler is used in the same frequency range, a 15% frequency separation must be maintained to avoid any interference.

Antenna Coupler Group AN/SRA-33

Antenna coupler group AN/SRA-33 operates in the UHF (225-400 Mhz) frequency range. It provides isolation between as many as four transmitter and receiver combinations operating simultaneously into a common uhf antenna without degrading operation. The AN/SRA-33 is designed for operation with shipboard radio sets AN/SRC-20, AN/SRC-21, and AN/WSC-3. The AN/SRA-33 consists of four antenna couplers (CU-1131/SRA-33 through CU-1134/SRA-33), a Control Power Supply C-4586/SRA-33, an Electronic Equipment Cabinet CY-3852/SRA-33, and a set of special-purpose cables.

OA-9123/SRC

The OA-9123/SRC multicoupler enables up to four UHF transceivers, transmitters, or receivers to operate on a common antenna. The multicoupler provides low insertion loss and highly selective filtering in each of the four ports. The unit is interface compatible with the channel select control signals from radio sets, AN/WSC-3(V) (except (V)1). It is also interface compatible with AN/SRC-20/21 only in the LOCAL mode. The unit is self-contained and is configured to fit into a standard 19-inch open equipment rack.

The OA-9123/SRC consists of a cabinet assembly, control power supply assembly, and four identical filter assemblies. This multicoupler is a state of-the art replacement for the AN/SRA-33 and only requires about one half of the space.

RECEIVE ANTENNA DISTRIBUTION SYSTEMS

Receiving antenna distribution systems operate at low power levels and are designed to prevent multiple signals from being received. The basic distribution

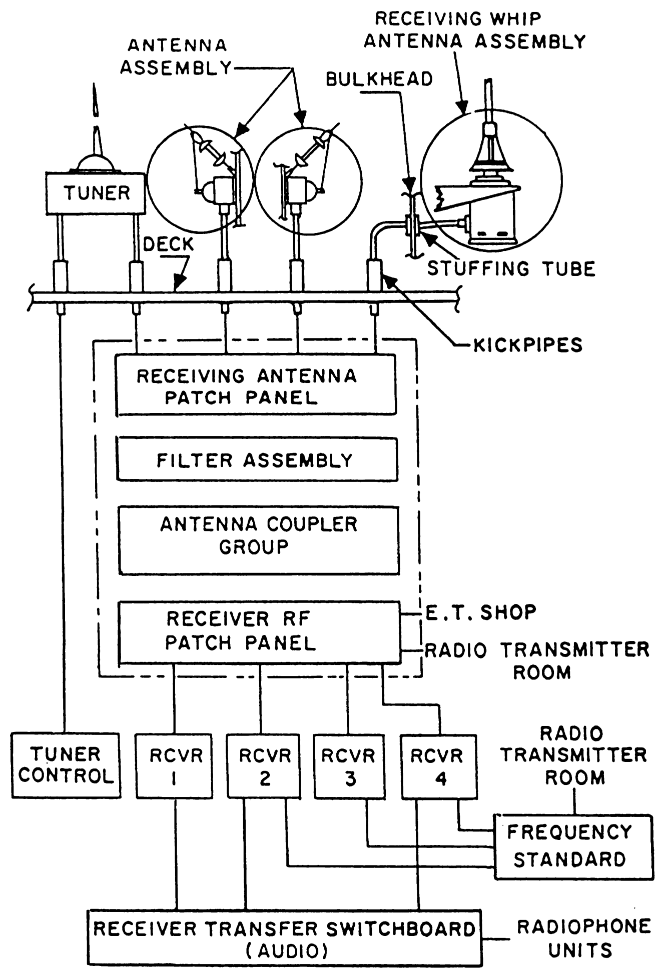


Figure 10-21.–Receive signal distribution system.

system has several antenna transmission lines and several receivers as shown in figure 10-21. The system includes two basic patch panels, one that terminates the antenna transmission lines, and the other that terminates the lines leading to the receivers. Thus any antenna can be patched to any receiver via patch cords.

Some distribution systems will be more complex; i.e., four antennas can be patched to four receivers, or one antenna can be patched to more than one receiver via the multicouplers.

Receiving Multicoupler AN\SRA-12

The AN/SRA-12 filter assembly multicoupler provides seven radio frequency channels in the frequency range from 14 kHz to 32 MHz. Any of these channels may be used independently of the other channels, or they may operate simultaneously. Connections to the receiver are made by use of coaxial patch cords, which are short lengths of cable with a plug attached to each end.

Antenna Coupler Groups: AN/SRA-38, AN/SRA-39, AN/SRA-40, AN/SRA-49, AN/SRA-49A, and AN/SRA-50

These groups are designed to connect up to 20 medium-frequency and high-frequency receivers to a single antenna, with a highly selective degree of frequency isolation. Each of the six coupler groups consists of 14 to 20 individual antenna couplers and a single-power supply module, all slide-mounted in a special electronic equipment rack. An antenna input distribution line termination (dummy load) is also supplied. In addition, there are provisions for patching the outputs from the various antenna couplers to external receivers.

MODULATION

Modulation is the process of varying some characteristic of a periodic wave with an external signal. The voice frequencies (about 110-3,000 Hz) are contained in the audio frequency spectrum 10-20,000 Hz. In naval communications, the terms *voice communications* and *audio communications* are sometimes used interchangeably. The audio signal is impressed upon the radio frequency carrier because it is impractical to transmit frequencies in the audio range, due in part to the excessive wavelength. (Wavelength was discussed previously in this chapter). The physical size of circuit components at these frequencies is too large to be practical.

Three characteristics of the carrier wave may be varied at an external signal rate: amplitude, frequency, and phase.

AMPLITUDE MODULATION

Amplitude modulation (AM) is the process of combining audio frequency and radio frequency signals in a manner that causes the amplitude of the radio frequency waves to vary at an audio frequency rate.

FREQUENCY AND PHASE MODULATION

Frequency modulation (FM) is the process of combining audio and carrier signals in a manner that causes the frequency of the carrier wave to vary at an audio rate, while the amplitude of the carrier wave remains essentially constant. The carrier frequency can be varied a small amount on either side of its average or assigned frequency by means of the audio frequency (af) modulating signal. The amplitude of the audio modulating signal determines the amount of change (increase) in the frequency of the FM signal. The greater the audio signal amplitude (i.e., the louder the sound in voice modulation), the greater the increase in frequency of the FM signal.

TRANSMITTERS

The transmitter may be a simple, low power (milliwatts) unit, for sending voice messages a short distance, or it may be a highly sophisticated unit, using thousands of watts of power, for sending many channels of data (voice, teletype, t.v., telemetry, and so on) simultaneously over long distances.

Basic transmitters include continuous wave (cw), amplitude modulation (am), frequency modulation (fm), single-sideband (ssb), frequency shift keying (fsk), and phase shift keying (psk). A basic description of each of these transmitters is given in the following paragraphs.

CW TRANSMITTER

The cw transmitter is turned on and off (keyed) to produce long or short radio frequency (rf) pulses that correspond to the dots and dashes of the Morse code

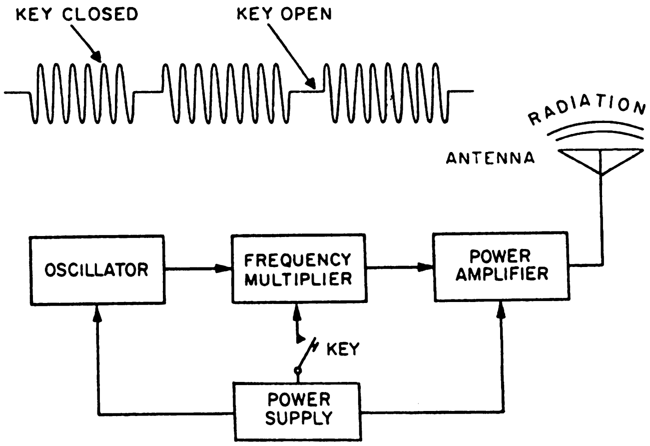


Figure 10-22.–Continuous-wave transmitter block diagram.

characters. The transmitter (fig. 10-22) has four essential components:

1. a generator of rf oscillations,
2. a means of amplifying and, if necessary, multiplying the frequencies of these oscillations,
3. a method of keying the rf output according to the code to be transmitted, and
4. a power supply to provide the operating voltage to the various electron tubes and transistors.

Although not physically a part of the transmitter, an antenna is required to radiate the keyed output radio wave of the transmitter.

CW is one of the oldest and least complicated forms of radio communications. Two advantages of CW transmission are a narrow bandwidth, which requires less power out, and a degree of intelligibility that is high even under severe noise conditions. A major disadvantage is that the cw transmitter must be manually turned on and off at specified intervals to produce Morse code keying. This method of transmitting intelligence is very slow and inefficient by present-day standards. Therefore, the Navy relies on modulation of the carrier frequency (rf output of the transmitter) for communications.

AM TRANSMITTER

Figure 10-23, a block diagram of an AM transmitter, gives you an idea of what a simple AM transmitter looks like. The oscillator, buffer amplifier, and power amplifier serve the same purpose as those in the cw transmitter. The microphone converts the audio frequency (af) input (a person's voice) into corresponding electrical energy. The driver amplifies the audio, and the modulator further amplifies the audio signal to the amplitude necessary to fully modulate the carrier. The output of the modulator is applied to the

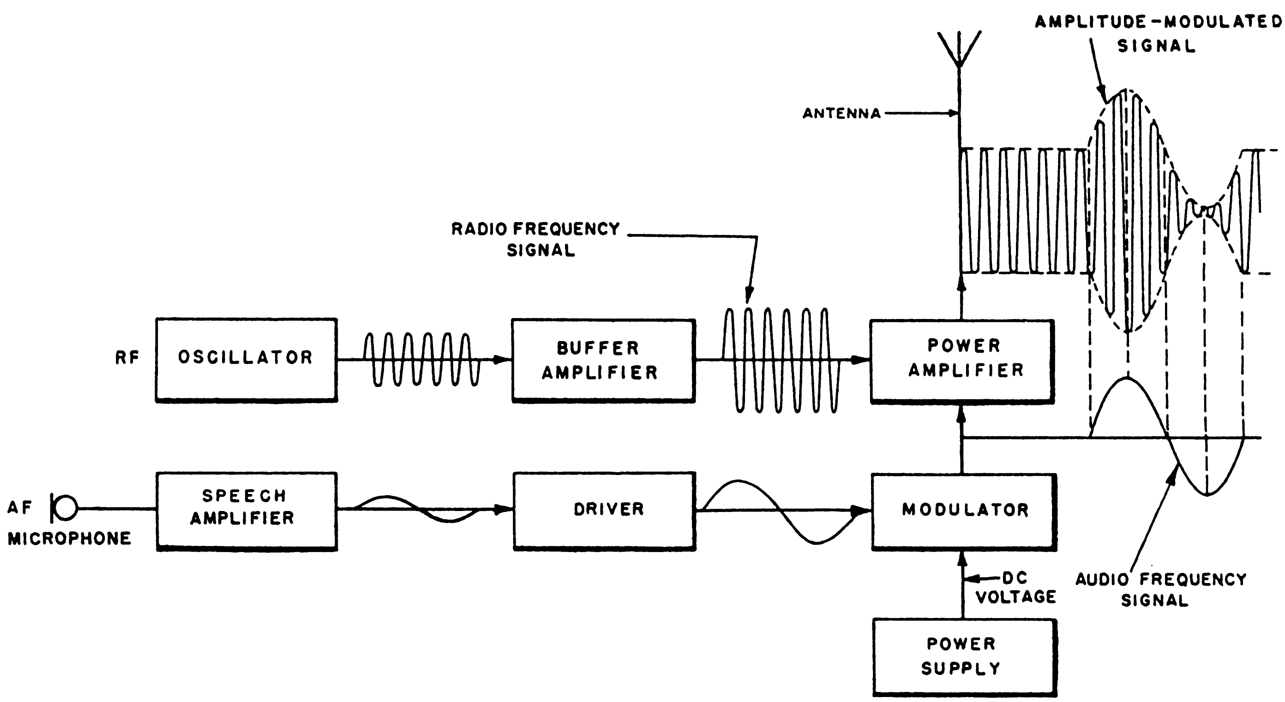


Figure 10-23.–An AM radiotelephone transmitter block diagram.

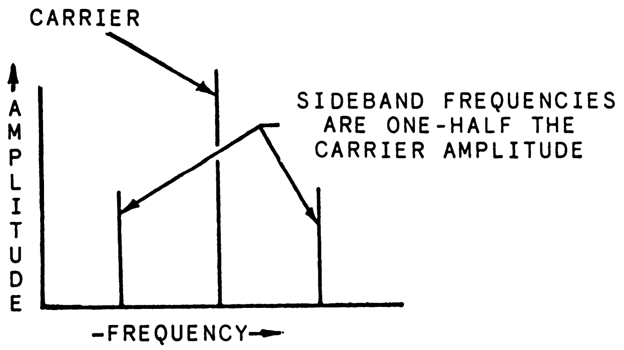


Figure 10-24.–Spectrum analysis of an AM signal.

power amplifier (pa). The pa combines the rf carrier and the modulating signal to produce the amplitude-modulated signal output for transmission. In the absence of a modulating signal, a continuous rf carrier is radiated by the antenna.

Variations in rf power output similar to the compression and refraction of sound occur throughout each audio cycle. The waveform at the antenna thus contains three major frequencies: (1) the carrier frequency, (2) the carrier frequency plus the audio frequency (sum frequency), and (3) the carrier frequency minus the audio frequency (difference frequency). The sum frequency is called the upper sideband; the difference frequency, the lower sideband. The sideband frequencies are always related to the carrier frequency by the sum and difference of the modulation frequency.

The relationship of the carrier, audio, and sideband frequencies is illustrated in figure 10-24. Assume that the carrier frequency is 1000 kHz and that the audio-modulating frequency is a single 1-kHz tone. Then each of the sidebands is displaced 1000 hertz from the carrier frequency. The lower sideband is 1,000,000 *hertz* – 1000 *hertz* = 999,000 *hertz* (or 999 kHz). The upper sideband is 1,000,000 *hertz* + 1000 *hertz* = 1,001,000 *Hz* (or 1001 kHz).

During modulation, the peak voltages and currents on the rf power amplifier stage are greater than those that occur when the stage is not modulated. To prevent damage to the equipment, a transmitter, designed to transmit both cw and radiotelephone signals, is provided with controls that reduce the power output for radiotelephone operation.

FM TRANSMITTER

Figure 10-25 is a block diagram of a frequency-modulated transmitter. The modulating signal applied to a varicap causes the reactance to vary. The varicap is connected across the tank circuit of the oscillator. With no modulation, the oscillator generates a steady center frequency. With modulation applied, the varicap causes the frequency of the oscillator to vary around the frequency according to the modulating signal. The oscillator output is then fed to a frequency multiplier to increase the frequency and then to a power amplifier to increase the amplitude to the desired level for transmission.

From the above discussion, you should understand that (1) the amount of variation from the carrier frequency depends on the magnitude of the modulating signal, and (2) the rate of variations in carrier frequency depends on the frequency of the modulating signal.

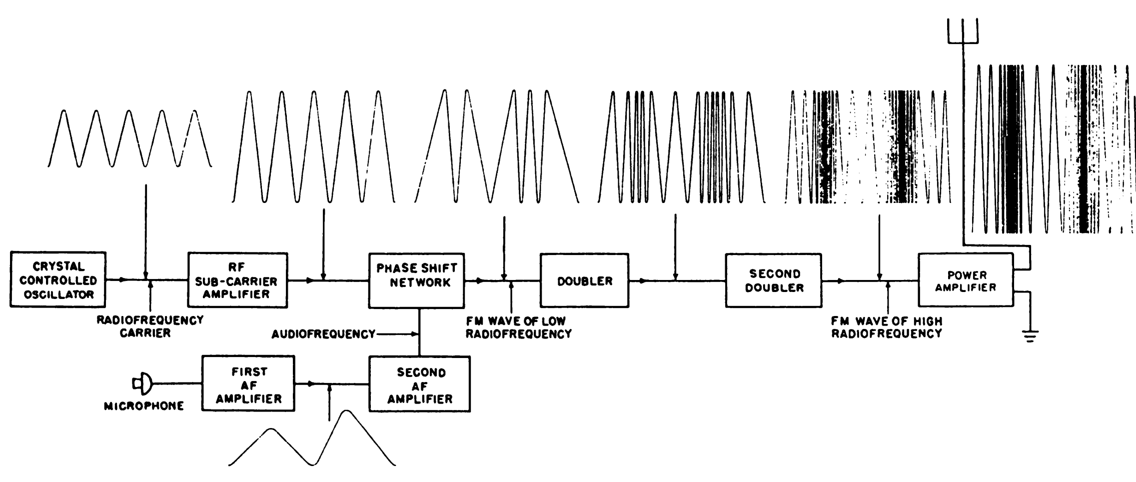


Figure 10-25.–Block diagram of an FM transmitter and waveforms.

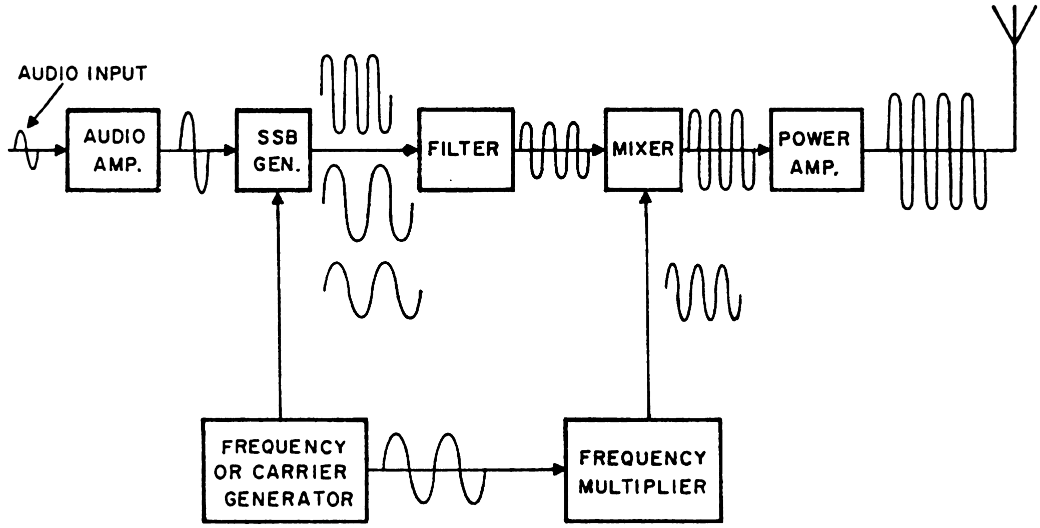


Figure 10-26.–SSB transmitter block diagram.

Frequency modulation and phase modulation (PM) are essentially the same. The primary difference is in the physical method of making the frequency shift in the transmitter. Both FM and PM can be received on FM receivers, and both are commonly referred to as FM. A block diagram of a representative FM transmitter, in which frequency modulation is achieved by a phase-shift system, is shown in figure 10-25. The transmitter oscillator is maintained at a constant frequency by a quartz crystal. This constant-frequency signal passes through an amplifier that increases the amplitude of the rf subcarrier. The audio signal is applied to this carrier phase-shift network in a manner that causes the frequency of the carrier to shift according to the variations of the audio signal. The FM output of the phase-shift network is fed into a series of frequency multipliers that raise the signal to the desired output frequency. Then the signal is amplified in the power amplifier and coupled to the antenna for radiation.

SINGLE-SIDEBAND TRANSMITTER

A carrier that has been modulated by voice or music is accompanied by two identical sidebands, each carrying the same intelligence. In amplitude-modulated (AM) transmitters, the carrier and both sidebands are transmitted. In a single-sideband transmitter (ssb), only one of the sidebands, the upper or lower, is transmitted, while the remaining sideband and the carrier are suppressed. *Suppression* is the elimination of the undesired portions of the signal.

There are several advantages to ssb communications. When the carrier and one sideband are eliminated, less power is required to send the signal. Also, an ssb signal occupies only a small portion of the frequency spectrum, in comparison to the AM signal. This results in two advantages, narrower receiver bandpass and the ability to place more signals in a small portion of the frequency spectrum.

Ssb communication systems have some disadvantages, however. The process of producing an ssb signal is somewhat more complicated than simple amplitude modulation, and frequency stability is much more critical in ssb communication. While there is not the annoyance of heterodyning from adjacent signals, a weak ssb signal may be completely masked or hidden from the receiving station by a stronger signal. Also, a carrier of proper frequency and amplitude must be reinserted at the receiver because of the direct relationship between the carrier and the sidebands.

Figure 10-26 is a block diagram of a single-sideband transmitter. You can see that the audio amplifier increases the amplitude of the incoming signal to a level adequate to operate the ssb generator. Usually the audio amplifier is just a voltage amplifier.

The ssb generator (modulator) combines its audio input and its carrier input to produce the two sidebands. The two sidebands are then fed to a filter that selects the desired sideband and suppresses the other one.

In most cases ssb generators operate at very low frequencies compared to the normally transmitted frequencies. For that reason, we must convert (or translate) the filter output to the desired frequency. This is the purpose of the mixer stage. A second output is obtained from the frequency generator and fed to a frequency multiplier to obtain a higher carrier frequency for the mixer stage. The output from the mixer is fed to a linear power amplifier to build up the level of the signal for transmission.

Suppressed Carrier

In ssb the carrier is suppressed (or eliminated) at the transmitter, and the sideband frequencies produced by the carrier are reduced to a minimum. You will probably find this reduction (or elimination) is the most difficult aspect in the understanding of ssb. In a single-sideband suppressed carrier, no carrier is present in the transmitted signal. It is eliminated after the signal is modulated and is reinserted at the receiver during the demodulation process. All rf energy appearing at the transmitter output is concentrated in the sideband energy as "talk power."

After the carrier is eliminated, the upper and lower sidebands remain. If one of the two sidebands is filtered out before it reaches the power amplifier stage of the transmitter, the same intelligence can be transmitted on the remaining sideband. All power is then transmitted in one sideband, instead of being divided between the carrier and both sidebands, as it is in conventional AM.

RECEIVERS

A receiver processes modulated signals received by its antenna, and delivers as an output a reproduction of the original signal that modulated the rf carrier at the transmitter. The signal can then be applied to some reproducing device such as a loudspeaker, or a terminal device such as a teletypewriter. Actual receivers vary widely in complexity. Some are very simple; others contain a relatively large number of complex circuits.

RECEIVER FUNCTIONS

Whatever its degree of sophistication, a receiver must perform certain basic functions to be useful. These functions, in order of their performance, are reception, selection, detection, and reproduction.

Reception

Reception occurs when a transmitted electromagnetic wave passes through the receiver antenna and induces a voltage in the antenna.

Selection

Selection is the ability to select a particular station's frequency from all other station frequencies appearing at the receiver's antenna.

Detection

Detection is the action of separating the low (audio) frequency intelligence from the high (radio) frequency carrier and is done in a detector circuit.

Reproduction

Reproduction is the action of converting the electrical signals to sound waves that can then be interpreted by the ear as speech, music, and the like.

RECEIVER CHARACTERISTICS

Receiver characteristics are useful in determining operational conditions and for comparing one receiver to another. Important receiver characteristics are sensitivity, noise, selectivity, and fidelity.

Sensitivity

Sensitivity is a measure of a receiver's ability to reproduce very weak signals. The weaker the signal that can be applied to a receiver and still produce a certain value of signal output, the better that receiver's sensitivity rating. Sensitivity of a receiver is measured under standardized conditions and is expressed in terms of the signal voltage, usually in the microvolts that must be applied to the antenna input terminals to give an established level of output. The output may be an ac or dc voltage measured at the detector output, or a power measurement at the loudspeaker or headphone terminals.

Noise

All receivers generate a certain amount of noise that must be taken into account. Noise is a limiting factor on the minimum usable signal that the receiver can process and still deliver a usable output. Therefore, the measurement is made by determining the amplitude of the signal at the receiver input required to give a signal plus-noise output at a predetermined ratio above the static noise output of the receiver.

Selectivity

Selectivity is the degree of distinction made by the receiver between the desired signal and unwanted signals. The better the receiver's ability to exclude unwanted signals, the better its selectivity. The degree of selectivity is determined by the sharpness of resonance to which the frequency-determining circuits have been engineered and tuned. Measurement of selectivity is usually by a series of sensitivity readings in which the input signal is stepped along a band of frequencies above and below resonance of the receiver's circuit (e.g., 100 kHz below to 100 kHz above tuned

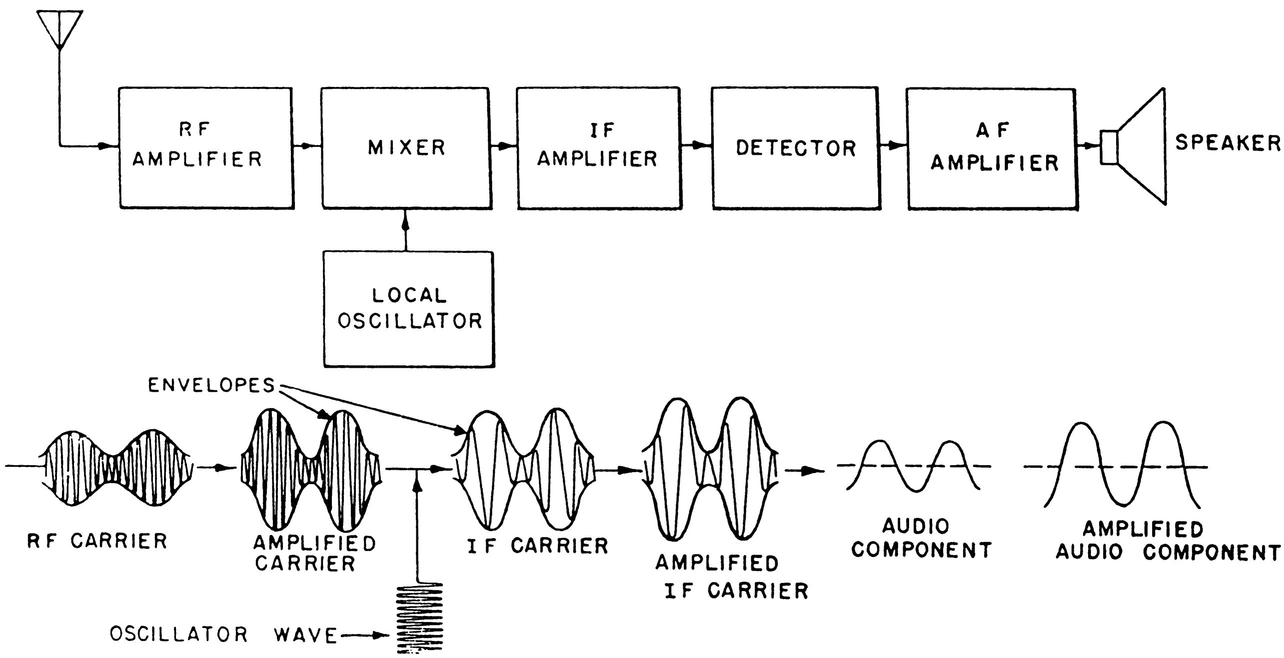


Figure 10-27.–AM superheterodyne receiver and waveforms.

frequency). As the frequency to which the receiver is tuned is approached, the input level required to maintain a given output level will fall. As the tuned frequency is passed, the required input level will rise. Input voltage levels are then plotted against frequency. The steepness of the curve at the tuned frequency indicates the selectivity of the receiver.

Fidelity

The fidelity of a receiver is its ability to reproduce accurately, in its output, the signal that appears at its input. In general, the broader the band passed by frequency selection circuits, the greater the fidelity. It may be measured by modulating an input frequency with a series of audio frequencies; then plotting the output measurements at each step against the audio input frequencies. The resulting curve will show the limits of reproduction.

Good *selectivity* requires that a receiver pass a narrow frequency band. Good *fidelity,* on the other hand, requires that the receiver pass a broader band to amplify the outermost frequencies of the sidebands. Therefore, receivers in general use are a compromise between good selectivity and high fidelity.

AM SUPERHETERODYNE RECEIVER

Figure 10-27 shows a block diagram with waveforms of a typical AM superheterodyne receiver developed to overcome the disadvantages of earlier type receivers. Let's assume you are tuning the receiver. When doing this you are actually changing the frequency to which the rf amplifier is tuned. The rf carrier comes in from the antenna and is applied to the rf amplifier. The output of the amplifier is an amplifier carrier and is sent to the mixer. The mixer also receives an input from the local oscillator. These two signals are beat together to obtain the IF through the process of heterodyning. (Heterodyning will be further discussed later in this chapter.)

The IF carrier is applied to the IF amplifier. The amplified IF carrier is then sent to the detector. The output of the detector is the audio component of the input signal. This audio component is then passed through an audio frequency amplifier. The amplified audio component is sent to a speaker for reproduction. This allows you to hear the signal.

A superheterodyne receiver may have more than one frequency-converting stage and as many amplifiers as needed to obtain the desired power output. (The additional amplifiers are not shown in the figure.)

Heterodyning

The intermediate frequency is developed by a process called *heterodyning.* This action takes place in the mixer stage (sometimes called a converter or first detector). Heterodyning is the combining of the incoming signal with the local oscillator signal.

The local oscillator is set to track with the tuning of the incoming signal so that it produces a frequency higher or lower than the frequency of the incoming signal by the exact amount of the fixed IF frequency. By

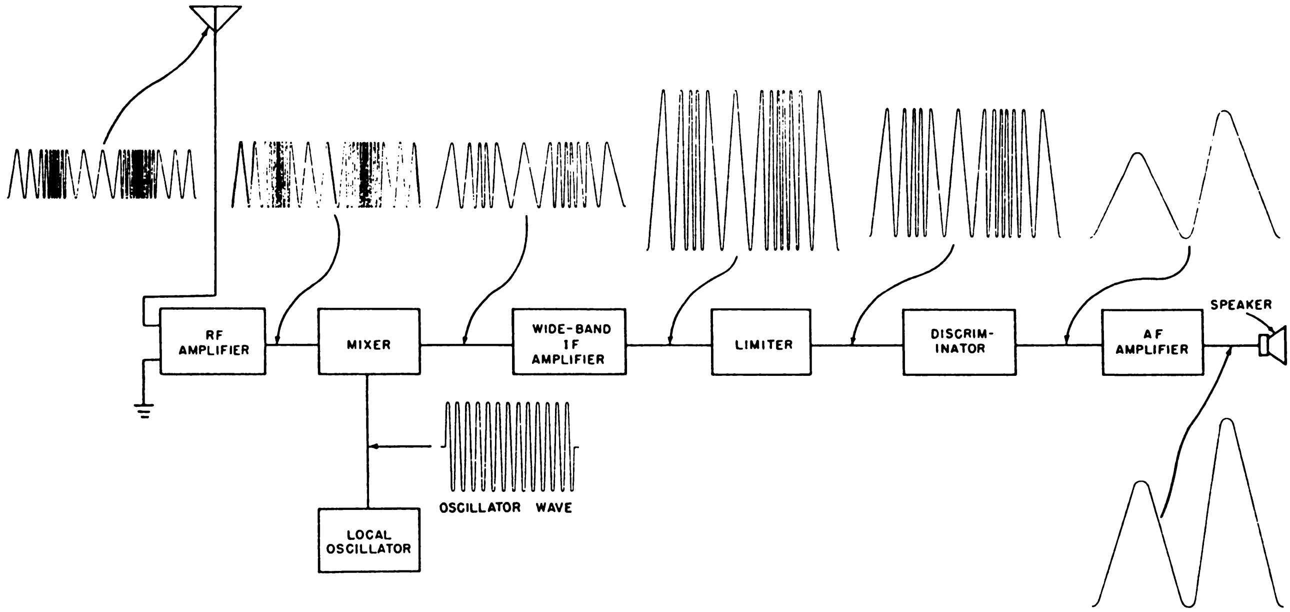


Figure 10-28–Block diagram of an FM receiver and waveforms.

heterodyning the incoming signal and locally produced signal in the mixer stage, four frequencies appear at the mixer output. They are (1) the incoming rf signal, (2) the local oscillator signal, (3) the sum of the incoming rf signal and the local oscillator signal, and (4) the difference in these frequencies. The IF amplifier will be tuned to the difference frequency. A typical intermediate frequency for AM communication receivers is 455 kHz.

Detection

Once the IF stages have amplified the intermediate frequency to a sufficient level, it is fed to the detector (or second detector, if referring to the mixer as first detector) to extract the modulating audio signal. The detector stage consists of a rectifying device and filter, which respond only to the amplitude variations of the IF signal to develop an output voltage varying at an audio frequency rate. The output from the detector is further amplified in the audio amplifier and used to drive a speaker or earphones.

FM SUPERHETERODYNE RECEIVER

The function of a frequency modulated (FM) superheterodyne receiver is the same as that of an AM superheterodyne receiver. There are certain important differences in component construction and circuit design because of differences in the modulating technique. The comparison of block diagrams (figures 10-27 and 10-28) shows that in both AM and FM receivers the amplitude of the incoming signal is increased in the rf stages. The mixer combines the incoming rf with the local oscillator rf signals to produce the intermediate frequency, which is then amplified by one or more IF amplifier stages. Note that the FM receiver has a wide-band IF amplifier. Since the bandwidth for any type of modulation must be wide enough to receive and pass all the side frequency components of the modulated signal without distortion, the IF amplifier in an FM receiver must have a broader passband than the IF amplifier in an AM receiver.

Sidebands created by FM systems differ from the sidebands in AM systems. Recall that the AM system consists of a single set of side frequencies for each radio frequency signal that is modulated. An FM signal inherently occupies a wider band than AM, and the number of these extra sidebands that occur in FM transmission is related to the amplitude and frequency of the audio signal.

Beyond the IF stage there is a marked difference between the two receivers. While AM demodulation involves the detection of variations in the amplitude of the signal, FM demodulation is the process of detecting variations in the frequency of the signal. In FM receivers, a "discriminator" is designed to respond to frequency shift variations. A discriminator is preceded by a limiter, which limits all signals to the same amplitude level to minimize noise interference. The audio frequency component is then extracted by the discriminator, amplified in the AF amplifier, and used to drive the speaker.

Electrically, there are only two fundamental sections of the FM receiver that are different from the

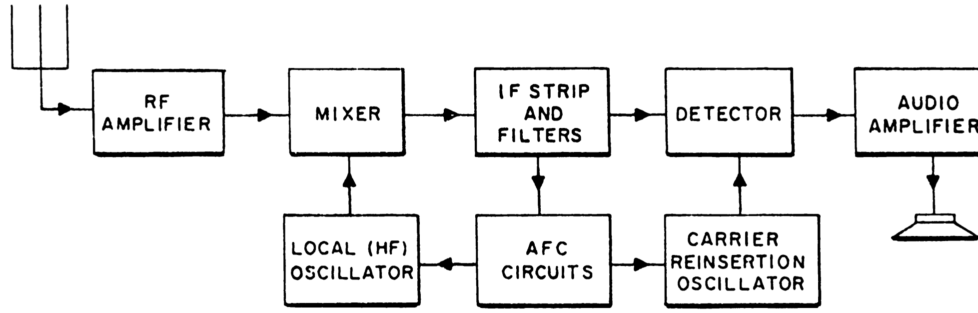


Figure 10-29.–Basic ssb receiver.

AM receiver: the discriminator (detector) and the accompanying limiter.

FM receivers have several advantages over AM receivers. In normal reception, FM signals are free of static, while AM signals are subject to cracking noises and whistles. FM followed AM in development and has the advantage of operating at the higher frequency, where a greater number of frequencies are available. FM signals provide a much more realistic reproduction of sound because of an increased number of sidebands.

The major disadvantage of FM is the wide bandpass required to transmit the FM signals. Each station must be assigned a wide band in the frequency spectrum. During FM transmissions, the number of significant sidebands that must be transmitted to obtain the desired fidelity is equal to the deviation (change in carrier frequency) divided by the highest audio frequency to be used. Thus, if the deviation is 40 kHz and the highest audio frequency is 10 kHz, the number of significant sidebands is:

$$\frac{40\ kHZ}{10\ kHZ} = 4$$

This number of sidebands exists on both sides of the rest frequency; therefore, there are eight significant sidebands. Because the audio frequency is 10 kHZ, and there are eight sidebands, bandwidth must accommodate an 80-kHz signal. This is considerably wider than the 10- to 15-kHz bandpass for AM transmitting stations.

SSB RECEIVER

Figure 10-29 illustrates the block diagram of a basic ssb receiver. It is not significantly different from a conventional superheterodyne AM receiver. However, a special type of detector and a carrier reinsertion oscillator must be used. The carrier reinsertion oscillator must furnish a carrier to the detector circuit at a frequency that corresponds almost exactly to the position of the carrier in producing the original signal.

The filters used in the rf amplifier section of the ssb receivers serve several purposes. As previously stated, many ssb signals may exist in a small portion of the frequency spectrum. Therefore, filters supply the selectivity necessary to adequately receive only one of the many signals that may be present. They may also select upper sideband (usb) or lower sideband (lsb) operation when desired, as well as reject noise and other interference.

The oscillators in an ssb receiver must be extremely stable. In some types of ssb data transmission, a frequency stability of plus or minus 2-hertz is required. For simple voice communication, a deviation of plus or minus 50 hertz may be tolerable.

Ssb receivers may use additional circuits that enhance frequency stability, improve image rejection, or provide automatic gain control (agc). However, the circuits contained in the basic receiver of figure 10-29 will be found in all single sideband receivers.

Carrier Reinsertion

Extreme frequency stability is necessary because a small deviation from the correct value in local oscillator frequency will cause the IF produced by the mixer to be displaced from its correct value. In AM reception this is not too damaging, since the carrier and sidebands are all present and will all be displaced an equal amount. Therefore, the relative positions of carrier and sidebands will be retained. However, in ssb reception there is no carrier, and only one sideband is present in the incoming signal.

The carrier reinsertion oscillator frequency will be set to the IF frequency that would have resulted had the carrier been present. For example, assume that a transmitter, with a suppressed carrier frequency of 3 MHz is radiating an usb signal. Also assume that the intelligence consists of a 1-kHz tone. The transmitted sideband frequency will be 3,001 kHz. If the receiver has a 500-kHz IF, the correct local oscillator frequency

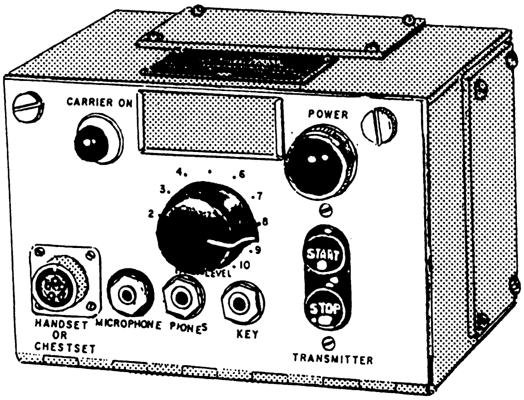


Figure 10-30.–Radio set control.

should be 3,500 kHz. The output of the mixer to the IF stages will be the difference frequency of 499 kHZ. The missing carrier would have been based on an IF frequency of 500 kHz. Therefore, the carrier reinsertion oscillator frequency should be 500 kHz to preserve the frequency relationship of carrier to sideband at 1 kHz.

Recall that 1 kHz is the modulating signal. If the local oscillator frequency drifts to 3500.5 kHz, the IF output of the mixer will become 499.5 kHz. The carrier reinsertion oscillator, however, will still be operating at 500 kHz. This will result in an incorrect audio output of 0.5 kHz rather than the original 1-kHz tone. If the intelligence transmitted were a complex signal, such as speech, it would be unintelligible because of the displacement of the side frequencies caused by the local oscillator deviation. It is, therefore, very important that the local oscillator and carrier reinsertion oscillator be extremely stable.

ANCILLARY COMMUNICATIONS EQUIPMENT

To be useful, every transmitter and receiver must be connected to certain additional items or equipment. The most frequently used items and equipment are described below.

HANDSET

The handset is a device used to convert acoustical energy (sound) to electrical energy for use in modulating the transmitter for the transmission of a signal, and to convert electrical energy to acoustical energy for the reproduction of the received signal. When the push-to-talk button is depressed on the handset, the dc keying circuit to the transmitter is closed, placing the transmitter on the air.

The handset is normally connected to a radio set control.

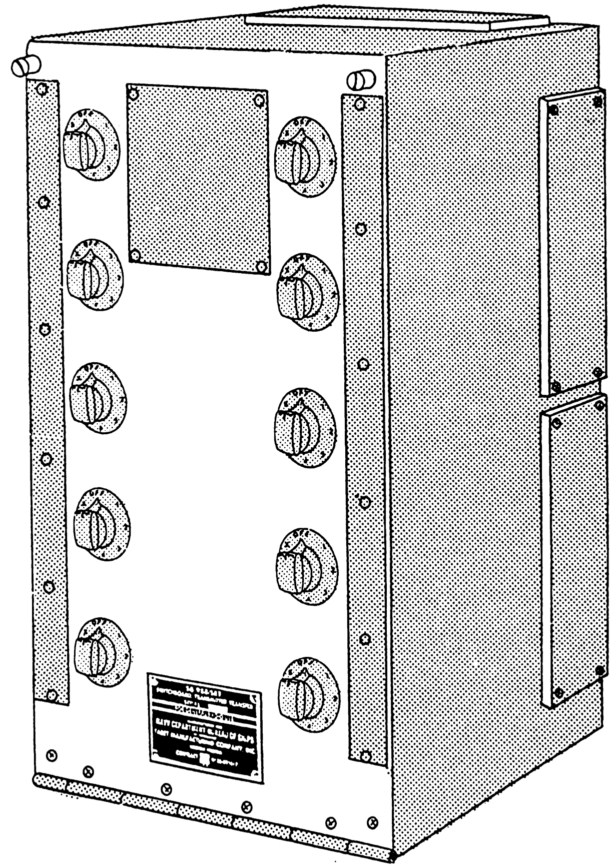


Figure 10-31.–Transmitter transfer switchboard (SB-988/SRT).

RADIO SET CONTROL

The radio set control unit provides the capability to control certain radiophone transmitter functions and the receiver output from a remote location. Some control units contain circuits for turning the transmitter on and off, for voice modulating the transmission (or keying when cw operation is desired), for controlling the audio output level of the receiver, and for muting the receiver when transmitting.

A representative radio set control unit is shown in figure 10-30. Under standard operating conditions, as many as four of these, or similar units, may be paralleled to a single transmitter/receiver group to provide additional operating positions. This setup is often found aboard ship where a transmitter or receiver is controlled and operated from several locations such as the Bridge, Combat Information Center, or Helicopter Control Station.

TRANSMITTER TRANSFER SWITCHBOARD

The transmitter transfer switchboard allows the remote control station functions and signals to be selectively transferred to the transmitters. Figure 10-31

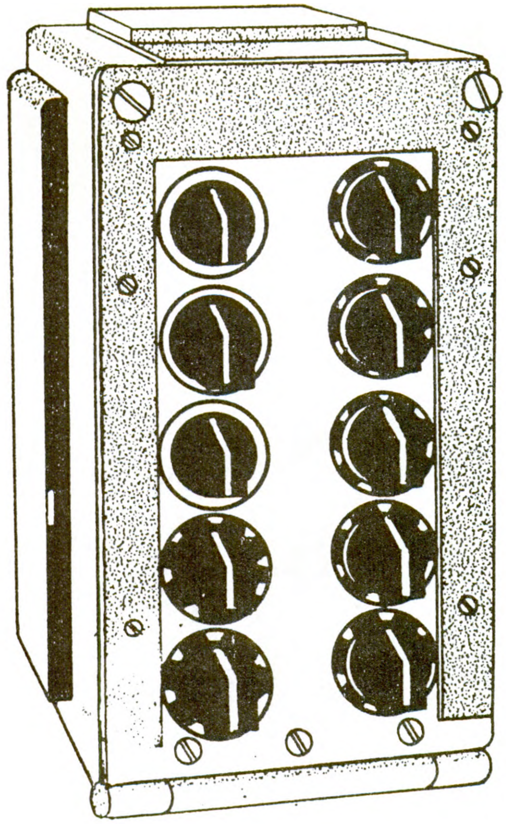


Figure 10-32.–Receiver transfer switchboard (SB-973/SRT).

shows a transfer switchboard that allows the functions and controls of any one, or all, of 10 remote control station functions and signals to be selectively transferred to any one of six transmitters. The cabinet has 10 rotary switches, arranged in two vertical rows of five switches each. Each switch operating knob corresponds to a remote control station. Each switch has eight positions. Positions 1 through 6 correspond to the transmitters attached to the switch. The seventh position, position X, allows control of the switch's transmitters to be passed to another switchboard. The eighth position, OFF, allows the remote to be removed from the system. The circuitry is designed so that no more than one transmitter at a time can be connected to any remote control station.

Suppose, for example, that remote control station number two must have control of transmitter number three. The switch knob designated number two will be rotated until its pointer indicates position three on its dial plate. Thus, any of the remote stations may be used to control any of the transmitters installed in the system.

RECEIVER TRANSFER SWITCHBOARD

The receiver transfer switchboard allows the audio output from the receivers to be transferred to remote control station audio circuits. A representative receiver transfer switchboard is shown in figure 10-32. This switchboard contains 10 seven-position switches. Each switch represents to a remote control station and each switch position (one through five) represents a receiver.

Position X on each switch allows the circuits attached to the switch to be transferred to another switchboard, as is done on the transmitter transfer switchboard.

COMMUNICATIONS SYSTEMS EQUIPMENT CONFIGURATIONS

A communications system is a collection of equipment used together to accomplish a specific communications requirement. For a pictorial view of a typical communications system containing the necessary components for transmission and reception of voice, cw, and teletype signals, refer to figure 10-33.

Shipboard communications are highly sophisticated and versatile. Through equipment design and installation, many equipments are compatible with each other and can be used to accomplish many functions. With this design concept, nearly all of the communications needs for a ship can be met with fewer pieces of communications equipment than were previously required.

As an example of multiple use of equipment, suppose a radio operator needs to send and receive teletype information from another ship. The operator must first establish voice communications with the other ship. From a position in Facilities Control, the operator can use switching arrangements to connect a uhf transceiver to a local position for voice communications, and can connect a teletypewriter to an hf transmitter and receiver for transmission and reception of the teletype information. This arrangement allows the operator to use the communications equipment for different functions, while remaining at the operating position.

In the following discussion, communication equipment configurations are explained individually. They are then shown coupled with one another, forming a simple block diagram of the systems covered. Included are the low-frequency, high-frequency, very-high frequency, and ultrahigh-frequency systems.

LOW FREQUENCY

The low-frequency band is used for long-range direction finding, medium- and long-range communications, and aeronautical radio navigation.

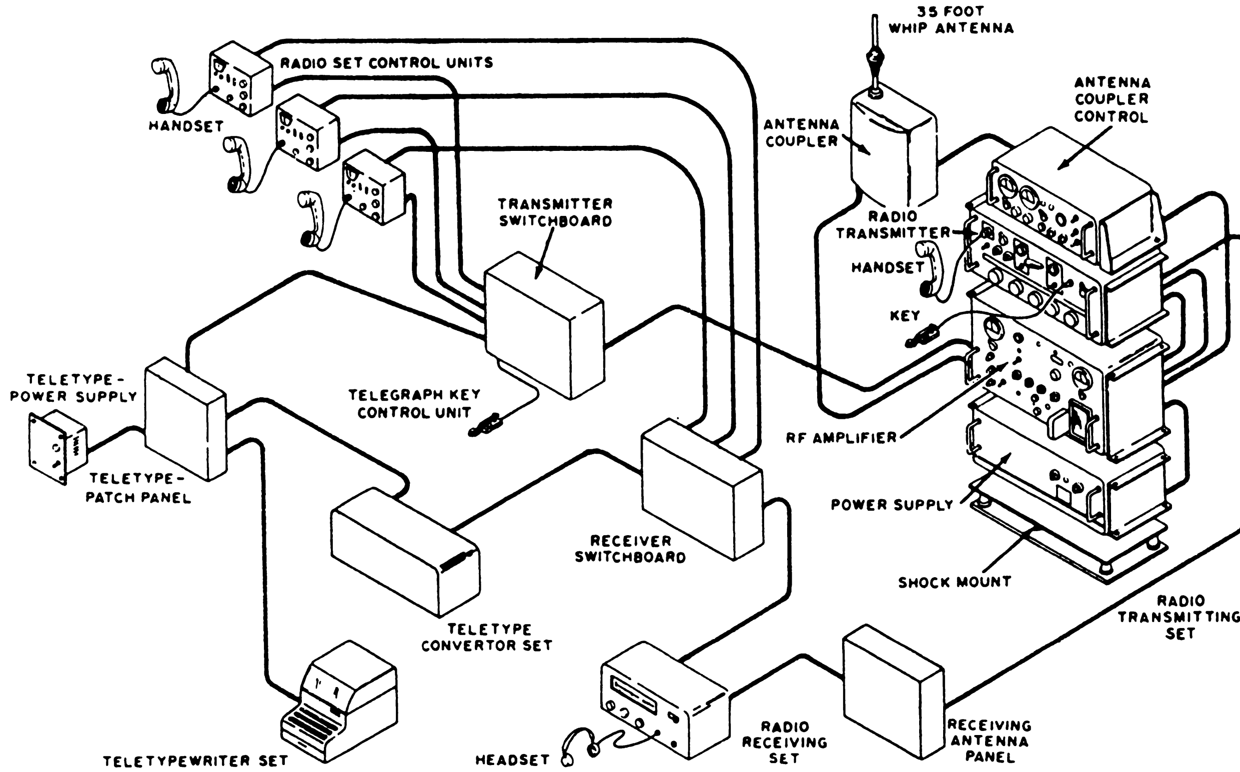


Figure 10-33.–Communication system pictorial view.

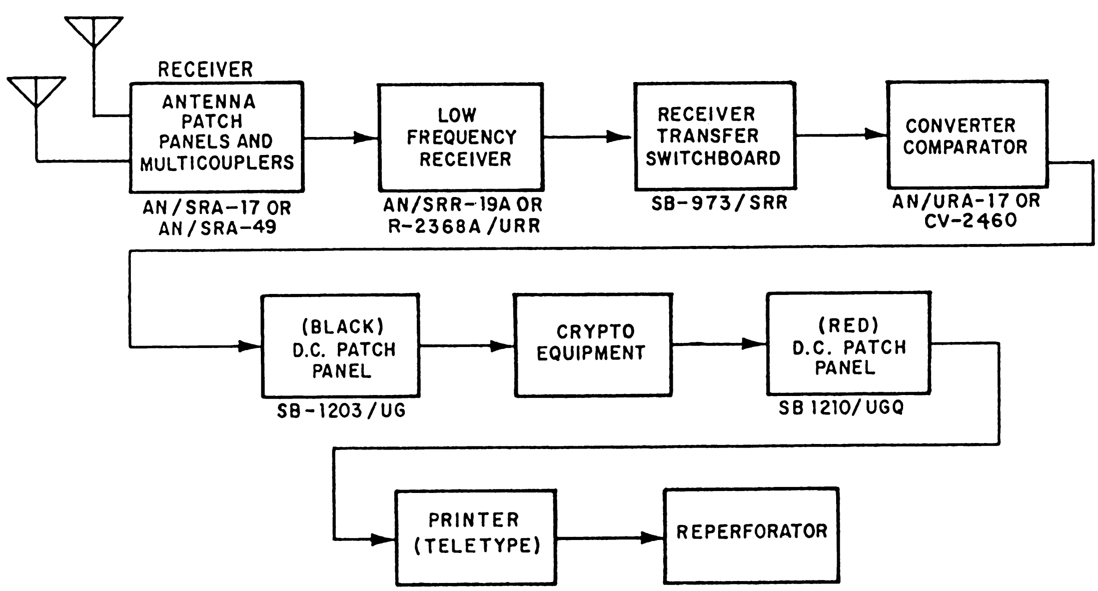


Figure 10-34.–Low-frequency receive system.

Low-Frequency Transmit

The low-frequency transmitter is used to transmit a high-powered signal over very long distances. The AN/FRT-72 transmitter is designed for this purpose. The transmitter produces 50-kW peak-envelope power (25 kW average power) and covers a frequency range of 30 to 150 kHz. Low-frequency transmitters are normally used only on shore stations or for special applications.

Low-Frequency Receive

The low-frequency receive system is designed to receive low-frequency broadcast signals and reproduce the intelligence that was transmitted. A typical low-frequency receive system is shown in figure 10-34. The low-frequency signal is received by the antennas and sent to the multicoupler and patch panel. The multicoupler and patch panel (AN/SRA-17, AN/SRA-49) allow the operator to select different

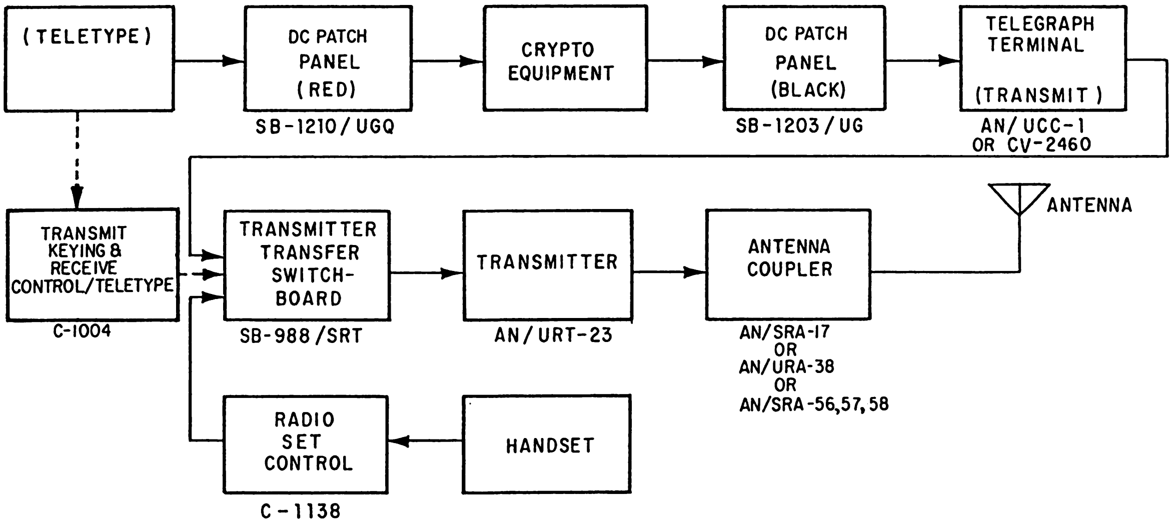


Figure 10-35.–High-frequency transmit system.

antennas and connect them to different receivers, thus selecting the correct combination for a particular job. In the low-frequency receive system in figure 10-34, the receiver used is the AN/SRR-19A or R-2368A/URR. The AN/SRR-19A operates in the frequency range of 30 to 300 kHz, while the R-2368A/URR operates from 14 kHz to 30 MHz. The output of the receiver (audio) is fed to the SB-973/SRR receiver transfer switchboard. The switchboard can connect the receiver output to numerous pieces of equipment. In figure 10-34, the receiver output is connected to an AN/URA-17 or CV-2460 converter comparator set. The set converts the received signal to dc for use by the teletype (TTY) equipment. The dc output is fed to a dc patch panel, such as the SB-1203/UG. The dc patch panel permits the signal to be patched to any crypto equipment desired. The crypto equipment decrypts the signal and sends it to a red dc patch panel such as the SB-1210/UGQ. The SB-1210/UGQ can be patched to a selected teletype printer that prints the signal in plain text, or to a reperforator, where a paper tape will be punched and stored, for printing at a later date.

HIGH FREQUENCY

The high-frequency band, 3 to 32 MHz, is used primarily by mobile and maritime units. The military uses this band for long-range voice and teletype communications. This band is also used as a backup for the satellite communications system.

High-Frequency Transmit

The high-frequency transmit signal can contain either voice or teletype information. Figure 10-35 shows a typical high-frequency transmit system used aboard ship.

The same equipment used to receive teletype messages on low frequencies (the teletype, D.C. Patch Panel SB-1210/UGQ, the crypto equipment, and D.C. Patch Panel SB-1203/UG) is used to send teletype messages on the high-frequency system, with the functions done in the reverse order.

An AN/UCC-I(V) or CV-2460 telegraph terminal converts dc signals into tone signals. The output of the AN/UCC-1(V) is connected to the SB-988/SRT transmitter transfer switchboard. A C1004 transmit keying and receive control/teletype is used to key the transmitter during TTY operation. Voice communications from some remote locations are also connected to this switchboard. The voice communications are developed at a handset (remote phone unit) and connected to the C-1138 radio set control. The output of the radio set control is connected to the SB-988/SRT transmitter transfer switchboard. The transmitter transfer switchboard permits the operator to select the proper transmitter for the selected frequency. The AN/URT-23 transmitter receives the input signal from the switchboard and changes the signal to a modulated rf signal that is connected to the AN/SRA-34, 56, -57, -58, or AN/URA-38 antenna coupler. The antenna coupler is used to match the output impedance of the transmitter to the input impedance of the antenna. Antenna couplers also permit more than one

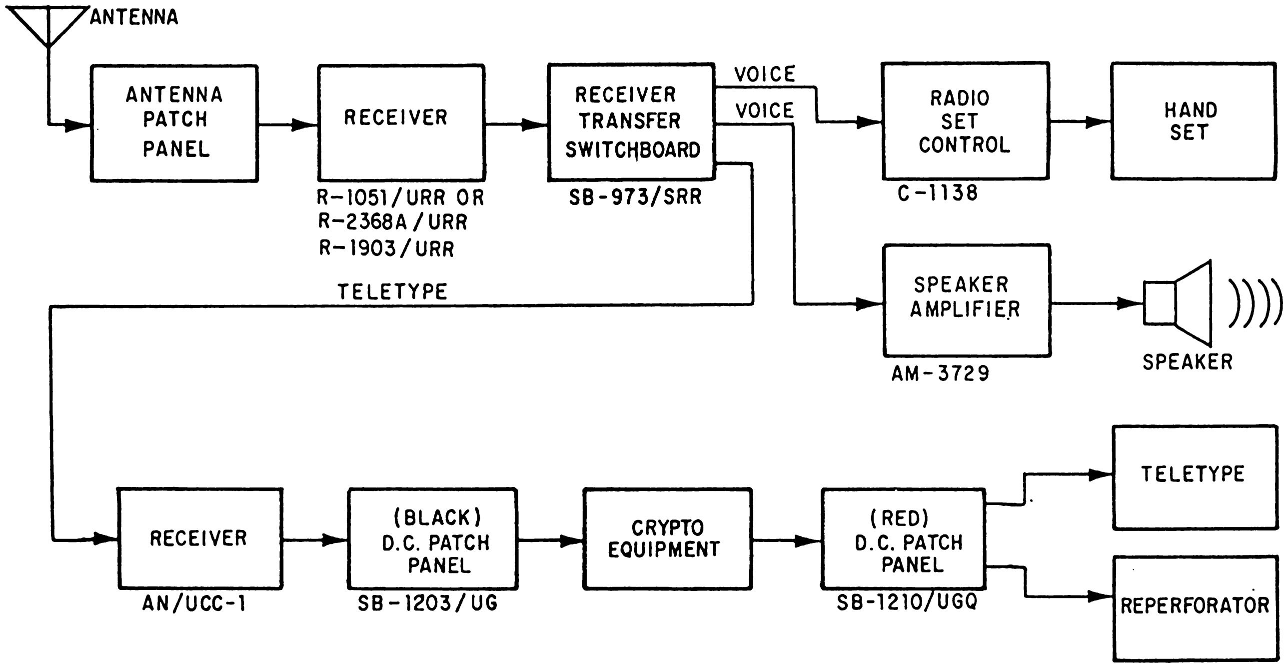


Figure 10-36.–High-frequency receive system.

transmitter to be connected to the same antenna as long as certain conditions are met. When the signal reaches the antenna, it is radiated into the atmosphere.

High-Frequency Receive

A typical high-frequency receive system is shown in figure 10-36. A transmitted signal, similar to the one just described in the previous section, is received by the antenna, and converted from electromagnetic energy to electrical energy. The signal is connected to an antenna patch panel where it can be distributed to any number of receivers. In figure 10-36, receivers R-1051/URR, R-2368/URR, or R-1903/URR convert the rf signal into either a teletype signal (fsk) or a voice signal, depending upon which is desired. The output of the receiver is then connected to the SB-973/SRR receiver transfer switchboard. The teletype signal from the SB-973/SRR will follow the same path used by the low-frequency signal previously discussed. Identical pieces of equipment are used to perform the same functions. The voice signal from the SB-973/SRR receiver transfer switchboard is sent to the C-1138 radio set control. The output is then connected to a handset. The voice signal can also be sent from the switchboard to an AM-3729 remote speaker amplifier. There, it can be placed on a speaker so the user can listen to the received signal without holding on to the handset.

VERY-HIGH-FREQUENCY

The very-high-frequency band, 30 to 300 MHz, is used for aeronautical radio navigation and communications, radar, amateur radio, and mobile communications. The Navy uses this band for mobile communications, such as for boat crews and landing parties, and bridge-to-bridge communications.

Very-High-Frequency Transmit

A basic block diagram of a vhf transmit and receive system is shown in figure 10-37. On the transmit side of

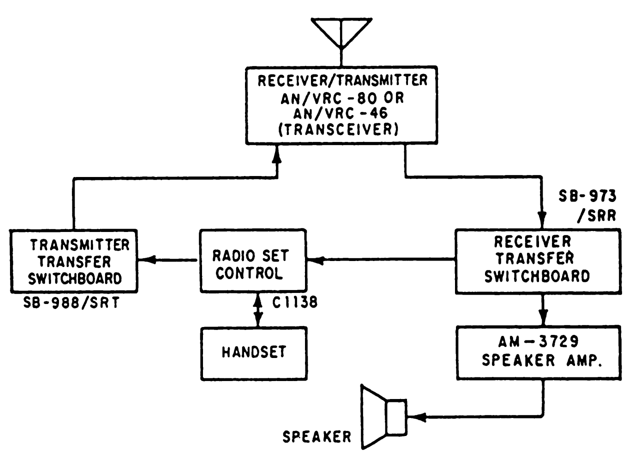


Figure 10-37.–Very-high-frequency transmit and receive.

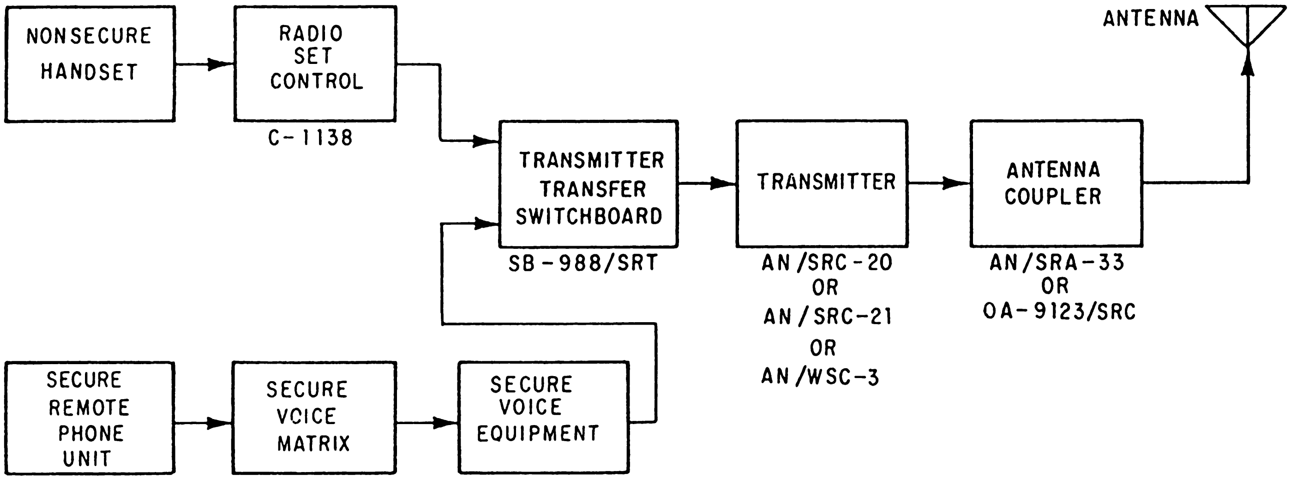


Figure 10-38.–Ultrahigh-frequency transmit.

the system, the operator, at a remote location, talks into the handset. The handset is connected to a C-1138 radio set control. The output of the radio set control is connected to an SB-988/SRT transmitter transfer switchboard. The switchboard performs the same function as it did in the lf and hf systems. The output of the switchboard is connected to the transmit side of the AN/VRC-46 receiver/transmitter (transceiver). The transceiver converts the input signal to an rf signal for radiation by the antenna.

Very-High-Frequency Receive

The incoming signal (fig. 10-37) is received by the antenna. The signal is connected to the receive side of an AN/VRC-46 transceiver. The output of the transceiver is connected to an SB-973/SRR receiver transfer switchboard. The output of the receiver transfer switchboard is connected to either a C-1138 radio set control or an AM-3729 speaker amplifier, or both, depending on the preference of the user. The output of the radio set control is connected to the handset. The output of the speaker amplifier is connected to the speaker.

ULTRAHIGH-FREQUENCY

The ultrahigh-frequency band is used for line-of-sight (short-range) command and control communications. Line-of-sight means that both antennas must be aimed at one another, with no obstruction between them for proper operation. This band is also used for satellite communications. Satellite communications are still line-of-sight (though the distance traveled by the signal is much greater than that of surface communications) because the antennas remain in sight of each other.

The transmitter and receiver used in the uhf system form one piece of equipment (a transceiver); however, we will describe the transmit and receive systems separately. Although the UHF description in subsequent paragraphs pertains to voice communication, UHF equipment can also process teletype data as shown in the discussion on HF.

Ultrahigh-Frequency Transmit

A basic block diagram of a uhf transmit system is shown in figure 10-38. On the transmit side of the nonsecure voice system, the operator at a remote location talks into the handset. The handset is connected to a C-1138 radio set control. The C-1138 is connected to an SB-988/SRT transmitter transfer switchboard, where it is patched to the transmitter.

On the transmit side of the secure voice system, the operator at a remote location talks into the secure voice remote phone unit (RPU). The RPU is connected to the secure voice matrix. The matrix is the tie point for the connection of more than one remote phone unit. The output of the matrix is connected to the secure voice equipment, which encrypts the information received. The output of the secure voice equipment in connected to an SB-988/SRT transmitter transfer switchboard.

The transmitter transfer switchboard is used to connect numerous remote phone units to any number of transmitters. The output of the patch panel is connected to the transmitter side of the AN/SRC-20/21 or AN/WSC-3, which in turn is connected to an

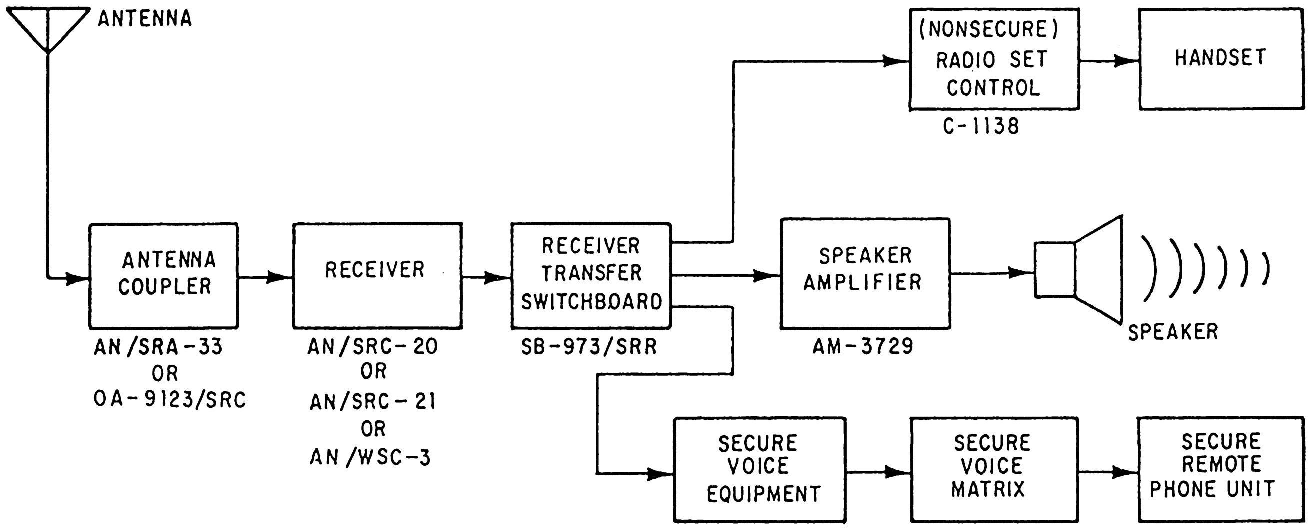


Figure 10-39.–Ultrahigh-frequency receive.

AN/SRA-33 or OA-9123 antenna coupler and then is connected to the antenna.

Ultrahigh-Frequency Receive

A basic block diagram of a uhf receive system is shown in figure 10-39. The received signal is picked up by the antenna and sent to the receiver side of the AN/SRC-20/21 or AN/WSC-3 through an AN/SRA-33 or OA-9123/SRC antenna coupler. The output of the receiver is connected to an SB-973/SRR receiver transfer switchboard, where it can be connected to either the nonsecure or secure voice system, depending upon the mode of transmission. When a nonsecure signal is received, the output of the receive transfer switchboard is connected to either the C-1138 radio set control or the AM-3729 speaker amplifier, or both, depending on the preference of the user.

If a secure voice transmission is received, the output of the receiver transfer switchboard is connected to the secure voice equipment, where it is decrypted. The output of the secure voice equipment is connected to the secure voice matrix, which performs the same function as the matrix on the transmit system. The output of the secure voice matrix is connected to the secure remote phone unit, where the signal is converted back to its original form.

COMMUNICATIONS EQUIPMENT CONFIGURATION

All of the communications equipment described in this chapter are combined in figure 10-40 (a foldout at the end of this chapter) to show a representative shipboard communications system. Each system that has been described can be followed on figure 10-40. This figure illustrates that one piece of equipment can be used for more than one system. Examples of this are the SB988/SRT transmitter transfer switchboard and the SB973/SRR receiver transfer switchboard. With the equipment connected as shown, one operator at any given location has access to any number of different pieces of equipment, using different patching arrangements. Such arrangements allow the operator to accomplish the mission assigned.

PORTABLE AND PACK RADIO EQUIPMENT

Because portable and pack radio sets must be lightweight, compact, and self-contained, they usually are powered by a battery or hand generator, have low output power, and are either transceivers or transmitter-receivers. Navy ships carry a variety of these radio sets for emergency and amphibious communications. The numbers and types of this equipment vary according to the individual ship.

EMERGENCY EQUIPMENT

A few radio sets are designed to be used by individuals or groups who find themselves separated from their ships or aircraft in emergency situations. Two of those sets are described below.

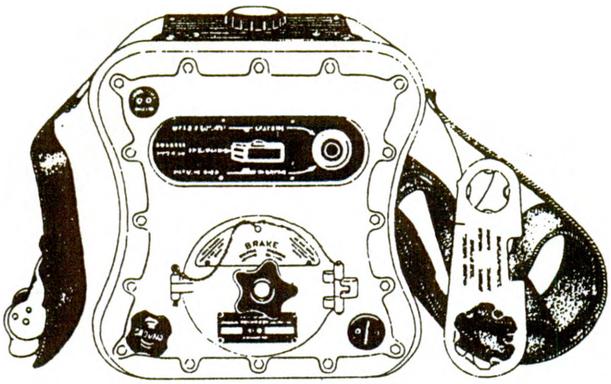


Figure 10-41.–Emergency lifeboat Radio Transmitter AN/CRT-3A.

Transmitter AN/CRT-3A

The AN/CRT-3A radio transmitter, popularly known as the "Gibson girl," is a rugged emergency transmitter carried aboard ships and aircraft for use in lifeboats and liferafts. It is shown in figure 10-41. No receiving equipment is included.

The transmitter operates on the international distress frequency (500 kHz) and the survival craft communication frequency (8364 kHz). The complete radio transmitter, including the power supply, is contained in an airtight and waterproof aluminum cabinet. The cabinet is shaped to fit between the operator's legs, and has a strap for securing it in the operating position.

The only operating controls are a three-position selector switch and a pushbutton telegraph key. A handcrank screws into a socket in the top of the cabinet. The generator, automatic keying, and automatic frequency changing are all operated by turning the handcrank. While the handcrank is being turned, the set automatically transmits the distress signal SOS in Morse code. The code consists of six groups of SOS followed by a 20-second dash, transmitted alternately on 500 kHz and 8364 kHz. The frequency automatically changes every 50 seconds. These signals are intended for reception by two groups of stations, each having distinct rescue functions. Direction-finding stations cooperating in long-range rescue operations normally use 8364 kHz signals, whereas aircraft or ships locally engaged in search and rescue missions use 500-kHz signals.

Besides the automatic feature, the transmitter can be keyed manually, on 500 kHz only, by means of the pushbutton telegraph key.

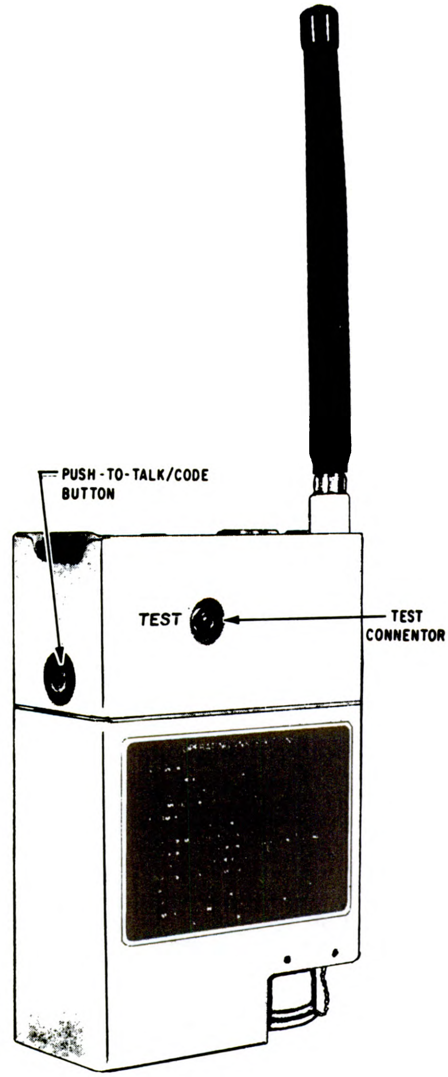


Figure 10-42.–Portable Transceiver AN/PRC-96.

Additional items (not shown) packaged with the transmitter include the antenna, a box kite, and balloons for supporting the antenna, hydrogen-generating chemicals for inflating the balloons, and a signal lamp that can be powered by the handcrank generator. The equipment floats, and is painted brilliant orange-yellow to provide greatest visibility against dark backgrounds.

Radio Set AN/PRC-96

The AN/PRC-96 radio set (fig. 10-42) is a dual-channel, battery powered, portable transceiver, that provides homing information and two-way voice communications between life rafts and searching ships and aircraft. A microminiature, solid state, hand-held radio, which operates on the 121.5-MHz and 243-MHz guard channels, the transceiver has four operating controls: the VOL (volume) control; the two position

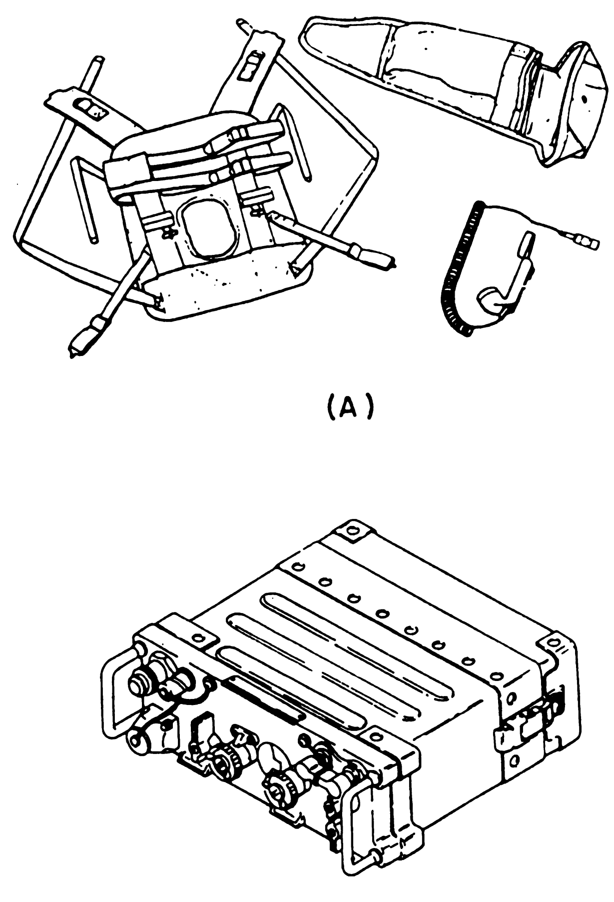


Figure 10-43.–Typical VHF/UHF backpack transceiver.

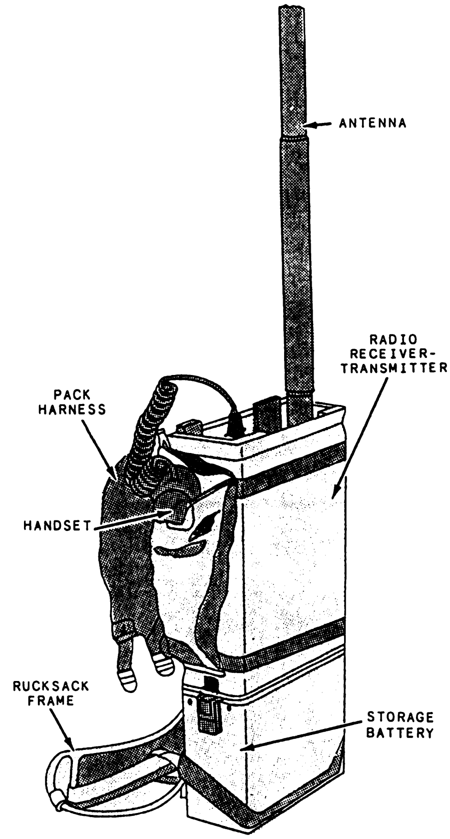


Figure 10-44.–Radio Transceiver AN/PRC-41.

FREQUENCY Selector; the PUSH-TO-TALK/CODE button; and the three-position MODE switch.

The antenna is a 7.75-inch, rubber covered, omni-directional, flexible whip antenna. The batteries supplied with the radio set are lithium D cells. Each cell is fused to protect against damage from external short circuits. Two cells are installed in the transceiver and four are packaged as spare assemblies.

OPERATIONAL PORTABLE EQUIPMENT

Duty assignments frequently require workers to use portable communications equipment. Several types of such equipment are described below.

An operational transceiver is shown in figure 10-43. It is watertight, lightweight, portable, and operates in the vhf and uhf ranges. It was designed mainly for backpack use, but may also be used at a fixed station or in vehicles. When not in use, the equipment is disassembled and stowed in a special aluminum case similar to an ordinary suitcase. This type of transceiver can be operated on any of 1,750 channels, spaced 200 kilohertz apart, in the 225-400 megahertz range. Its mode of operation is AM voice, with an average output power of 3 watts.

Figure 10-43 also shows a typical vhf miniaturized manpack radio set. View A shows the pack frame, the handset, and the canvas accessory pouch. The pouch contains two antennas (one flexible steel bandtype whip and one collapsible rigid whip). The handset fits in the pouch when not in use. View B shows the transmitter-receiver.

Transceiver AN/PRC-41

The AN/PRC-41 radio set (fig. 10-44) is a watertight, lightweight, portable uhf transceiver that may be operated on any of 1750 channels spaced 100 kHz apart in the 225- to 400-MHz range. Its only mode of operation is AM voice, at an average output power of 3 watts. Although designed principally for manpack operation, the set may also be used for fixed station and vehicular operation when complemented by certain accessories. When not in use, the equipment is disassembled and stowed in a compartmentized aluminum transit case similar to an ordinary suitcase.

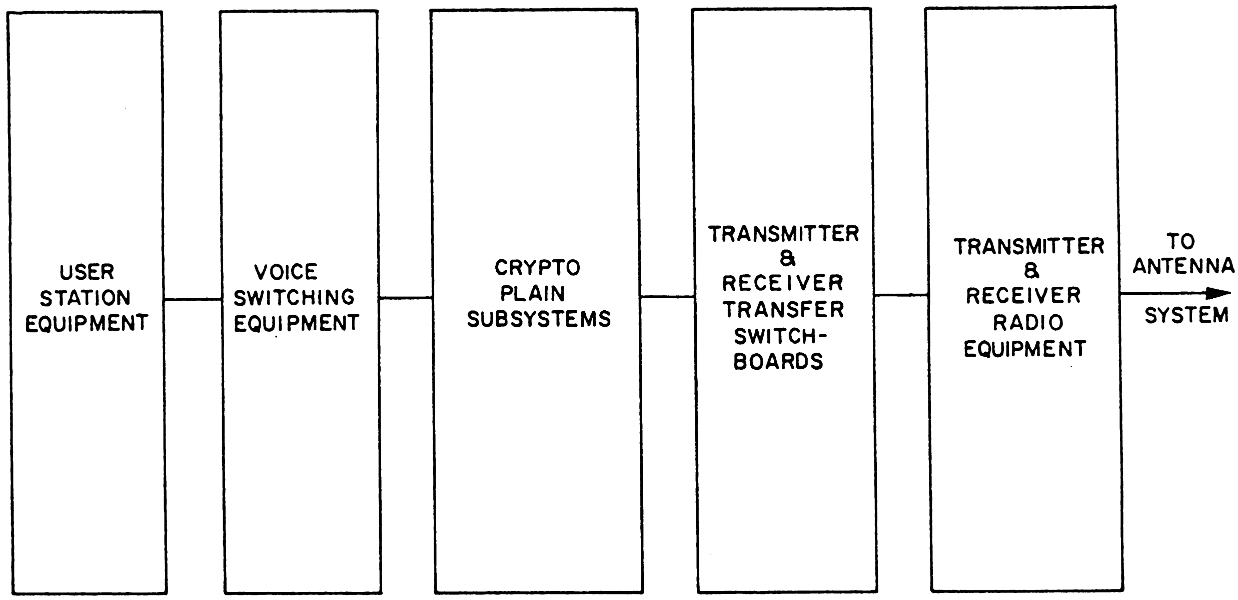


Figure 10-45.–Single Audio System (SAS).

MULTIPLEXING

The number of communications networks in operation per unit of time throughout any given area is constantly increasing. As a result, all areas of the rf spectrum have become highly congested.

To a great extent, the maximum permissible number of intelligible transmissions taking place in the radio spectrum per unit of time is being increased through the use of multiplexing. Multiplexing involves the simultaneous transmission of a number of intelligible signals using only a single transmitting path. Either of two methods of multiplexing may be used. These are time-division and frequency-division multiplexing, both widely used in U.S. Naval communications.

TIME-DIVISION MULTIPLEXING

Time division multiplexing is mostly used in AM voice and tone communications. A common equipment used in time division multiplexing is the AN/SSR-1.

FREQUENCY DIVISION MULTIPLEXING

Frequency division multiplexing (fdm) can be divided into two categories, one used for voice communications, and the other for teletype communications. A common piece of equipment used in frequency division multiplexing is the AN/UCC-1.

For more detailed information on multiplexing, refer to NEETS Module 17.

SINGLE AUDIO SYSTEM

The Single Audio System (SAS) was developed to fulfill the requirement for an integrated secure or nonsecure shipboard voice communications system. It consists of newly developed telephone sets, voice-signal switching devices, various control devices, and field changes to existing equipments, in conjunction with other existing elements of the overall radio communications system. The SAS is essentially the baseband (hf, vhf, or uhf) audio subset of the shipboard exterior communications system. It incorporates the voice communications circuits, user control of the operating mode (both secure and nonsecure), and various degrees of user control over circuit selection. Figure 10-45 shows the major equipment groups and subsystems and theory interrelationship. There are two versions of SAS: automated (ASAS) and manual (MSAS). The principal differences are in their voice switching equipments and in the means provided for user control over circuit selection. (An example of user control is the choice of desired communication channel.) Information in this section applies to both the ASAS and the MSAS unless otherwise specified.

There is no specific list of equipments that constitutes an SAS installation. There can be different types and quantities of equipment in each of the groups identified in figure 10-45. Equipment quantities are dictated by the communications requirements of individual ships and ship classes. Commonly used equipment in the SAS presently installed in the fleets can be found in *Operation and Maintenance*

Instructions, Single Audio System, NAVELEX EE109-CA-OMI-010/E110 SAS, tables 1-1 and 1-2.

SYSTEM CAPABILITIES

The SAS incorporates the basic capabilities for setting up and operating voice communications circuits. An SAS installation has the unique capability to communicate in a secure or nonsecure mode, at the discretion of the operator, from a single telephone or NTDS device. This single audio interface with various crypto or plain subsystems in the ship's communications system is the essence of the SAS. The SAS has the capability to have:

1. The user select the transmit operating mode except for FLTSATCOM secure voice and PLAIN configuration
2. The system notify the user of the transmit operating mode selected both visually and with audio indications
3. The system notify the user by visual indication if the voice station equipment is not connected to a crypto or plain subsystem
4. The system notify the user of any incoming CIPHER signals by both visual and audio indications except for the FLTSATCOM secure voice configuration
5. The voice channel selected by the user and indicated visually

In addition to the capabilities listed above for the SAS, the ASAS version has the following features:

1. A processor-controlled, programmable voice switch.
2. A voice switch self-test and fault location readout (built-in test).
3. The system will notify the user (with audio indication) when the voice switch built-in-test (BIT) detects a short in a trunk line (trunk short).
4. A technical control monitor phone, incorporated into the voice switch, which can access all voice channels.

SYSTEMS EQUIPMENT AND PHYSICAL LOCATION

The following paragraphs provide a brief description of the major equipments included in a typical SAS installation. Figure 10-45 illustrates the audio path of the system and the order in which we will discuss the equipments.

User Station Equipment

User station equipment is located in various operations centers throughout the ship, such as the bridge, combat information center (CIC), flag plot, secondary conn, and other stations where exterior voice communication is required by the ship's mission. This equipment consists of telephone sets, audio amplifiers, loudspeakers, headsets, recorders, audio jackboxes, Navy tactical data system (NTDS) consoles and intercom units, and local switching devices for added system configuration flexibility.

Voice Switching Equipment

The voice switching equipment is a major component of the SAS. It is the interface and primary switch between the user's equipment and all crypto and plain subsystems. It is designed for very high interchannel isolation, a TEMPEST requirement for all equipments that handle both secure and nonsecure signals simultaneously. (The ASAS and MSAS use different switches for this function.)

Crypto and Plain Subsystems

The various crypto and plain subsystems are located in the main communications spaces. Cryptographic devices and other "red" equipments are located in a secure area within these spaces. There are five crypto and plain subsystems used within the SAS: NESTOR, VINSON, PARKHILL, FLTSATCOM secure voice, and PLAIN ONLY. Additional classified information on these subsystems is available on a need-to-know basis.

Transmitter and Receiver Transfer Switchboards

These equipments are part of the overall exterior communications switching system and are located in the main communications spaces, generally in the vicinity of the technical control working area. The switchboard equipment group interconnects crypto and plain subsystem equipments with the appropriate radio equipments. These switchboards are also the interconnecting points for other subsystems within the overall exterior communications system and are not unique to the SAS.

Transmit and Receive Radio Equipment

These equipments may be located in both the main communications spaces and in separate rooms located in various parts of the ship. This equipment group consists of the various transmitters, transceivers, and receivers used for voice nets. The more common transceivers that you will encounter are the AN/SRC-20 series, AN/VRC-46, AN/WSC-3(V)3 and (V)7, AN/URC-93, and AN/WSC-6. Common transmitters include the AN/URT-23, AN/URT-24, T-1322/SRC, and AN/GRT-21. Common receivers are the R-1051 series, R-1903, and AN/GRR-23. For additional information on individual pieces of equipment, refer to the applicable equipment technical manual.

ASSOCIATED EQUIPMENTS

The transmitter and receiver radio equipment group of the SAS interfaces with the usual radio-frequency (rf) components of the ship's exterior communications system. While these components must operate satisfactorily for the SAS to operate successfully, they have no direct application to the single audio concept and therefore are not discussed in this section. If you desire information on applicable rf components such as couplers, rf switches, and antennas, consult your ship's documentation.

SATELLITE COMMUNICATIONS

Experience with satellite communications has shown that such systems can provide reliable, survivable, high capacity, secure, and cost effective telecommunications for the military.

Satellites are the ideal, if not the only, solution to problems of communicating with highly mobile forces deployed worldwide.

For the past 50 years, the Navy has used high-frequency (hf) transmission as its primary method of sending messages. In the 1970s, an era when the hf spectrum was overcrowded, when "free" frequencies were at a premium, and when hf jamming techniques became highly sophisticated, the need for new and advanced long-range transmission methods became readily apparent.

Communications via satellite is a natural outgrowth of modern technology and the continuing demand for greater capacity and higher quality communication.

Although the communications facilities of the various military departments have generally been able to support requirements in the past, large-scale improvements will have to be made to satisfy future needs. The usage rate of available frequencies by both commercial and military systems has increased steadily in recent years, and there appears to be general agreement that this trend will continue. Centralized control of military operations, with its accompanying reliability and security requirements, has generated demands for communications with greater capacity and for long-range communications to previously inaccessible areas. Some of these requirements can be met only by the sophisticated modulation techniques and narrowband, long-distance communications made possible by the use of satellites.

SATELLITE COMMUNICATIONS SYSTEM FUNDAMENTALS

A satellite communications system uses earth-orbiting vehicles or satellites to relay radio transmissions between earth terminals. There are two types of communication satellites, active and passive. A passive satellite merely reflects radio signals back to earth. An active satellite, on the other hand, acts as a repeater; it amplifies signals received and then retransmits them back to earth. This amplification results in a stronger signal at the receiving terminal than would be possible from a passive satellite. Therefore communication system use active satellites.

A typical operational link involves an active satellite and two earth terminals. One station transmits to the satellite on a frequency called the *uplink* frequency. The satellite amplifies the signal, translates it to the *downlink* frequency, and then transmits it back to earth where it is picked up by the receiving terminal. This basic concept is illustrated by figure 10-46, which shows several types of earth terminals.

The basic design of a satellite communication system depends to a great degree upon the satellite's orbit. An orbit is generally either elliptical or circular, with an inclined, polar, or equatorial orientation. A special type of orbit, called a *synchronous* orbit, has a period the same as the earth's rotation. Communication satellites are in equatorial synchronous orbits and therefore appear stationary to an earth terminal. The area of the earth that a particular satellite can cover is known as the footprint, as depicted in figure 10-47.

The essential basic system components of an operational communication satellite system are (1) an orbiting vehicle with a communication receiver and transmitter installed and (2) two earth terminals

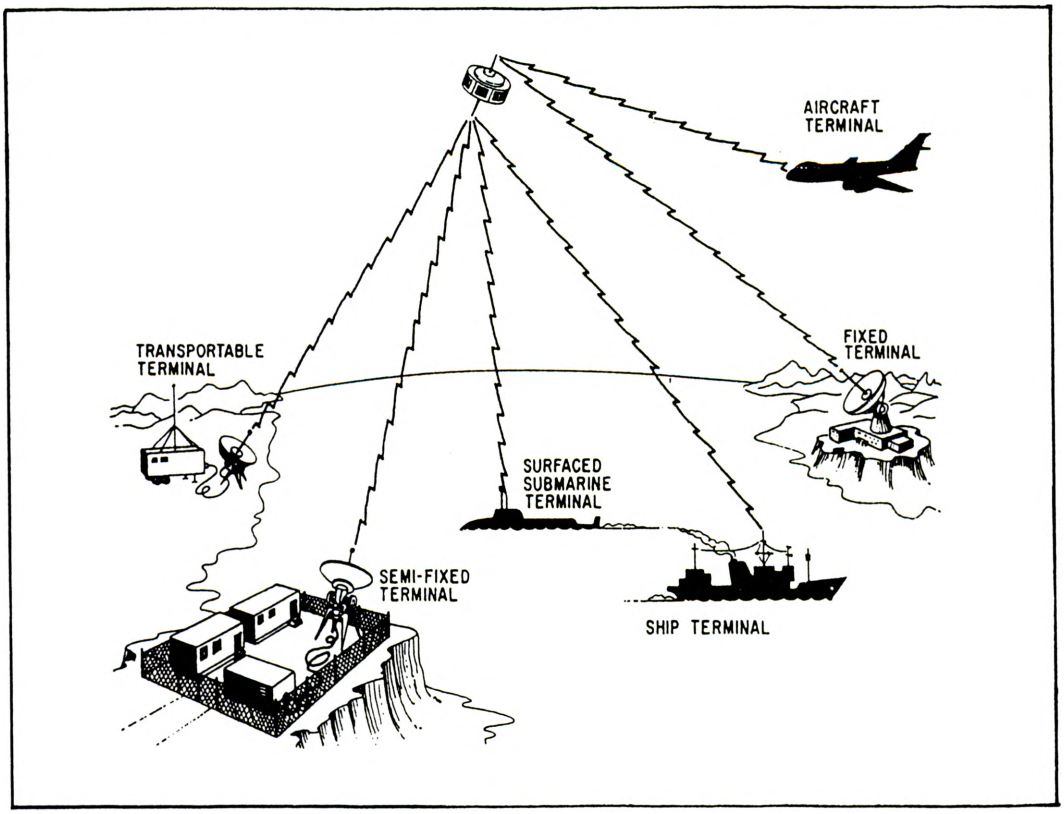


Figure 10-46.–Satellite communication system.

equipped to transmit and receive signals to and from the satellite. The end use or purpose determines the complexity of the various components and the manner in which the specific system operates.

ROLE OF SATELLITE COMMUNICATIONS

In the context of a worldwide military communications network, satellite communications systems are very important. Satellite communications links add capabilities and provide additional alternate routings for communications traffic. Satellite links, as one of several kinds of long-distance links, interconnect switching centers located strategically around the world.

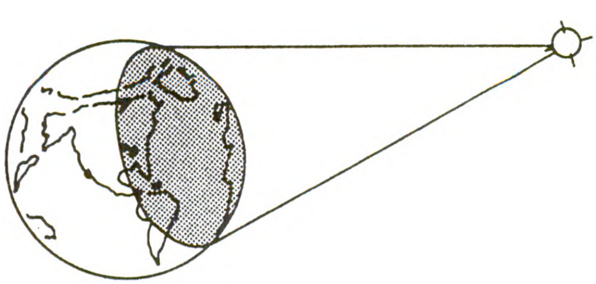


Figure 10-47.–Footprint of a satellite.

They are part of the defense satellite communication system (DSCS) network and Fleet Satellite Communications. One important aspect of the satellite communications network is that it continues in operation under conditions that sometimes render other methods of communications inoperable. Because of this, satellites make a significant contribution to improved reliability of Navy communications.

ADVANTAGES OF SATELLITE COMMUNICATIONS

Satellite communications have unique advantages over conventional long-distance transmissions. Satellite links are unaffected by the propagation variations that interfere with hf radio. They are also free from the high attenuation of wire or cable facilities and are capable of spanning long distances. The numerous repeater stations required for line-of-sight or troposcatter links are not needed. Satellite links furnish the reliability and flexibility of service that is needed to support a military operation.

Capacity

The present military communications satellite system is capable of providing communications between backpack, airborne, and shipborne terminals. The system is capable of handling thousands of communications channels simultaneously.

Reliability

Communications satellite frequencies do not depend on reflection or refraction and are affected only slightly by atmospheric phenomena. The reliability of satellite communications systems is limited only by the equipment reliability and the skill of the operating and maintenance personnel.

Vulnerability

Destruction of an orbiting vehicle by an enemy is possible. However, destruction of a single communications satellite would be quite difficult and expensive compared to the tactical advantage gained. The earth terminals offer a more attractive target for physical destruction. These can be protected by the same measures that are taken to protect other vital installations.

A high degree of freedom from jamming damage is provide by the highly directional antennas at the earth terminals. The wide bandwidth system can accommodate sophisticated antijamming modulation techniques and also lessen vulnerability.

Flexibility

Most operational military satellite earth terminals are highly mobile. With trained crews these terminals can be deployed and put into operation in a matter of hours. Worldwide communications can be established quickly to remote areas nearly anywhere in the world.

SATELLITE LIMITATIONS

Limitations of a satellite communications system are determined by the technical characteristics of the satellite and its orbital parameters. Active communications satellite systems are limited by transmitter power on the down links and receiver sensitivity on the up links.

The amount of energy available in an active satellite is limited by its solar cells. Therefore, the satellite's rf output power is severely limited. This problem is amplified by users who unknowingly increase their rf output power to the satellite. The satellite in turn will try to retransmit at the new power level at the expense of the other user signals that will be reduced.

DEFENSE SATELLITE COMMUNICATIONS SYSTEMS (DSCS) (PHASE II)

The Defense Satellite Communications System provides SHF, high speed, worldwide, jam-resistant satellite communication for all branches of the Department of Defense. Virtually any form of communications, from DSN (formerly Autovon) to complex digital data circuits, can be transmitted over the DSCS network. The DSCS satellites are maintained by the Air Force, but the Army has been given overall responsibility for the DSCS Program. The Navy uses four basic SHF satellite terminals to meet the worldwide DSCS satellite communications requirement. These four systems are: AN/FSC-78(V), AN/GSC-39, AN/GSC-52, and AN/WSC-6. The first three are used at fixed ground stations. The AN/WSC-6 is used aboard fleet flag ships to provide SHF lateral communications with fleet commanders. For further information on the Defense Satellite Program, see *NTP 2 Navy Satellite Operations.*

FLEET SATELLITE COMMUNICATIONS

The Fleet Satellite Communication (FLTSATCOM) System provides communications links, via satellite, between designated mobile units and shore sites. The area of coverage for these communications links is worldwide, between the latitudes of 70°N and 70°S.

You can understand the impact of the FLTSATCOM System upon naval communications when you realize that equipment in support of this system is being placed on surface ships, submarines, aircraft, and shore stations. These equipment installations vary in size and complexity, depending on the communication requirements at each installation. Furthermore, with the exception of voice communications, the system applies the technology of computer controlled rf links and uses computers in the preparation and handling of message traffic.

Although any part of the FLTSATCOM System may be operated as a separate module, the system integration provides connections for message traffic and voice communications to DOD communications networks. Backup capability that can be used in the event of an outage is provided between shore stations. This capability is built in as part of the system design, and is limited to selected FLTSATCOM subsystems and by the ability of shore stations to access various satellites.

The FLTSATCOM system represents a composite of information exchange subsystems that use the satellites as a relay for communications. Each subsystem has been designed to address a selected area of naval communications. The following subsystems compose the Navy's portion of the FLTSATCOM system.

- Fleet Satellite Broadcast (FSB) Subsystem. This subsystem is an expansion of Fleet Broadcast transmissions that historically have been the central communications medium for operating naval units.

- Common User Digital Information Exchange Subsystem (CUDIXS)/Naval Modular Automated Communication System (NAVMACS). CUDIXS/NAVMACS form a communications network that is used for transmission of general service message traffic between designated ships and shore installations.

- Submarine Satellite Information Exchange Subsystem (SSIXS). The SSIXS complements existing communications links between SSBN and SSN submarines and shore terminals.

- Officer in Tactical Command Information Exchange Subsystem (OTCIXS). The OTCIXS is an interbattle group command and control network for AAW, ASUW, ASW, ASMD battle force coordination.

- Tactical Data Information Exchange Subsystem (TADIXS). This is a one-way broadcast of tactical information from command centers ashore to afloat units primarily in support of over-the-horizon targeting.

- Secure Voice Subsystem. This is a secure uhf link that provides beyond line-of-sight voice communications between ships and connection with wide-area voice networks ashore. This subsystem is used for passing alert, warning, tactical, and directional information.

- Tactical Intelligence Information Exchange Subsystem (TACINTEL). This subsystem is specifically designed for special intelligence communications.

- Control Subsystem. This subsystem is a communication network that provides status reporting and management of FLTSATCOM system assets.

The installation of a particular subsystem equipment aboard ships and aircraft is determined by communications traffic levels, types of communications, and operational missions. Fleet Satellite Broadcast message traffic, as a common denominator for naval communications, will be received by all types of units. In some installations, such as large ships, the Fleet Broadcast receiver is one part of the FLTSATCOM equipment suite. A typical suite on a ship would include Fleet Broadcast, NAVMACS, Secure Voice, and possibly TACINTEL equipment.

FLTSATCOM SHOREBASED TERMINALS

FLTSATCOM shore terminals are installed at four Naval Communications Transmission and Monitoring Stations (NCTAMS) which bear prime responsibility, in selected geographical areas, for naval communications on FLTSATCOM satellites. These stations are as follows:

– NCTAMS LANT; Norfolk, Virginia

– NCTAMS MED; Bagnoli, Italy

– NCTAMS WESTPAC; Finegayan, Guam

– NCTAMS EASTPAC; Wahiawa, Hawaii

FLEET SATELLITE BROADCAST SUBSYSTEM

The Fleet Satellite Broadcast Subsystem provides the capability to transmit Fleet Broadcast message traffic in a high level jamming environment. The subsystem provides 15 subchannels of covered message traffic. These 15 subchannels are time division multiplexed and transmitted in a one-way shf transmission to the satellite. At the satellite, the transmission is translated from shf to uhf for transmission on the down link to the subscriber.

Two frequency bands, shf and uhf, are available for Fleet Broadcast transmission. The shf band uses the AN/FSC-79 Satellite Communications Terminal, and the uhf band uses the AN/WSC-5(V) Transceiver for backup operation.

The Fleet Broadcast message traffic is arranged and channelized prior to transmission by two processor-controlled message switching systems. These

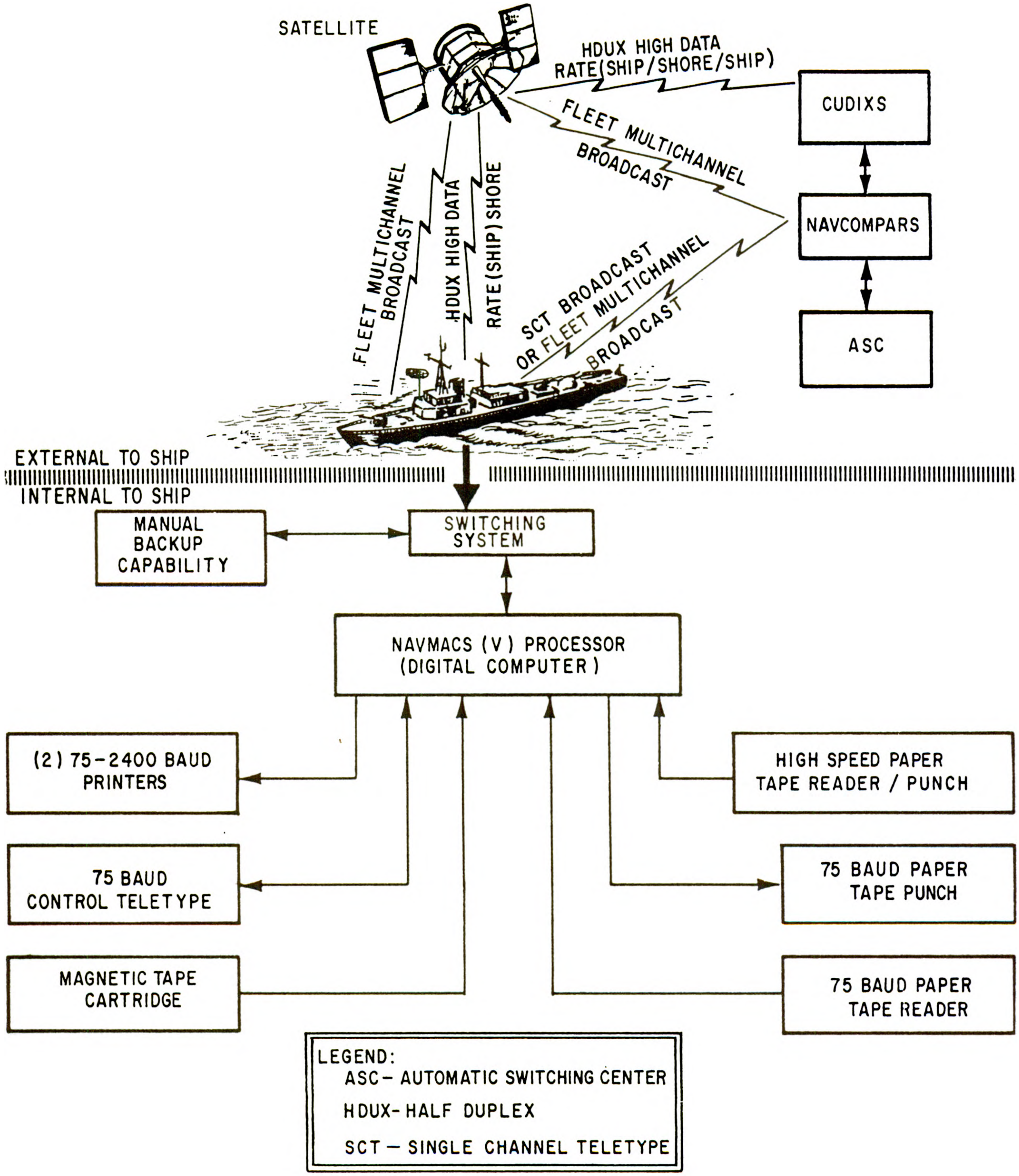


Figure 10-48.–NAVMACS (V) communications interface.

systems are the Naval Communication Processing and Routing System (NAVCOMPARS), for general service message traffic, and Streamliner, for special intelligence message traffic. Fleet weather data, which is also transmitted on Fleet Broadcast, is put into the transmission by teletype from Naval Oceanographic Centers.

CUDIXS/NAVMACS SUBSYSTEM

The NAVMACS (V) is a shipboard message processing system that automatically guards a minimum of four broadcast channels, serves as an automated shipboard terminal for the CUDIXS, and provides accountability for all incoming and outgoing message processing needs for ships of the fleet. There are currently three configurations of NAVMACS systems used in the fleet. A basic NAVMACS is depicted in figure 10-48.

A basic NAVMACS consists of the following equipment:

- NAVMACS (V) PROCESSOR.–A general-purpose computer used for control functions and message processing. An AN/UYK-20() is commonly used.
- 75-2400 BAUD PRINTERS (2).–These printers are used to print headings and the text of incoming messages and operator requested reports. The TT624 is the commonly used printer.
- CONTROL TELETYPE.–This teletype is used by the operator to interface with the system.
- MAGNETIC TAPE CARTRIDGES.–These cartridges are used for loading the computer program and for long term message storage.
- HIGH-SPEED PAPER TAPE READER/ PUNCH.–The reader is used for inputting outgoing messages. The punch is used as an output device for operator requested retrievals of messages and off-line encrypted messages. This can also serve as a backup for the magnetic tape cartridge
- 75 BAUD PAPER TAPE PUNCH.–This punch is used as a backup for the high-speed tape punch.
- 75 BAUD PAPER TAPE READER.–This reader is used as a backup for the high-speed tape reader.

The computer interfaces with the CUDIXS link through an interconnection group and with the broadcast channels through a converter or switchboard.

The operator communicates with the system via the control teletype. Using the control teletype, the operator instructs the system concerning major operational functions. These functions include identifying wanted messages, broadcast channels to be guarded, the status of the CUDIXS link, and the status of the equipment.

The NAVMACS (V) reads the headings of incoming broadcast message traffic and separates all messages addressed to the ship or commands for which it is guarding. The system compares every addressee on each incoming first-run message against entries in its command guard list (CGL), which contains the addresses for which the ship is guarding. When the system finds one or more matches between addresses on the first-run message and the entries of the CGL, the message is printed (copied) completely on a line printer. If an Emergency or Flash precedence message (which could affect everyone in the system) on a first-run message is received, it is printed completely regardless of whether or not a match is found. When a match is not found with the CGL for a message having a precedence lower than Flash, only the heading of the message is printed.

CUDIXS LINK TRAFFIC

The CUDIXS is a high-speed, half-duplex, automated digital communications network using a satellite channel. Communication is between a shore-based network control station (NCS) and subscribers (ships). The NCS accepts and relays messages. There are two types of CUDIXS subscribers: a Primary Subscriber, which can receive narrative message traffic from the NCS, and a Special Subscriber, which can send or receive narrative message traffic to or from the NCS. Narrative message traffic refers to usual naval teletype messages as opposed to computer-to-computer control messages and operator-to-operator (order wire) messages. Information exchange is computer controlled at both the NCS and the shipboard subscriber terminals. NAVMACS (V) provides computer control for either type of shipboard subscriber.

SECURE VOICE SUBSYSTEM

The secure voice subsystem enables, via satellite relay, the transmission of the ship-to-ship, ship-to-shore, and shore-to-ship voice communications. Ship-to-shore voice communications beyond the immediate area of NAVCOMMSTA are provided by Automatic Secure Voice Communications (AUTOSEVOCOM) extension. The subsystem transmits and receives secure voice communications via a half-duplex, push-to-talk satellite link. Channels on each of the four FLTSATCOM satellites are allocated for use by the secure voice subsystem. Control of the voice channels is maintained by the secure voice controller (operator) at the responsible NCTAMS/NAVCOMMSTA within a satellite footprint.

The subsystem uses digitized voice at a rate low enough to be compatible with a 3-kHz voice channel; therefore, it is considered narrowband. This requires special analog-to-digital processing of the speech signal at the handset terminal. The rf transmission data rate is 2,400 bps. The secure voice subystem has dedicated rf channels on the Gapfiller and FLTSATCOM satellites

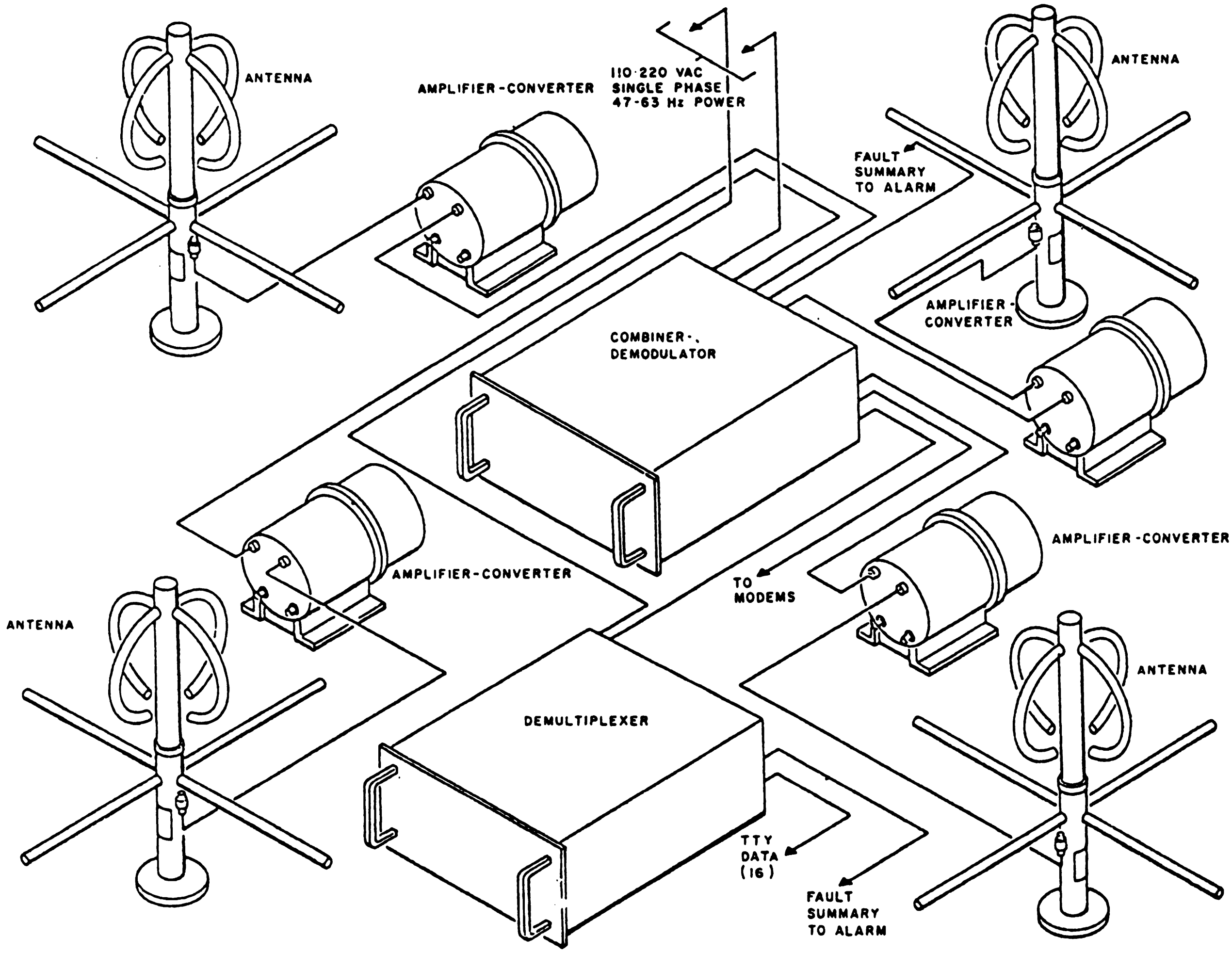


Figure 10-49.–Typical receive-only system.

and dedicated DAMA time slots for future operation on FLTSATCOM and LEASAT satellites.

SHIPBOARD FLEET BROADCAST RECEIVERS

The purpose of a shipboard receive-only system is to receive fleet multichannel teletypewriter broadcasts.

Figure 10-49 is a typical shipboard receive-only system. In this system the transmitted carrier may be frequency modulated (fm) or phase-shiftkey (psk) modulated for tty operation. The receiving antennas for this system are positioned about the ship. They are arranged in a manner (normally one in each quadrant of the ship) that at no time allows the line-of-sight to be blocked between the relay satellite and one or more antennas. Incoming signals pass from the antennas to an amplifier-converter. Each amplifier-converter routes an IF signal on one line of a twin axial cable that connects it to the combiner-demodulator. An operating power signal and a local-oscillator signal are coupled from the combiner-demodulator to each amplifier-converter on the other line of the cable used for the IF signal. Because of the signal path variations, shading, and reflections, the incoming signals are subject to random phase and amplitude variations. The combiner operation performed within the combiner-demodulator removes the phase variations from each input signal. It then measures the amplitudes of the signals for optimum combining and sums the signals. After being combined, the signal is demodulated and coupled from a receiver transfer switchboard to a telegraph demultiplex terminal. The typical equipment used for this is the AN/SSR-1.

DEMAND ASSIGNED MULTIPLE ACCESS (DAMA)

The uhf Demand Assigned Multiple Access subsystem was developed to multiplex several baseband subsystems, or users, on one 25-kHz satellite channel.

This has the effect of adding more satellite circuits per channel to the uhf Satellite Communications Systems. Without uhf DAMA, each satellite communications subsystem requires a separate satellite channel.

The DAMA equipment accepts encrypted data streams from independent baseband sources and combines them into one continuous serial output data stream. DAMA was designed to interface the Navy uhf SATCOM baseband subsystem and the AN/WSC-5(V) and AN/WSC-3 transceivers. The DAMA unit (TD1721B/U multiplexer) includes an internal modem, eliminating the need to use a separate modem at or within the transceiver.

SHIPBOARD COMMUNICATION SYSTEMS QUALITY MONITORING

In recent years the volume of shipboard communications has increased dramatically. This rapid expansion has led to the shipboard installation of increasingly sophisticated equipment. Factors such as frequency accuracy, dc distortion, intermodulation distortion (IMD), and distribution levels are critical to the operation of communication systems. Satisfactory operation of these systems demands precise initial line-up and subsequent monitoring to ensure that certain standards are met and maintained. System degradation is often caused by many small contributing factors which, added together, render the system unusable. The traditional and widespread practice of confining monitor efforts to looking only at the page printer or listening to the signal is entirely inadequate. To be effective, you must know exactly what signal you are transmitting and receiving.

Quality monitoring is the performance of scheduled, logical checks to ensure continuous, optimum performance of shipboard communication systems, and in many cases prevent outages before they occur. The importance of high quality communications cannot be overemphasized. Unfortunately, quite often communications personnel fail to realize the benefits of quality monitoring. An attitude develops that questions the need for quality monitoring, since seemingly adequate communications are already being accomplished without it. The result of this incorrect attitude is that circuits are either IN or OUT. Communications personnel with this attitude perform no quality monitoring when the circuits are in and are therefore forced to treat each outage as if it were a unique occurrence. With no precise information concerning the trend of the system's performance, personnel must jump from one assumed probable cause to another, while valuable circuit time is lost. Implementation of a monitoring program decreases the workload of communications personnel by allowing system degradation to be detected, isolated, and corrected before outages occur. Additionally, a ship that has implemented an aggressive quality monitoring program will, as a result, produce personnel who are thoroughly familiar with all installed communication systems.

Shipboard Communications Systems Quality Monitoring (NAVTELCOMINST C2796.1) NAVTEL is a manual that provides the necessary information and instructions required to exercise effective quality monitoring of shipboard systems. Extensive instructional material is included. The manual was developed by fleet communicators and is based on proved, successful quality monitoring techniques that have resulted in extraordinary improvement in quality and continuity of service. A thorough understanding of QMCS material is vital to maintaining effective communications. In this regard, the manual is a primary reference for training. Performance of the initial line-up procedures and quality monitoring tests are required skills for shipboard communicators. Accordingly, an appropriate training program must be implemented to indoctrinate personnel on the contents of the manual.

Tests prescribed in the manual are based on the use of a Quality Monitoring Control System (QMCS) similar to the one depicted in figure 10-50, which will be described in the following section. This is the AN/SSQ-88.

QUALITY MONITORING AND CONTROL SYSTEM (QMCS)

The QMCS is a multifunction equipment group used as a master monitor for a Radio Communications System (RCS). QMCS permits evaluations of equipment performance to provide failure predictions, identification of interference origins, and equipment fault isolation through manual monitoring of the RCS systems. Monitoring and fault isolation functions are conducted on LF, MF, HF, VHF, and UHF communications equipment operating within the frequency range of 9 kHz to 400 MHz and using any of several modulation techniques.

Overall Functional Description

QMCS is used to determine if the active circuit's fault or degradation is caused by a failure on board or not on board. Facilities are provided to analyze the RCS

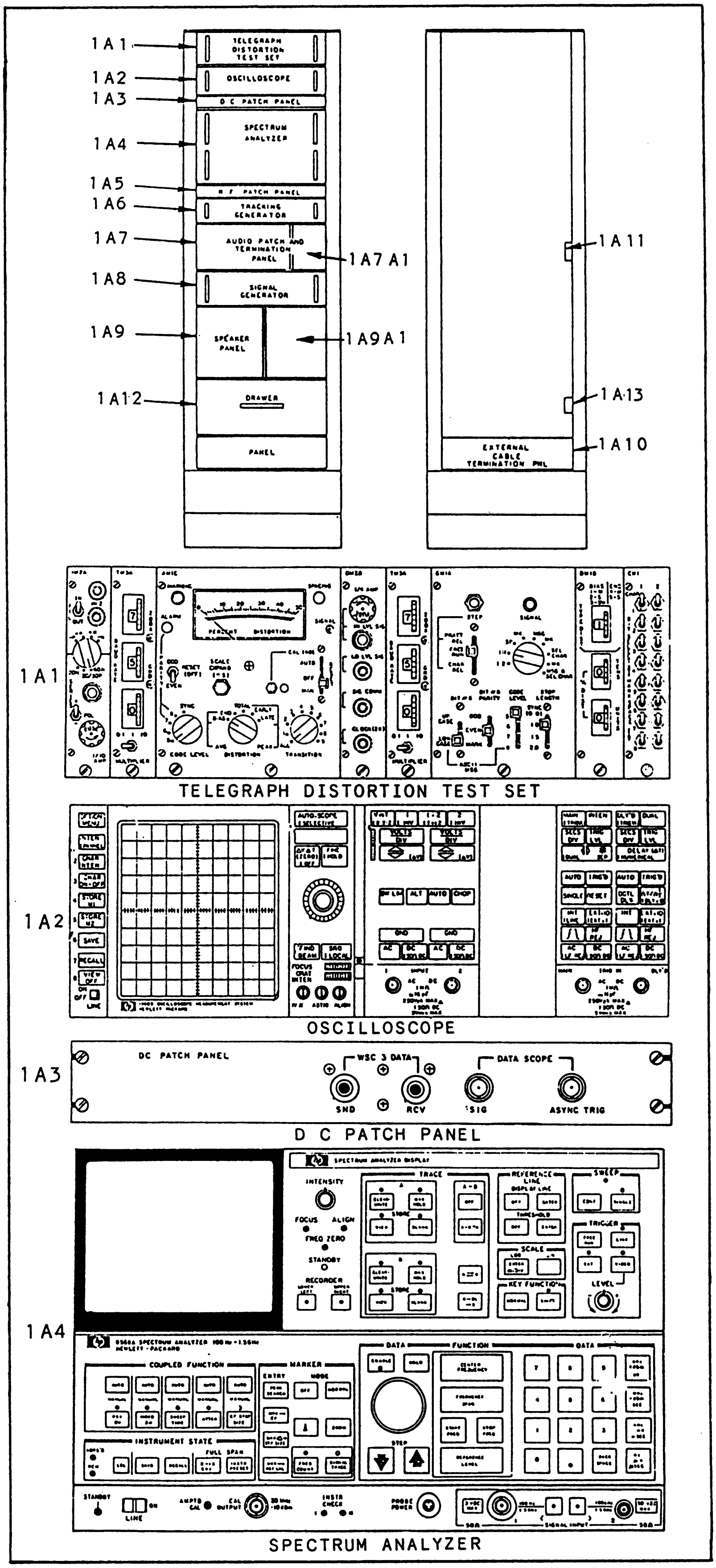


Figure 10-50.–Typical shipboard quality monitoring system.

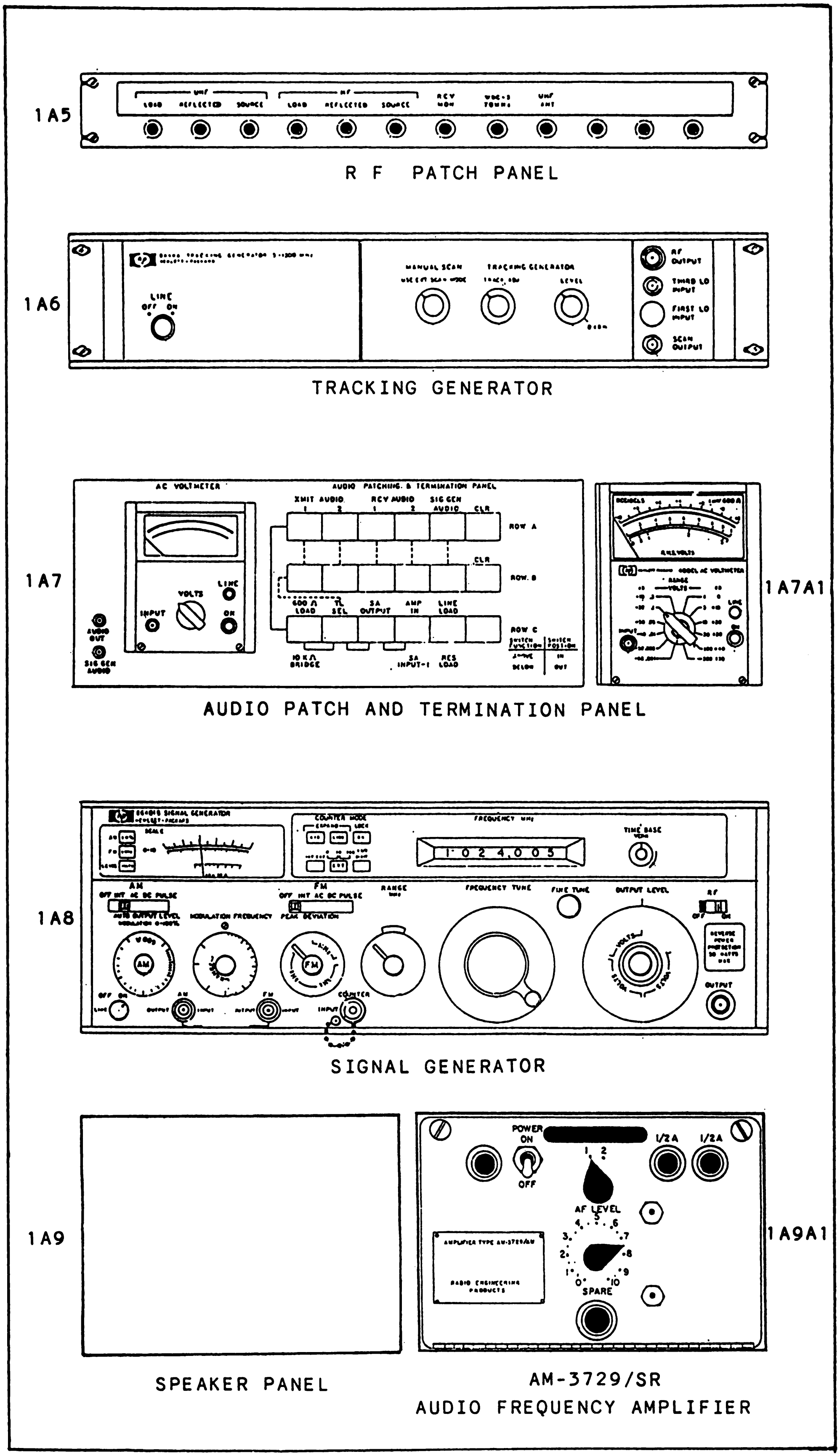


Figure 10-50.–Typical shipboard quality monitoring system–Continued.

to determine which equipment or area is causing the circuit fault, if the problem is on board.

Signal Monitoring and Analysis

The QMCS enables the measurement and display of selected operational parameters for transmitter and receiver systems in the RCS. The system has access to both baseband and rf signals, which are sampled at strategic points within the transmitter and receiver systems to permit measurement display, and realtime analysis of equipment operation with no interruption of an active communications channel. This analysis capability enables an operator or controller to detect communications failures and to institute corrective action as necessary.

Functional Areas

The QMCS is subdivided into three functional areas: the measurement and display equipment, the generating and modulating equipment, and the ancillary equipment. The measurement and display function provides for all equipment required to measure and display DC, AF, and RF signals. The generating and modulating function provides a means to generate and modulate signals up to 400 MHz. The ancillary equipment function permits miscellaneous controlling of the three functions that provide the following capabilities:

1. Measuring AF or RF voltage levels
2. Measuring audio dB levels
3. Amplifying selected audio signal for local monitoring
4. Generating modulated or unmodulated RF test signal
5. Measuring the frequency of RF signals
6. Measuring and displaying a channel spectrum
7. Generating teletype test signals
8. Analyzing teletype signals

The QMCS consists of one equipment rack, one UHF antenna, and one HF antenna (or HF directional couplers). The equipment rack houses 10 electrical assemblies, one rear mounted connector panel (see figure 10-50) and a stowage drawer. These equipments are described in the following paragraphs and are used to perform measurement and display functions.

Telegraph Distortion Test Set 1A1

The telegraph distortion test set 1A1 is a teletype signal distortion analyzer and test pattern generator. The analyzer function of this instrument is used to measure distortion in start-stop and synchronous dc teletype signals. The test pattern generator section of the distortion set provides generating and modulating signals used for testing.

Oscilloscope 1A2

The oscilloscope 1A2 (HP180D or HP1980B) is used for teletype signal display functions required in QMS signal analysis operations.

DC Patch Panel 1A3

The dc patch panel 1A3 provides the interface between the RCS OK326/WSC patch panel and the telegraph distortion test set for both send and receive data. An interface is also provided between the signal and asynchronous trigger outputs of the telegraph distortion test set and the oscilloscope.

Spectrum Analyzer 1A4

The spectrum analyzer 1A4 provides signal spectrum analysis capabilities. The spectrum analyzer provides a crt display of complex baseband and radio frequency signal power/frequency spectral relationships, to permit measurement of bandwidth, carrier, intermodulation products, and modulation sidebands.

RF Patch Panel 1A5

The RF patch panel 1A5 provides the interface between the QMS measurement and display, generation and modulation equipment, and the dedicated RF interfacing devices. An interface is also provided between the QMCS and the RCS RF receiver antenna patch field.

Tracking Generator 1A6

The tracking generator 1A6 is designed to complement the spectrum analyzer 1A4 functions as a system to perform frequency response measurements.

Audio Patch and Terminal Panel 1A7

The audio patch and terminal panel 1A7 provides an interface between the RCS transmitter and receiver patch panels, the QMS measurement and display equipment, and the generation and modulation equipment.

AC Voltmeter 1A7A1

The ac voltmeter 1A7A1 is used for making all audio frequency voltage and power measurements required in QMS signal analysis operations.

Signal Generator 1A8

The signal generator 1A8 provides the option of selecting AM, FM, or pulse modulation, and has a built-in counter (6 digit LED display), a phase lock mode, and front panel controls for operating convenience and flexibility.

Speaker Panel 1A9

The speaker panel 1A9 is used for monitoring audio signals.

External Cable Termination Panel 1A10

The external cable termination panel provides for interconnection of the assemblies in the equipment rack and the assemblies and equipment of the ship's RCS. Figure 10-51 shows how this panel actually ties into the system.

Dual Directional Coupler 1A11

The dual directional coupler provides the interface required between the tracking generator, spectrum analyzer, and UHF antenna systems for swept frequency analysis.

Storage Drawer 1A12

The storage drawer is used for general-purpose storage.

ELECTROMAGNETIC INTERFERENCE (EMI)

The following are excerpts from a CNO message to all Navy Flag Officers.

> "EMI jeopardizes our Navy's warfighting ability. It degrades, even disables, the very electronic systems we depend on to provide a decisive edge. I am determined to restore lost combat capability, to prevent future degradation, and to give the fleet an organic capacity to control and cope with EMI. Correction of EMI is a top priority and requires both awareness and active intercession by all hands."

Many complex electronic systems are installed aboard today's modern ships. As more complicated systems, with higher power and greater receiver sensitivity, are crowded into a restricted and corrosive environment, the environment itself becomes a major limitation to the effective employment of a Total Ship System. The problem is further aggravated by the requirement that all systems operate simultaneously, while still performing to specifications. Thus, the ship must be treated as a combination of systems whose overall performance depends on system-to-system and platform-to-system compatibility. The ability of an equipment or system to operate in its intended electromagnetic environment (EME) without suffering degradation caused by EMI is known as *electromagnetic compatibility* (EMC).

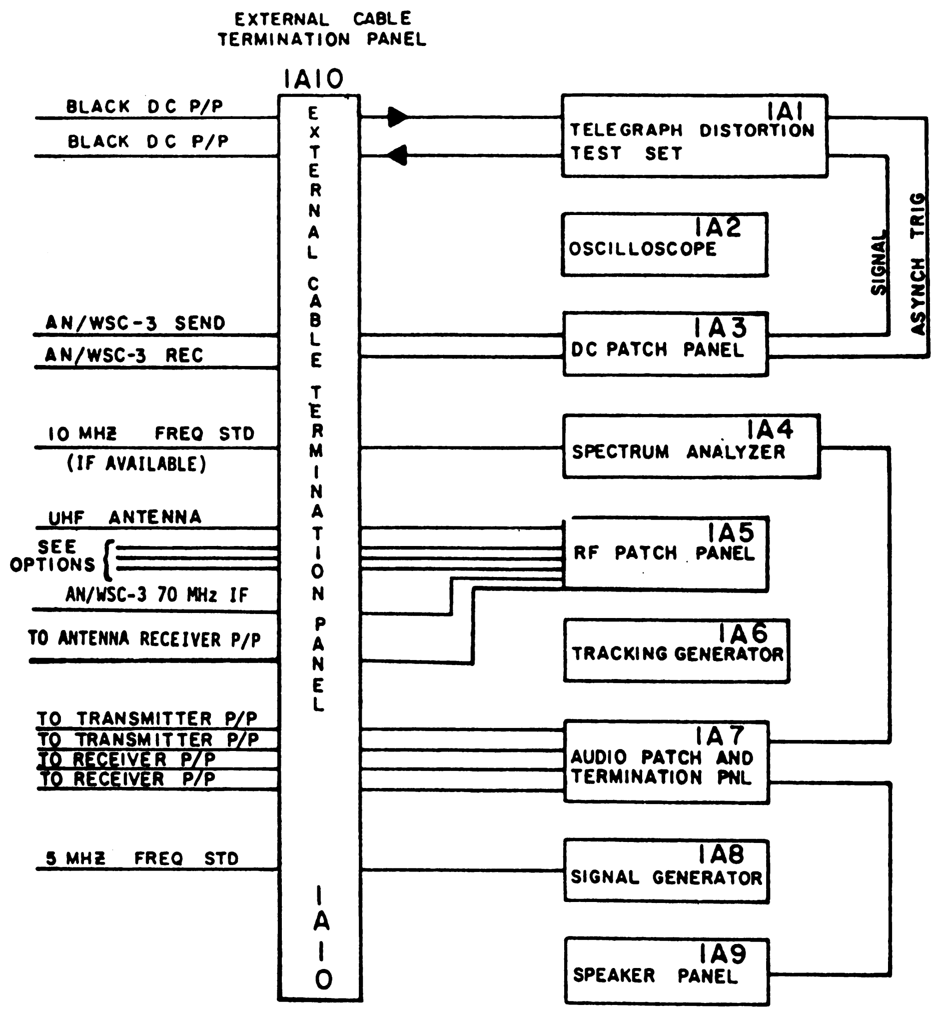
Electromagnetic interference (EMI) is an electromagnetic or electrostatic disturbance that causes electronic equipment to malfunction or to produce undesirable responses or conditions.

As an EMO, you must be aware of the problems caused by EMI and the solutions to these problems. No magic is involved in reducing or eliminating EMI; instead, problems are resolved by using everyday, commonsense approaches to maintaining equipment.

There are three elements to every EMI problem: (1) the source, (2) the victim, and (3) a means of transferring energy called the coupling path. Each EMI problem can be characterized by the use of a triangle (see figure 10-52). Each side of the triangle represents an element of an EMI interference condition. When an EMI problem is encountered, resolution will involve making a determination of which side(s) of this triangle can be most effectively removed or controlled.

SOURCES OF ELECTROMAGNETIC INTERFERENCE (EMI)

The key to reducing shipboard EMI is to first identify the source of the offending electromagnetic energy, then to determine a method of correction and, finally, to correct or minimize the effect.



OPTIONS:

1. QMS HAS ITS OWN DEDICATED HF ANTENNA.
2. QMS SHARES THE 2-32 MHZ ANTENNA DEDICATED TO THE AN/SRA-49 BY USE OF A BI-DIRECTIONAL COUPLER.
3. QMS SHARES THE ANTENNAS FOR THE AN/SRA-38, AN/SRA-39, AND AN/SRA-40 TO OBTAIN FREQ. COVERAGE OF 2-32 MHZ BY USE OF A BI-DIRECTIONAL COUPLER.

Figure 10-51.–Interconnection of the QMCS.

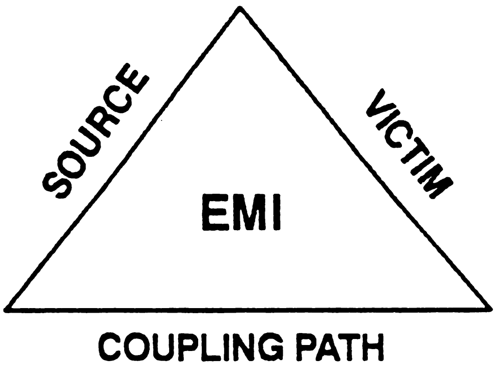


Figure 10-52.–EMI Triangle.

The sources of electromagnetic energy affecting shipboard systems fall into four broad categories: (1) natural; (2) incidental; (3) functional; and (4) hull-generated.

Natural EMI

Natural EMI is caused by natural phenomena, such as electrical storms, rain particles, and solar and interstellar radiation. It is recognized by the following audible noise:

- Intermittent impulses of high intensity that are caused by nearby electrical storms
- Steady rattling or cracking caused by distant electrical storms
- Continuous noise of precipitation static caused by electrically charged rain drops
- A steady hiss at high frequencies caused by interstellar noise

Incidental EMI

Incidental EMI can originate from manmade sources that are not designed specifically to generate electromagnetic energy, but which do, in fact, cause interference. Examples of incidental EMI sources include power lines, motors, and switches.

Functional EMI

Functional EMI can originate from sources that are designed to radiate electromagnetic energy. These signals are potentially major sources of interference to receiving equipment. This interference may be unintentional, caused by other on-board or adjacent platform systems, or it may be intentional, caused by electronic countermeasures (ECM).

Hull-Generated EMI

Hull-generated EMI can be caused by the radiated energy interacting with elements of the ship's hull and rigging which can serve as efficient RF antennas. This interaction generally results in one of two types of interference, *intermodulation interference* (IMI) or *broadband noise* (BBN).

INTERMODULATION INTERFERENCE (IMI).–Interference that occurs as the result of mixing two signals (hetrodyning) in a nonlinear element such as the first stage of a receiver or the final stage of a transmitter. The nonlinear element may also be external to the equipment, as in the case of a corroded metal-to-metal joint. Nonlinear junctions are commonly referred to as "rusty bolts." This mixing may result in generating a new signal of sufficient amplitude to be detected as interference. The number of these signals will depend on the number of transmitters "on the air." These new signals are called intermodulation products, and radiate into the environment from the same hull and superstructure elements that received the original RF signals. Intermodulation products occur at discreet frequencies, but may appear as BBN under severe conditions.

BROADBAND NOISE (BBN).–Elements of the ship's superstructure are susceptible to high levels of induced RF voltage from nearby transmitter antennas. If the induces voltage levels as high enough, an electrical arc may be generated. This arc will, in turn, generate a broadband spectrum of electromagnetic energy. RF arcing may be continuous, depending on conditions, but it is usually intermittent, much like energy noises generated by nearby electrical storms. Frequently, such arcing occurs between loose or broken elements of an antenna. Other sources of BBN include various metallic objects that carry induced RF currents and rub or touch each other intermittently while the transmitting antennas are energized. When a ship is at sea in constant motion because of pitch and roll, the movement of various structures in the topside area of the ship can increase the BBN level.

These structures may include items such as lifelines with corroded sister hooks, broken corroded welds on liferails, loose metallic objects stored on deck, such as pipes, ladders, and spare wire and safety chains commonly used aboard ship. The BBN levels may be of sufficient magnitude to mask IMI from detection. If these same junctions are corroded as well as rubbing or touching each other, they can also produce IMI. BBN often proves to be from the same source as IMI.

While little can be done to control natural interference, operational work-arounds may help to minimize its impact upon ship operations. However, much interference that is assumed to be natural is actually functional, incidental, or hull-generated. Therefore, you need to investigate all interference to verify whether or not it is natural EMI, before selecting a corrective action.

Incidental EMI usually can be eliminated, or effectively controlled, at its source by proper design, installations, and maintenance.

Functional EMI poses a more difficult problem, since the source of the interference generally is essential to the operation of the equipment. In complex systems, such as communications, radar, or electronic warfare (EW) transmitters, the generation of the functional signal often results in generation of undesired electromagnetic energy at frequencies other than the operating frequency. These spurious outputs, which impact adversely upon total ship system performance, should be eliminated, or reduced to an acceptable level or amplitude, by the application of proven EMI-reduction techniques. Many of these techniques are available to, and can be applied successfully by, the ship's force in its efforts to improve total ship system performance.

Hull-generated EMI is of particular concern. The resulting intermodulation or broadband interference effects can easily mask a host of other EMI problems.

EMI COUPLING

EMI is coupled between systems by a radiated path, a conducted path, or sometimes by a radiated and then conducted (combination) path. No interference condition can exist unless the EMI source is coupled to the EMI victim through a coupling path; therefore, elimination of this path provides another possible solution to resolving any EMI problem.

Radiated EMI is transferred through space to the EMI victim by an electromagnetic field. The radiated field represents energy that escapes from or is radiated intentionally by an EMI source and spreads out in free space according to the laws of wave propagation. When this radiated field transfers energy to a EMI victim (susceptible device), it has followed a radiated coupling path.

Conducted EMI is transferred through conductors between an EMI source and an EMI victim. This requires a complete electrical path for flow of interference currents between them. The path can be made entirely of metallic conductors, or the return path may be through the earth or a common ground.

EMI VICTIMS

Any equipment or system capable of responding to electromagnetic fields or to electrical signals must be considered a potential victim.

One of the basic objectives of the Department of Defense (DOD) is to provide equipment and systems whose performance will not be adversely affected by EMI. The effects of EMI on a system may be either permanent, during which the system will not operate until the problem has been corrected, or temporary, during which the system will operate in a degraded mode when EMI is present. Examples of the different effects that can be produced, depending on the victim, are as follows:

1. Burnout or voltage breakdown of components, antennas, and so on
2. Performance degradation of receiver signal processing circuits
3. Erroneous or inadvertent operation of electromagnetical equipment, electronic circuits, components, ordnance, and so on
4. Unintentional detonation or ignition of electroexplosive devices, flammable materials, and so on
5. Personnel injuries

RESOLVING EMI PROBLEMS

There are several avenues available to you for resolving EMI problems. The remainder of this chapter will outline your available resources.

PMS

Several MRCs include checks for the presence of EMI sources, and victims. These MRCs include visual and operational checks of equipment and systems.

Shipboard Technicians

During class A and C schools, technicians are taught to recognize and correct shipboard EMI problems.

Electromagnetic Compatibility Technician (Surface) ET-1419

Normally billeted to MOTUs, IMAs, and high value ships, these technicians perform tests, measurements, and analyses of systems and equipments using a wide variety of electronic test equipment to determine the presence or severity of EMI problems. Additionally, they are able to perform RADHAZ monitoring.

Intermediate Maintenance Activity (IMA)

IMAs provide on-call technician assistance in matters related to EMC and RADHAZ. Specific areas of assistance include topside visual surveys, EMI problem location and resolution using approved techniques.

Shipboard Electromagnetic Compatibility Improvement Program (SEMCIP)

The SEMCIP is a CNO sponsored, NAVSEA-SYSCOM managed program that identifies and develops fixes for EMI problems. In addition, it: (1) provides a quick response capability for emergent fleet EMI problems; (2) conducts EMI surveys and installs EMI fixes in fleet units; (3) provides Navywide technical assistance and training; and (4) promotes the incorporation of electromagnetic control measures into the policies of industrial activities.

SEMCIP is composed of the four elements discussed in the paragraphs that follow.

SEMCIP ENGINEERING.–This is the engineering, problem-solving, and research and development (R&D) arm of SEMCIP. It provides teams of highly skilled technical personnel to test, evaluate, research, and develop corrections for individual shipboard EMI problems on a quick-response basis and provides full-scale EMC evaluation and total ship analysis. SEMCIP engineering teams provide shipboard testing and engineering analysis in all areas of ship operation affecting EMC and have trained experts in the following areas: communications, radar, electronic warfare, RADHAZ, sonar, and EMC problems encountered in belowdecks equipment, such as propulsion control systems.

SEMCIP WATERFRONT CORRECTIVE ACTION PROGRAM (WCAP).–This is the groom-and-fix-it area of SEMCIP that you will deal with continually. WCAP is responsible for locating, evaluating, and correcting known EMI problems on individual ships. WCAP provides the advantages discussed in the following paragraphs.

Quick Response.–WCAP assets are strategically positioned at MOTUs. Within hours, a WCAP technician can be on board to determine if the problem is, in fact, EMI and to determine the extent of personnel and equipment resources required to resolve the problem.

Combat Readiness Events.–WCAP participates in Combat System Readiness Reviews (CSRRs) for the Atlantic Surface Fleet and Combat System Readiness Tests (CSRT) for the Pacific Surface Fleet. The WCAP portion of these events includes conducting topside visual surveys, system interoperability tests, instrumented communications, and structure-generated EMI tests; correcting deficiencies;, and assisting ships in preparing OPNAV Form 4790.2K for outstanding discrepancies.

Technical Assistance.–WCAP technical assistance provides for investigation and concurrent corrective action to resolve maintenance-related EMI discrepancies below the industrial level and to install known fixes to known problems. WCAP technical assistance provides the groom and repair skill needed to resolve obvious EMI problems that might otherwise mask more subtle problems.

EMI Awareness and Control Training.–WCAP technicians provide EMI awareness and control training throughout all WCAP evolutions. On-the-job training (OJT) and briefings are provided to shipboard personnel during technical assistance visits. Specialized EMI control courses in antenna maintenance are conducted either on board ship or at Mobile Technical Unit (MOTU) facilities.

SEMCIP INDUSTRIAL ELECTROMAGNETIC COMPATIBILITY (IEMC) PROGRAM.–This portion of SEMCIP is targeted toward incorporating EMC corrective measures in ship construction, modernization, overhaul, and repair processes. IEMC preserves corrections made in the field by SEMCIP engineering and WCAP as well as assuring that EMC has been included in alteration and repair planning. The IEMC portion of SEMCIP also provides manufacturing capability for prototype development and testing of proposed EMC-correction devices or materials.

COMBAT SYSTEMS FREQUENCY MANAGEMENT PROGRAM (CSFMP).–The Navy relies on radar, electronic warfare, and communications to make a battle group combat ready. A typical group of 12 ships has approximately 80 radars and 20 EW systems that can interfere with each other unless their frequencies are properly managed. The CSFMP provides the guidance the fleet requires to operate its radars and EW equipment for maximum compatibility.

SEMCIP TECHNICAL ASSISTANCE NETWORK (STAN).–The STAN is an online database geared to provide the EMI engineers and technicians with access to the latest information on the status of EMI problems. It also provides ship administrative information to assist in all phases of SEMCIP and information on the development, installation, and verification of known fixes. Additionally, STAN contains Electromagnetic (EM) Control Topside Arrangement Drawings. STAN information is accessible by the fleet through the WCAP.

SHIPBOARD EMI CONTROL REFERENCES

One of the keys to effective and long-lasting EMI reduction and control is the proper installation of EMI control measures. The following paragraphs will review a number of documents and procedures currently available to help you ensure that your ship's EMI control techniques are proper.

SHIPBOARD BONDING AND GROUNDING METHODS AND OTHER TECHNIQUES FOR EMC AND SAFETY, MIL-STD-1310

This standard provides requirements for shipboard bonding, grounding, shielding, and the use of nonmetallic materials to reduce EMI and IMI, to protect personnel from electrical shock, and to protect electronic equipment from an electromagnetic pulse (EMP). Methods for installing shipboard ground systems are also provided.

The requirements specified in MIL-STD-1310 apply to all ships, including submarines and nonmetallic hull ships, during normal operational periods and during periods involving construction, overhaul, alteration, and repair.

If your ship is required to follow MIL-STD-1310, read the standard carefully. You are only held accountable for the requirements that pertain to your particular ship. If you notice any conflicts between MIL-STD-1310 and other publications, specifications, standards, or drawings, notify either the SUPSHIP or NAVSEA. Electromagnetic control topside arrangement drawings are available, if you need them, to help you apply MIL-STD-1310 requirements to the topside of your ship.

Due to cost impact, the EMP protection requirements specified by MIL-STD-1310 are not implemented routinely, but only when specifically authorized.

To provide protection to solid-state electronics, MIL-STD-1310 provides additional requirements and details for EMI and EMP protection. Hardware to accomplish this protection has been developed and installation methods have been detailed. The bonding, grounding, and shielding requirements for both EMP protection and EMI reduction are similar, since the intent in both cases is to keep electromagnetic radiations (EMP and HF antenna radiations) from coupling to belowdeck equipment.

MIL-STD-1310 does not specify methods for achieving EMI reduction through equipment design, frequency selection, limits on operating power, equipment location, or use of multicouplers or blankers. These requirements are contained in other publications.

THE COMMANDING OFFICER'S GUIDE TO THE SHIPBOARD ELECTROMAGNETIC ENVIRONMENT, NAVSEA STD-407-5287555

This guide provides to the ship's commanding officer, executive officer, or other appropriate personnel a ready reference that describes the causes and effects of EMI problems typically found on board ship. It also serves the following purposes:

1. Discusses the RADHAZ problems within the capability of the ship's force to prevent or to correct

2. Discusses both equipment-specific and hull-related problems by citing typical unclassified examples and preventive and corrective actions that can be taken to minimize and control EMC degradation

3. Lists sources of information and assistance for identifying and resolving EMI control problems

4. Outlines methods for requesting engineering assistance and for help in characterizing problems that may eventually threaten other fleet ships

5. Demonstrates to the commanding officer ways to merge on board EMI control management and technical and training actions with his other command responsibilities.

THE ELECTRONIC MATERIAL OFFICER'S GUIDE TO SHIPBOARD ELECTROMAGNETIC INTERFERENCE CONTROL, NAVSEA STD-407-5287556

This standard provides appropriate EMC information, based on SEMCIP "lessons learned," to EMOs afloat and to facilities that train prospective EMOs and other supervisory personnel involved in the maintenance of electronic systems. Its format allows you to use it as a management tool and as a guide for achieving EMC by coordinating EMI control actions. It is a recommended plan for establishing the required management organization and recommended procedures for approaching common electromagnetic problems under the "Total Ship System" concept.

STANDARD EMI SURVEY PROCEDURE, NAVSEA STD-407-5291780

This document provides standardized EMI survey test requirements and methods for conducting all EMI surveys. Test philosophy is included so that planning and test personnel will know why as well as how tests are to be performed.

SHIPBOARD ELECTROMAGNETIC COMPATIBILITY IMPROVEMENT PROJECT (SEMCIP) STANDARD OPERATING PROCEDURES (SOP), T9407-AB-PRO-010

The SEMCIP SOP provides comprehensive procedures for you to follow in complying with the directives and policies of Navy EMC under the cognizance of the SEMCIP.

ELECTRONIC INSTALLATION & MAINTENANCE BOOKS (EIMB), GENERAL, NAVSEA 0967-LP-000-0100

This general handbook provides policies and instructions pertaining to the proper use of the EIMB series of handbooks. It provides guidance for all personnel in the naval establishment responsible for the installation, maintenance, and repair of electronic equipment. It also contains information about administration, supply, publications, and safety matters. Section 5 contains a comprehensive index for identifying the EIMB handbook(s) in which information of a particular subject may be located.

HANDBOOK OF SHIPBOARD ELECTROMAGNETIC SHIELDING PRACTICES, S9407-AB-010

This handbook augments the requirements of MIL-STD-1310. The purpose of this handbook is to specify cable spacing and shielding requirements and installation procedures that minimize the effects of EMI on installed electronic equipment. This handbook is intended for use by ship designers, planning engineers, personnel engaged in the installation of electronic equipment, overhaul and repair shipyards, tenders, and other repair and installation activities. The objective of this handbook is to ensure that electronic equipment will operate relatively free from effects of EMI in the shipboard electromagnetic environment.

ELECTROMAGNETIC COMPATIBILITY, THEORY & CONCEPTS, NAVSEA STD-407-5291779 REV A

This publication provides an overall review of the most current information available on electromagnetic compatibility (EMC) as it applies to U.S. Navy ships. It is intended to be the reference for modern-day electromagnetic interference (EMI) identification and reduction techniques. It also serves as a general reference guide for Navy and civilian engineers, technicians and technical supervisory personnel as the most current EMC information available.

The "1779" is for use by all levels of personnel involved in EMC on today's naval vessels. It applies to the day-to-day EMI reduction efforts conducted by ship's force personnel and to the EMI control functions carried out by the EMC engineer alike. The information applies to all U.S. Navy ships, including submarines and nonmetallic hull ships, during periods of normal operation and during ship construction, overhaul, alteration, and repair. Any conflict between this standard and other standards, drawings, publications, and so on, should be reported to NAVSEASYSCOM, Code 06D44, Washington, D.C., for resolution.

IEMC WORK PROCESS INSTRUCTIONS (WPI), NAVSEA STD-407-5287561

This publication provides standardized procedures to be used for installing shipboard electrical and electronic systems. The IEMC WPI is intended for use as a working document for Navy and industrial personnel involved with shipboard electrical and electronic systems. It is based on the information provided in MIL-STD-1310 (Navy) and other formal

Navy specifications, standards, and current publications.

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NEETS Modules 10, *Introduction to Wave Propagation, Transmission Lines, and Antennas*, NAVEDTRA 172-10-00-83, Naval Education and Training Program Management Support Activity, Pensacola, Fla., 1983.

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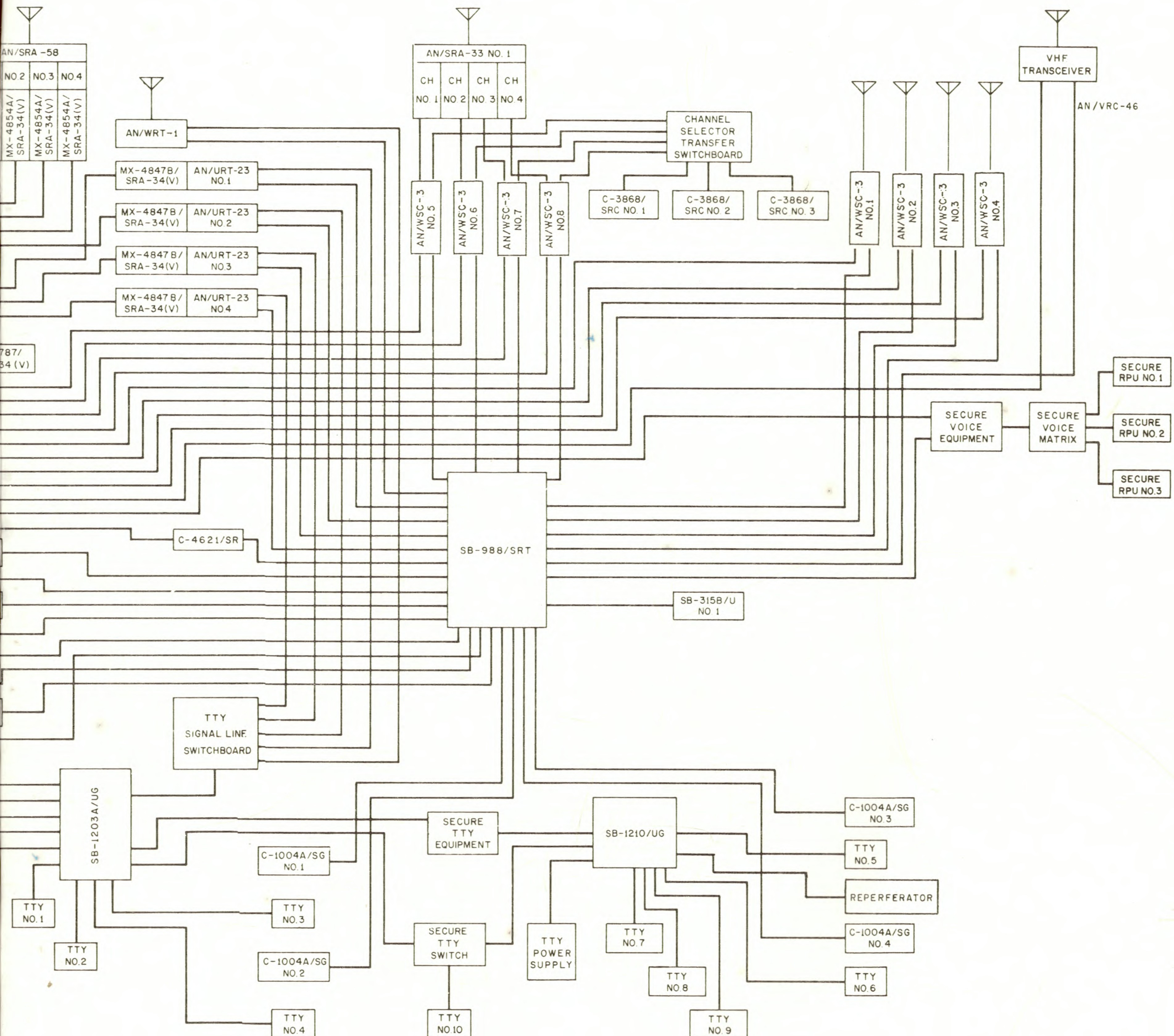


ipment configuration.

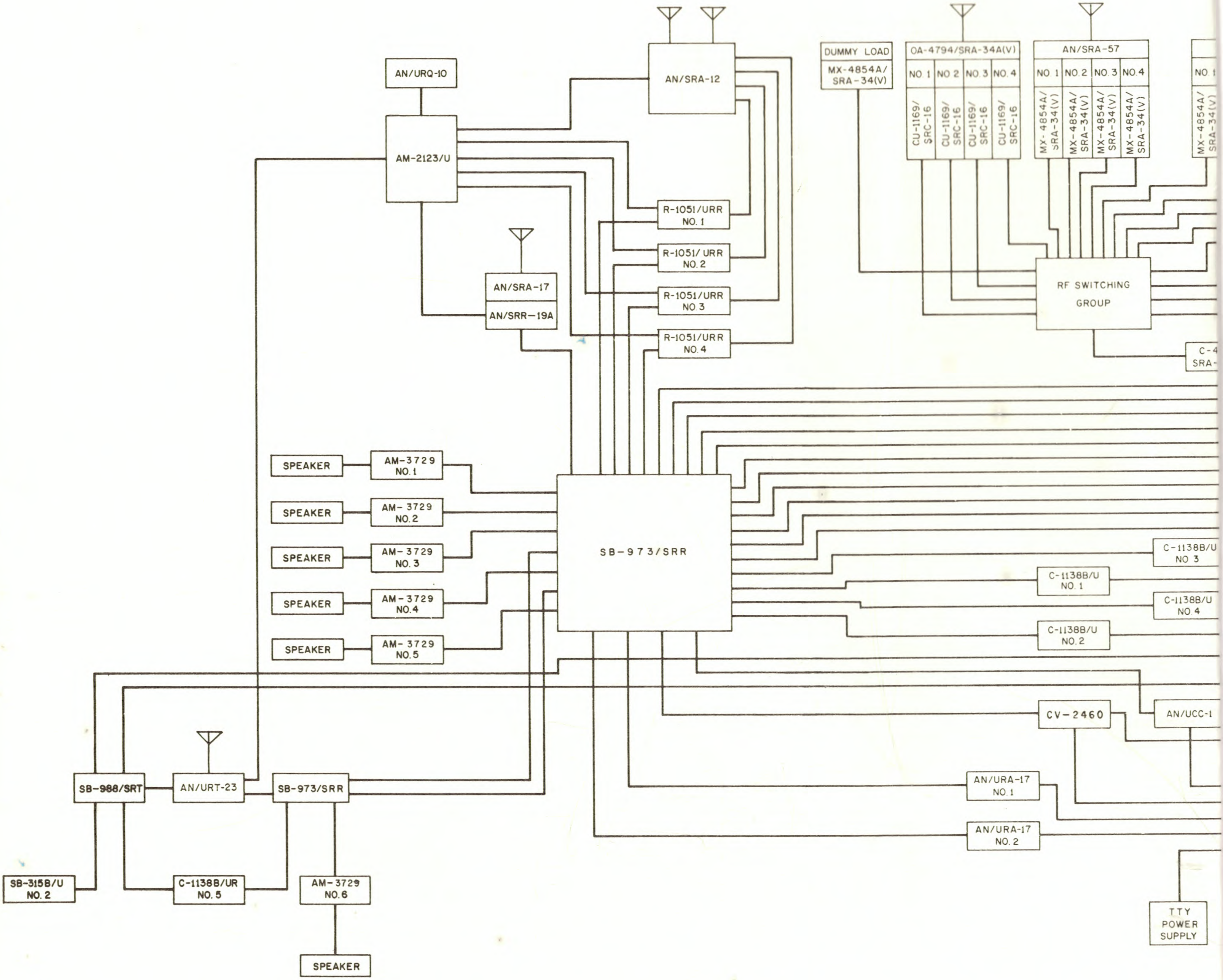


Figure 10-40.–Communications equ

CHAPTER 11

TELETYPEWRITER AND FACSIMILE EQUIPMENT

OVERVIEW

As the EMO, you need a basic understanding of teletypes since you will be involved with this equipment on a daily basis. If FAX equipment is on board, you will be inherently responsible for it.

OUTLINE

TTY theory

TTY systems

Encryption

Receive systems

Patching

Multiplexing

High/low level TTY

FAX

TEMPEST

Cryptographic basics

COMSEC

INTRODUCTION

In chapter 10 we discussed different methods of voice communications. At times, however, the message is too long for practical transmission by voice. To get information or an idea across to another person far away, you may need to use a chart, map, or photograph. Teletypewriter (TTY) and Facsimile (FAX) equipment allow us to do that with ease.

To explain how intelligence is sent via teletype, we will first use one of the simpler devices for electrical communication, the manual telegraph circuit. This circuit, shown in figure 11-1, includes a telegraph key, a source of power (battery), a sounder, and a movable sounder armature. If the key is closed, current flows through the circuit and the armature is attracted to the sounder by magnetism. When the key is open, the armature is retracted by a spring. These two electrical conditions of the circuit, "closed" (current flowing) and "open" (no current flowing), allow us, by means of a code, to transmit intelligence. The above are referred to as MARKING and SPACING. The marking condition occurs when the circuit is closed; the spacing condition occurs when it is open.

If the key at station A is replaced by a transmitting teletypewriter and the sounder arrangement at station B is replaced by a receiving teletypewriter, the basic

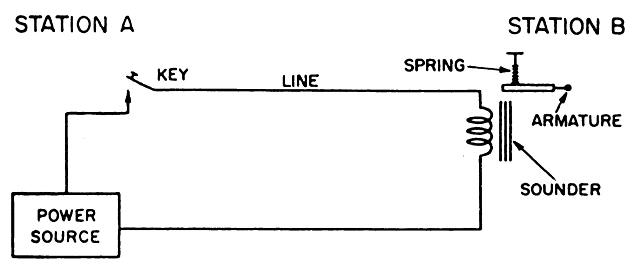


Figure 11-1.–Manual telegraph circuit.

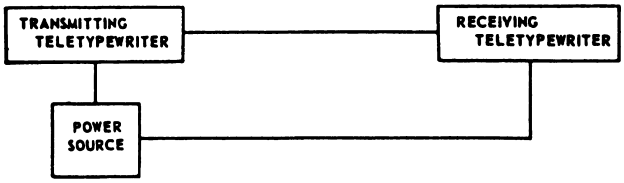


Figure 11-2.–Simple teletypewriter circuit.

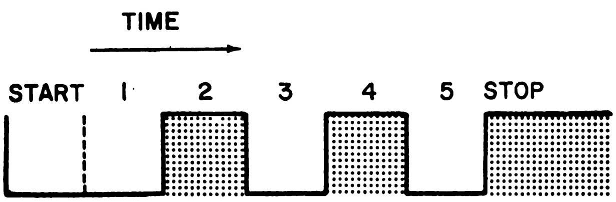


Figure 11-3.–Mark and space signals in the teletypewriter–character R.

teletypewriter circuit (loop) shown in figure 11-2 is formed.

If a teletypewriter signal could be drawn on paper, it would resemble figure 11-3. This is the code combination for the letter R. The shaded areas represent intervals during which the circuit is closed (a mark), and the blank areas represent the intervals during which the circuit is open (a space). There are a total of seven units in the signal. Five of these are numbered, and are called *intelligence* units. The first and last units of the signal are labeled *start* and *stop.* They are a part of every teletypewriter code signal. The start unit, which starts the signal, is always a space. The stop unit, which stops the signal, is always a mark.

CODES

The groups of electrical pulses used with the telegraph and teletype are referred to as codes. The primary codes, which are described in the paragraphs that follow, are the Morse code, the Baudot code, and the USA Standard Code for Information Interchange (USASCII).

MORSE CODE

In manual telegraphy, the most widely used code is the Morse code. In this code, two distinctive signal elements are used–the dot and the dash. The difference between a dot and a dash is usually one of time duration, a dash being three times as long in duration as a dot. Each character is made up of a number of dots, or dashes or a combination of dots and dashes. The dot and dash elements of a character are separated from each other by a time interval equal to the duration of one dot. The time interval between the characters for each word is equal to seven dots.

BAUDOT CODE

In teletypewriter operation, the code group for each character must be of uniform length. Since the Morse code is an uneven length code, it cannot be used in teletypewriter operation without additional code converters.

The FIVE-UNIT (five-level) CODE has been the most commonly used code in modern telegraphy and is universally used in teletypewriter operation. This code is also known as the *Baudot code.* The Baudot code is an example of an even length or constant length code. In Baudot code, each character consists of five signal elements; each element may be either a mark or a space. A total of 32 signal elements are possible with this arrangement.

The 32 possible combinations available in the Baudot code are insufficient to handle the alphabet, numbers, symbols, and nonprinting functions. Since this number of combinations is insufficient in itself, two of the 32 combinations are used as shift signals. Also referred to as case-shift signals; one is a letter shift and the other is a figure shift. When a letter shift is transmitted, it sets the receiving instrument in a condition to recognize any letter signal combination. It will recognize letter combinations until a figure shift is received. Then the receiving instrument resets itself to recognize any figure signal combination received. This allows 30 of the 32 available combinations to have two meanings.

AUTOMATED INFORMATION PROCESSING CODE

During recent years, through the cooperative effort of representatives of the data processing industry, the communications industry, and the Federal Government, a coded character set has been developed and approved as a USA Standard Code for Information Interchange (USASCII). This coded character set possesses a character order more acceptable for data manipulation and processing purposes. The USASCII is intended to serve as a universal code for input/output purposes and for information interchange in automatic data processing, data transmission, and data capture where coded characters are used. The general use of a standard coded character set minimizes requirements for code conversion and related types of intermediate processing operations when information is exchanged in machine code form throughout the Department of Defense.

The USA Standard Code for Information Interchange, commonly referred to as USASCII or ASCII, was made a federal standard by a Memorandum of the President of the United States on 11 March 1968. Additionally, the United Nations has approved a version of USASCII known as International Telegraph Alphabet No. 2 (ITA 2).

Current fleet use of USASCII is limited to automated data processing and manipulation, but a considerable effort is being made to use USACII for teletypewriter message transmission. Further information on TTY codes is presented in the MIL-STD 188 Series and in *Principles of Telegraphy,* 0967-LP-225-0010.

MODES OF OPERATION

There are two basic modes of teletypewriter operation: asynchronous (start-stop) and synchronous. The asynchronous mode is the most commonly used mode of teletype operation. Synchronous operation is used more in high-speed data systems.

ASYNCHRONOUS MODE

In the asynchronous mode of operation, the receiving device is allowed to run for only one character and is then stopped to await the reception of the start signal for the next character. In this mode, any difference in speed between the transmitting and receiving devices can accumulate only during the duration of one character. However, there is a penalty for this advantage. The length of each character must be increased to include an element to start the receiving device and another to stop it. The five (5) unit code described earlier is used in this mode.

SYNCHRONOUS MODE

Synchronous teletypewriter operation, as opposed to asynchronous operation, does not, in all cases, have to rely upon elements of the transmitted character to maintain proper position in relation to the receiving device. External timing signals may be used, allowing the start and stop elements to be discarded. Then, only the elements necessary to convey a character (and in some cases a reference element) need to be transmitted.

Synchronous systems have certain advantages over start-stop systems. The amount of time taken to transmit stop and start elements is made available for information transmission rather than for synchronizing purposes, since only the intelligence elements are transmitted. In start-stop signaling, the ability of the receiving device to select the proper line signal condition depends on whether or not interference affects the start-stop arrival. This means that if the stop-to-start transition arrives before it should (due to atmospherics), all subsequent selection positions in that character will appear earlier in time in each code element. A synchronous system has a higher capability to accept distorted signals because it does not depend on start-stop signals.

MODULATION RATE

There are several terms used in referring to teletypewriter modulation rates or signaling speeds. These include *baud, words per minute (wpm),* and *bits per second (bps).* Baud is the only one that is technically accurate without using additional qualifying terms. The others are either approximations or require explanation.

BAUD

The word *baud,* by definition, is a unit of modulation rate. It is sometimes used to refer to a signal element, but this reference is technically incorrect. Baud rate is the reciprocal of the time in seconds of the shortest unit interval. Hence, to find the modulation rate of a signal in bauds, you divide the number 1 by the time duration of the shortest unit interval present in the signal. For example, 22 milliseconds (.022) is the time interval of the shortest unit in the five-unit code at 60 words per minute. To find the number of bauds corresponding to 60 wpm, divide 1 by .022. Rounding off the results of the division provides the figure 45.5, which is the baud equivalent of 60 wpm. Each increase in wpm will correspondingly decrease the signal unit time interval. (The Defense Communications System standard speed for teletype operation is 100 wpm or 75 baud.)

WORDS PER MINUTE

Words per minute is used only when speaking in general terms for an approximation of speed. The term "100 wpm" means that 100 five-letter words with a space between them can be transmitted in a 60-second period. However, it is possible to obtain this nominal words-per-minute rate in several systems by varying either the modulation rate or the individual character interval (length). For this reason, the modulation rate (baud) rather than words per minute is used.

BIT

The term "bit" is a contraction of the words "binary digit." In binary signals, a bit is equivalent to a signal element. As a result of the influence of computer and data processing upon our language, modulation rate is sometimes expressed as "bits per second" (bps). When it is expressly understood that all signal elements being transmitted are of equal length, the modulation rate expressed in bits per second is the same as the modulation rate expressed in baud.

DC CIRCUITS

Recall that the two conditions, mark and space, may be represented by any convenient means. The two most commonly used means are the *NEUTRAL* operation and the *POLAR* operation. In the neutral operation, current flow represents the mark, and no current flow represents the space. In the polar operation, current impulses of one polarity represent the mark, and impulses of the opposite polarity and of equal magnitude represent the space.

Neutral circuits use the presence or absence of current flow to convey information. These circuits use 60 milliamperes (mA) (or, in some cases, 20 mA) as the line current value. A neutral teletypewriter circuit is composed of a transmitting device, a battery source to supply current, a variable resistor to control the amount of current, a receiving device, and a line for the transmission medium.

Polar operation differs from neutral operation in two ways. Information is always present in the system, and it is either in a positive or negative condition. A polar teletypewriter circuit is composed of the same items as a neutral circuit plus an additional battery source. The battery source is actually a solid-state DC power supply that provides variable current to the teletypewriters. The reason for having an extra battery source is that the standard polar circuit uses current from the positive side of a battery for marks and current from the negative side of a battery for spaces.

The most significant advantage to polar operation is that, for all practical purposes, it is almost impossible to distort a signal through low-line currents, high reactance, or random patching of signal circuits or equipment. Another advantage of polar signaling is that a complete loss of current (a reading of zero on the milliammeter) indicates line or equipment trouble, whereas the same condition with neutral signaling may indicate only that a steady space is being transmitted. This gives a condition called *running open*. Under this condition, the teletypewriter appears to be running because the machine is decoding the constant space as the Baudot character blank and the type hammer continually strikes the type box, but there is no printing or type box movement across the page.

BASIC SYSTEMS

When two teletypewriters are wire-connected (looped), the exchange of intelligence between them is direct. When the teletypewriters are not joined by wire, exchange of intelligence is more complex. Direct-current mark and space intervals cannot be sent through the air. The gap between the machines must be bridged by radio using a radio transmitter and receiver. The transmitter produces a radio frequency carrier wave to carry the mark and space intelligence. Also, a device such as a *keyer* is needed to change the dc pulses from the teletypewriter into corresponding mark and space modulation for the carrier wave in the transmitter. The radio receiver and a *converter* are required to change the radio frequency signal back to dc pulses.

RADIO-ACTUATED TELETYPE (RATT) SYSTEMS

The Navy uses two basic radio-actuated teletype (RATT) systems: the tone-modulated system, referred to as *audio frequency tone shift (AFTS),* and the carrier frequency shift system, referred to as *radio-frequency carrier shift (RFCS).* The RFCS system is more commonly called *frequency shift keying (fsk).*

Both variations require the use of two discrete radio frequencies to produce one channel of radio teletype: one frequency for the mark signal and the other for the space signal. At any given instant of time, only one of these frequencies is being emitted by a transmitter.

For frequency-shift (fsk) systems, the transmitter provides a source of radio-frequency excitation. Figure 11-4 illustrates a basic frequency-shift keyed system. In modern systems, the keyer is built into the transmitter. The keyer shifts the signal box below or above the assigned frequency to correspond with the mark or space required to transmit TTY characters. Normally the keyer is adjusted for 850-hertz speed 425 hertz above and 425 hertz below the assigned frequency. A spacing impulse will be 425 hertz above the operating frequency, and a marking impulse will appear 425 hertz below.

In both the tone-modulated system and the carrier-frequency shift system, all TTY signals pass through the TTY panel that controls the looping current in all the circuits. Looping current is the current supplied

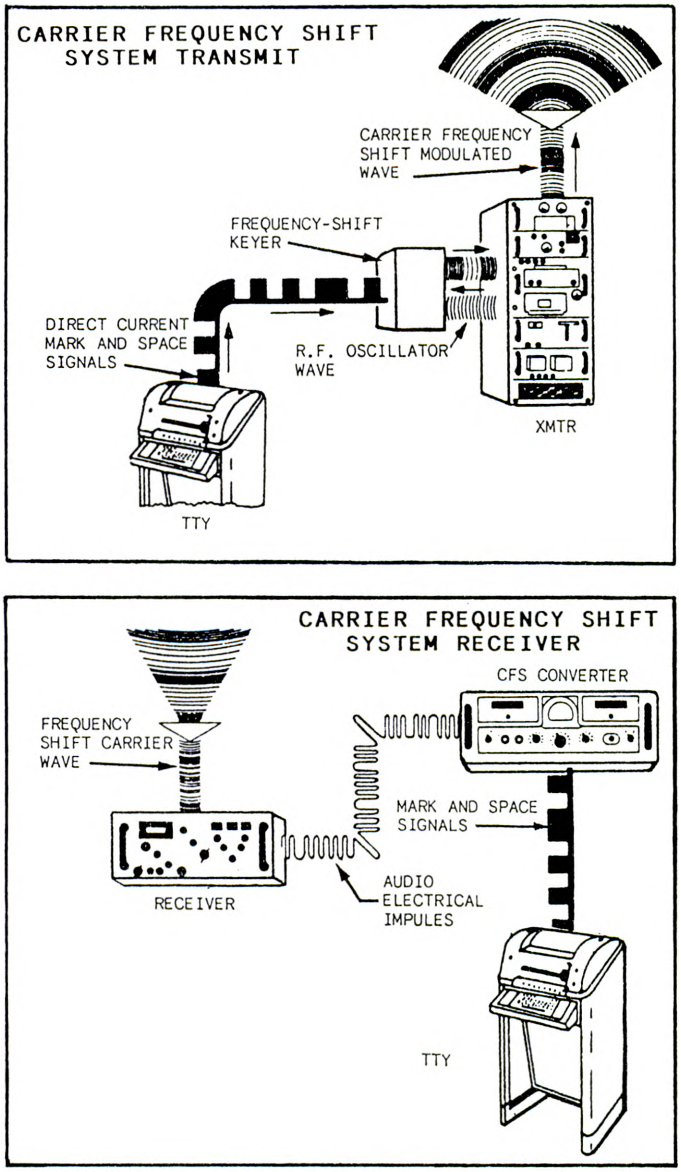


Figure 11-4.–Basic carrier frequency-shift (RFCS) system.

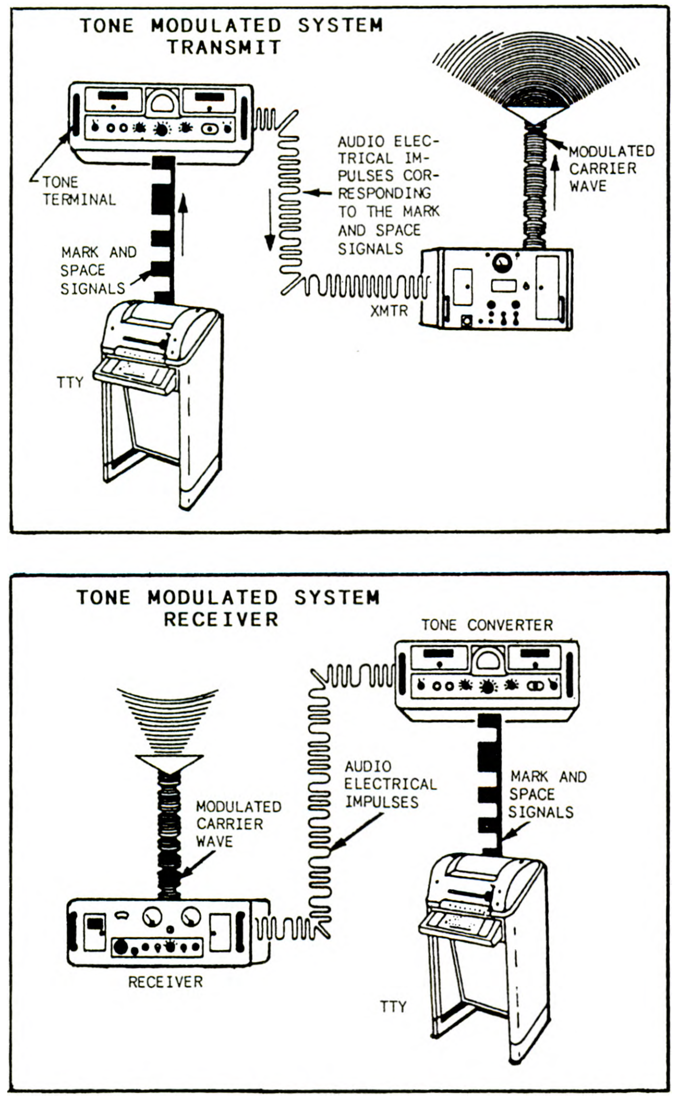


Figure 11-5.–Basic tone-modulated (AFTS) system.

by the TTY battery. The TTY panel integrates the tone-modulated and the carrier-frequency shift systems. It provides every possible interconnection of available TTY equipment. With this configuration maximum operational flexibility is achieved with the least amount of circuitry and equipment.

AFTS

Tone modulated (AFTS) systems use amplitude modulation to change dc mark and space impulses into audio electrical impulses. A basic tone-modulated system is shown in figure 11-5. Conversion to audio tones is done by an audio oscillator in the tone converter. Rapid varying of the tone, according to the characters transmitted from the TTY equipment, amplitude modulates the carrier wave in the transmitter. The receiver receives the modulated signal and separates the audio signal from the carrier. This process of separating the modulated signal is known as detection or demodulation and was described in the previous chapter.

COMMUNICATION SYSTEM OPERATION

The capability of a communication system to transmit and receive can be classified as simplex, half duplex, or duplex operation.

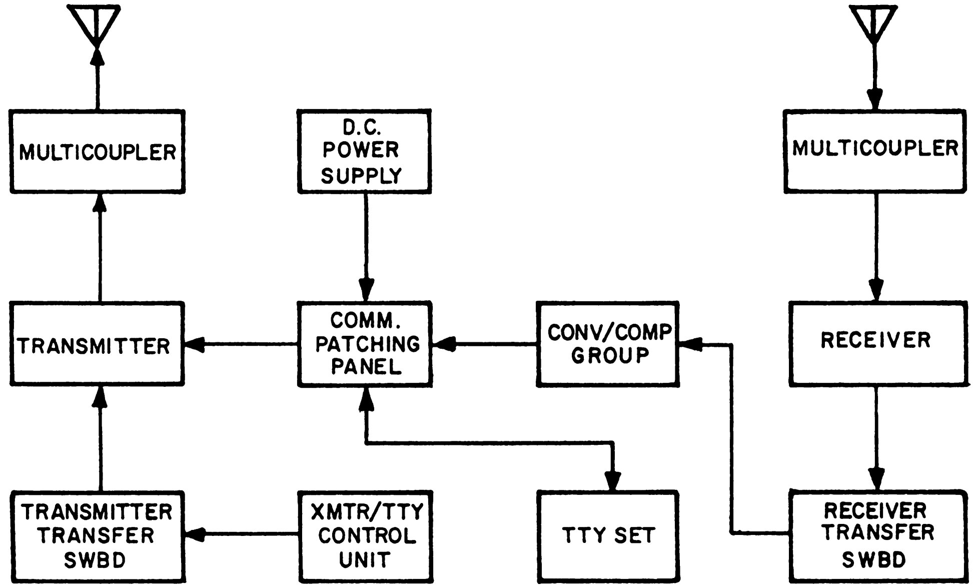


Figure 11-6.–Simplex RFCS teletype system.

Simplex Operation

A simplex operation permits the transmission of signals in either direction alternately. NOTE: Radio telegraph and data transmission systems may use either (1) a single frequency, time slot, or code address for transmission, and another frequency, time slot, or code address for reception; or (2) the same frequency, time slot, or code address for both transmission and reception.

Half-Duplex Operation

A half-duplex communications circuit permits two-way communications between stations. These communications can be in either direction, but not simultaneously. The term *half-duplex* is qualified by adding send only, receive only, or send or receive.

Duplex Operation

In duplex operation simultaneous two-way communications messages or information may be passed between any two given points simultaneously. For further information, refer to MIL-STD 188C and MIL-STD 188-120.

SIMPLEX RFCS TELETYPE SYSTEM

Radio frequency carrier shift teletype systems are used in the lf to hf bands for long-range communications. To reduce fading and interference problems in these bands, the Navy uses two methods of *diversity reception*. These methods are *space diversity* and *frequency diversity*.

In *space diversity* reception, one signal is transmitted, and is received by two or more receivers. The receiver antennas are separated by a distance greater than one wavelength. The outputs of the receivers are fed into frequency-shift converters that convert the audio frequency-shift signals into dc mark and space signals. The dc signals are then fed into a comparator, which selects the best mark and space signals for the teletypewriter. Because of required spacing between the receiver antennas, space diversity is mostly limited to shore stations.

In *frequency diversity* reception, two or more signals carrying the same intelligence are transmitted on different frequencies. The signals are received by receivers and processed in the same manner as in space diversity reception to operate teletype equipment from the best of the transmitted signals. This form of frequency diversity is known as rf diversity. Another form of frequency diversity called *af diversity* or *tone diversity* is used with multichannel broadcasts.

A simplified block diagram of a simplex mf/hf RFCS teletype system is shown in figure 11-6.

A *simplex* communication circuit consists of a single channel over which two or more stations may communicate. Each station may transmit and receive, but not simultaneously. On the transmit side (fig. 11-6), the teletypewriter (TTY) set keyboard or transmitter distributor applies the dc teletype signals to the

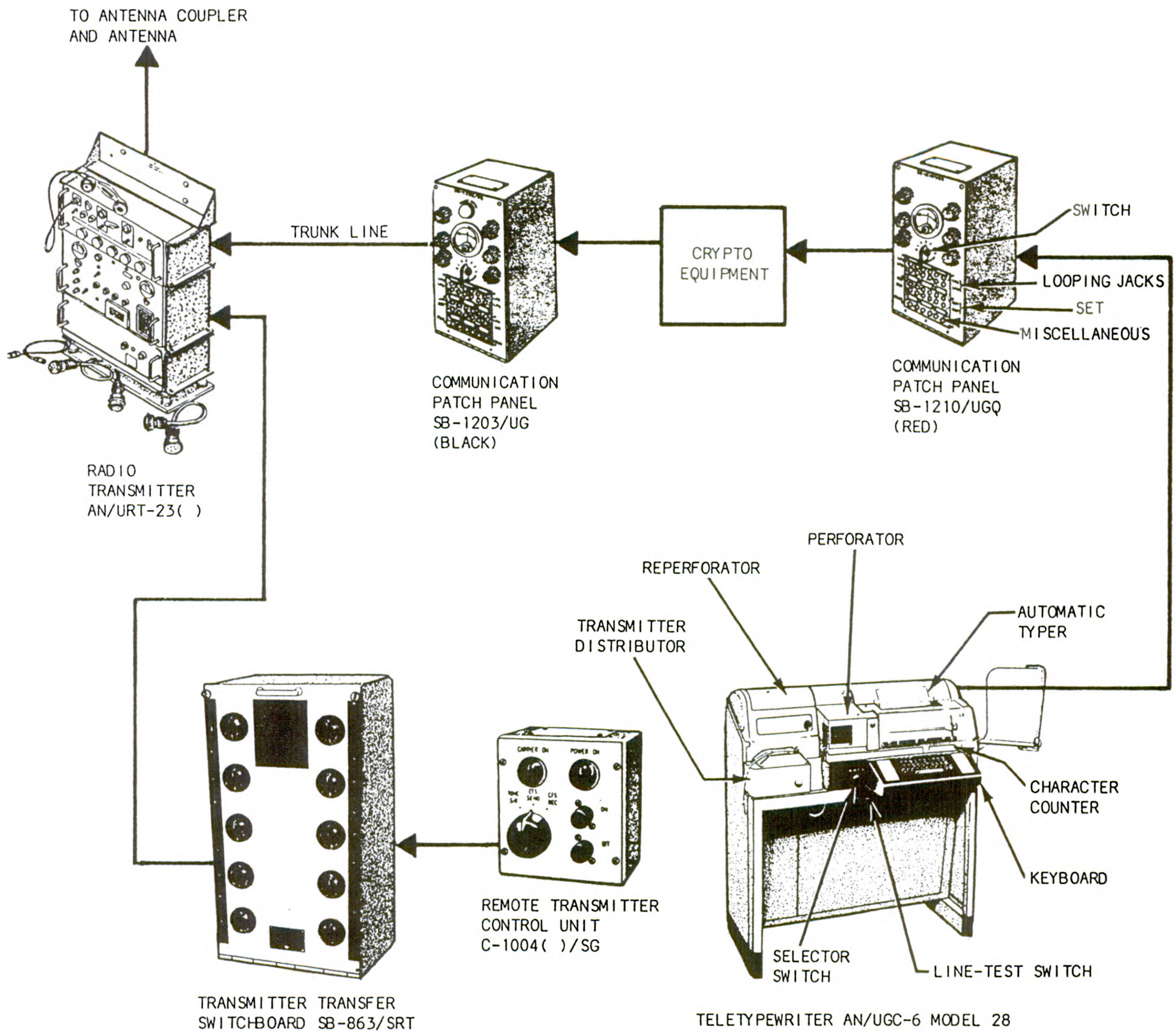


Figure 11-7.–RFCS transmit (send) system.

communication patch panel where they are patched to the transmitter. The dc mark and space signals shift the frequency of the rf carrier generated by the transmitter as explained previously.

On the receive side, the rf frequency-shift signal is received and demodulated by the receiver, resulting in an audio signal, which shifts 850 Hz between marks and spaces. This audio frequency-shift signal is fed to a converter in the converter/comparator group where it is converted into the original dc mark and space signals. The dc mark and space signals are then patched through the communication patch panel to the TTY set.

RFCS SEND SYSTEM

The following is a functional description of an RFCS teletype transmit communications system. See the pictorial diagram (fig. 11-7).

Teletypewriter Sets

There are currently two different models of teletypewriter (TTY) sets used by the Navy, the Model 28 family and the AN/UGC-143 series. Several teletypewriter sets have been included in the Model 28 family over the years. Model 28 equipments feature various weights and sizes, quiet operation, and high operating speeds. They present relatively few

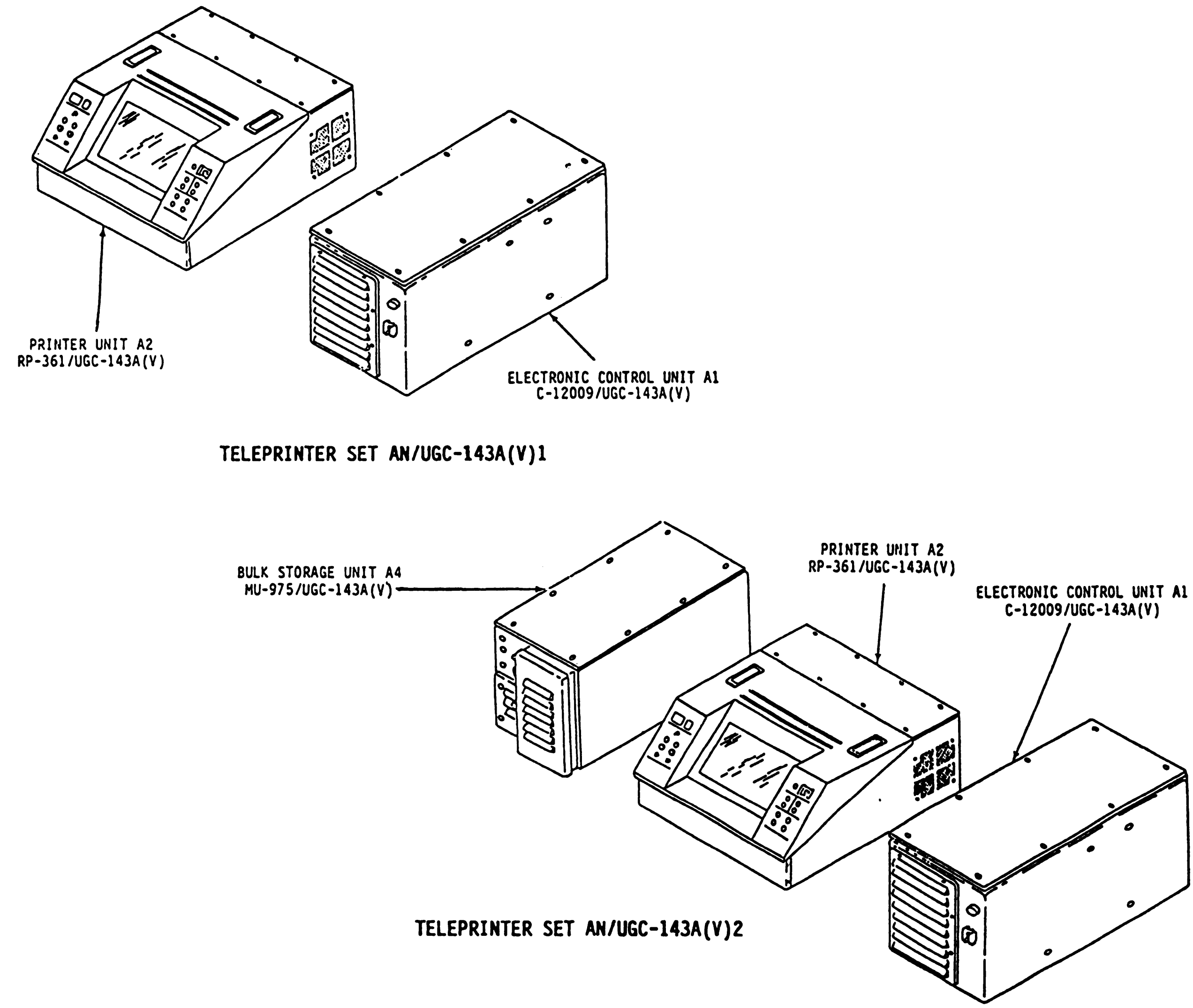


Figure 11-8.–AN/UGC-143A(V)1 & 2.

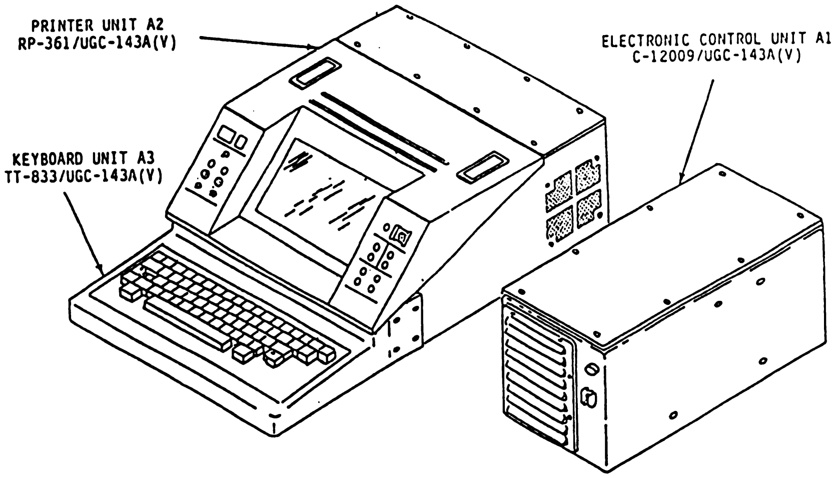
maintenance problems, and are particularly well-suited for shipboard use under severe conditions of roll, vibration, and shock.

Model 28 TTY sets may be send and receive units or receive- only units. They may be designed as floor models, table models, or rack and wall-mounted sets. A representative send and receive floor model set used for transmitting is shown in figure 11-7. A typical receive only model is discussed later in the chapter.

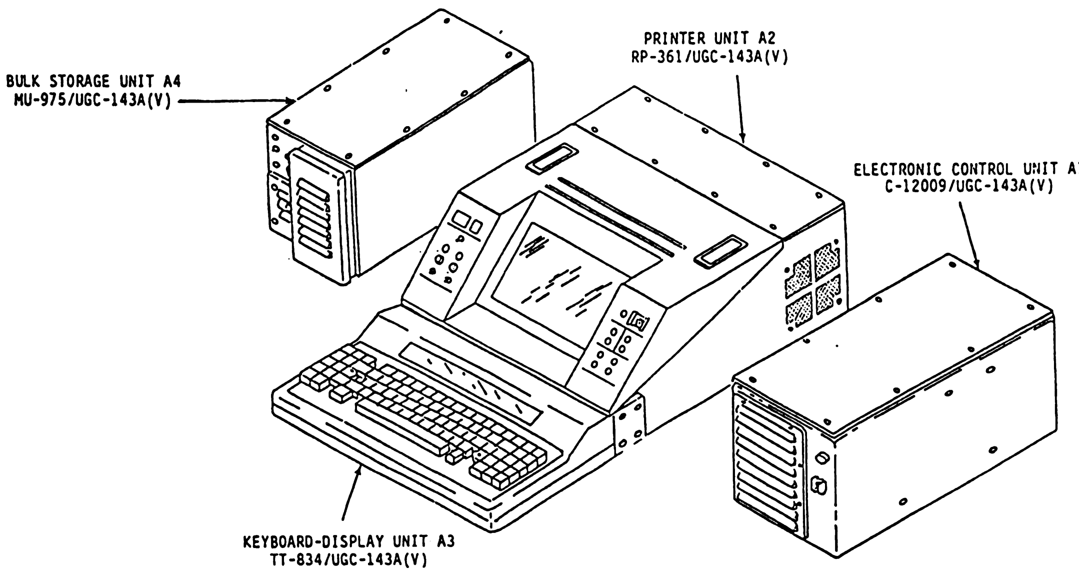
The TTY set receives teletype messages from the line and prints them on page-size copy paper. It can also record them on perforated tape. The Model 28 can send messages from either the keyboard or perforated tape, with page size copies provided.

Model 28 teletypewriter sets may be composed of the following components, depending upon their specific function: a cabinet, a keyboard, a page printer, a typing perforator, a transmitter distributor, a typing reperforator, power distribution panels, and power supply.

In operation, the components are linked by electrical or mechanical connections to offer a wide range of possibilities for sending, receiving, or storing teletypewriter messages. All equipment components are housed in the cabinet. Transmission signals are initiated through the keyboard or through the transmitter distributor. Signals are received, or local transmission can be monitored, on the page printer. The typing perforator and typing reperforator are devices for preparing tapes on which locally initiated or incoming teletypewriter messages can be stored for future transmission through the transmitter distributor.



TELEPRINTER SET AN/UGC-143A(V)3



TELEPRINTER SET AN/UGC-143A(V)4

Figure 11-9.–AN/UGC-143(V)3 & 4.

The newest teletypewriter set in the fleet is the AN/UGC-143A(V), also known as the Navy Standard Teleprinter (NST). The AN/UGC-143A(V) has the following characteristics:

- Fully automated
- Accepts data in Baudot code or USACII
- Bulk storage modules contain tape drives similar to the AN/USH-26
- Can be configured to interface with Navy standard personal computers
- Fully compatible with current cryptographic devices
- Capable of supporting paper tape operations

There are currently four variations of the AN/UGC-143A(V).

AN/UGC-143A(V)1 & 2–The (V)1 is strictly a printer, while the (V)2 has a bulk storage unit and can store messages on magnetic tape for rapid retrieval at a later time. Both units are depicted in figure 11-8.

AN/UGC-143A(V)3, Keyboard Send/Receive (KSR) Teleprinter–This configuration (fig. 11-9) has the capability for message composition, editing, transmitting, and receiving.

AN/UGC-143A(V)4, Automatic Send/Receive (ASR) Teleprinter–This configuration (fig. 11-9) has the features necessary for message composition, editing, receiving, transmitting, and storage.

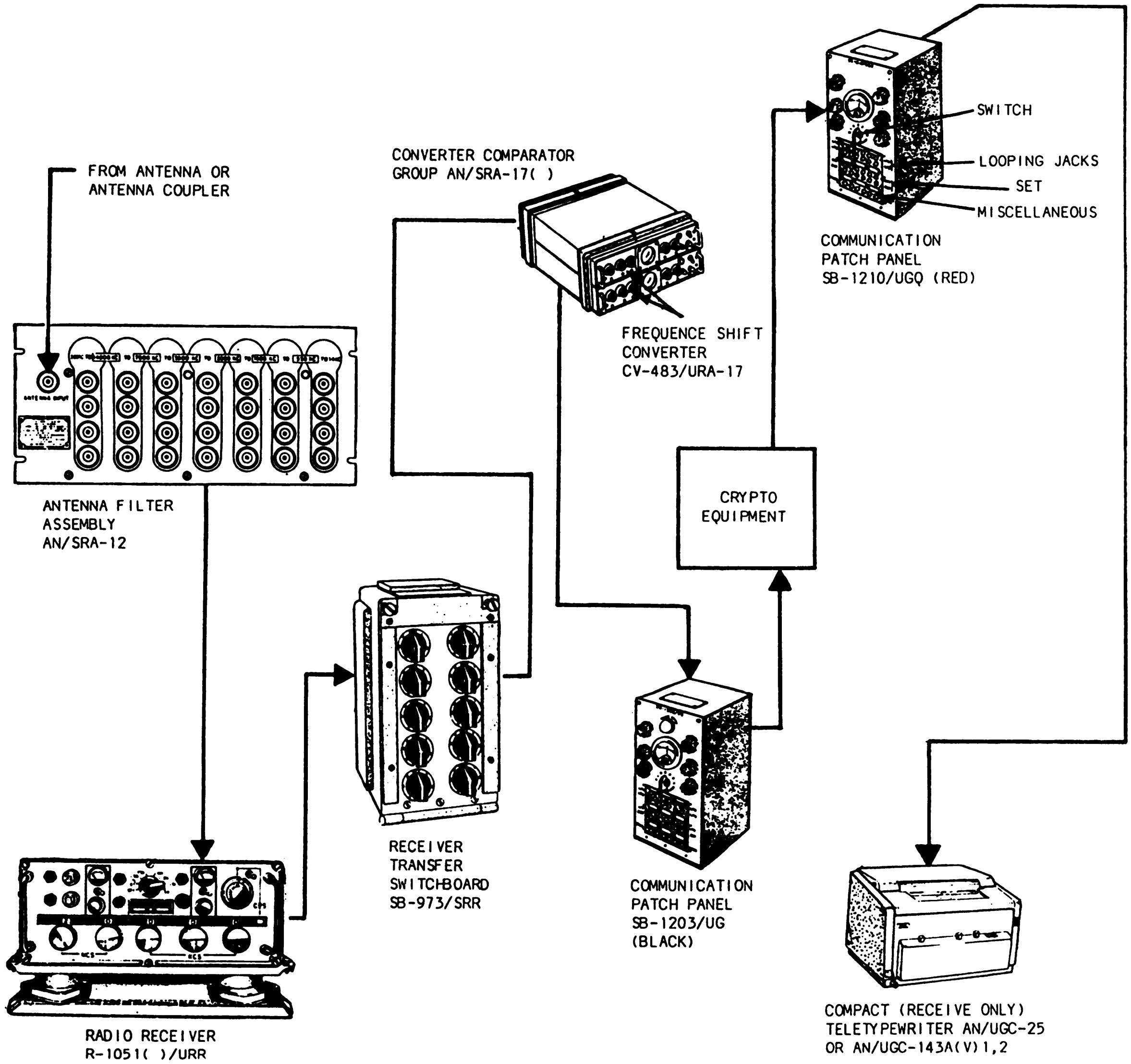


Figure 11-10.–RFCS receive system.

Communication Patching Panels

To provide flexibility in teletype systems, the wiring of all teletypewriters and associated equipment is terminated at jacks in communication patching panels, usually referred to as teletype patch panels. The equipment then is connected electrically in any desired combination by patching cords.

The plugs on the cords are inserted into the jacks at the front of the panel. In some instances, commonly used combinations of equipment are permanently wired together within the panel (called *normal-through*). They are wired so that individual pieces of equipment can be "lifted" from the combination, and then used alone or in other combinations.

In addition to providing flexibility, teletype panels also furnish a central point for connecting the dc voltage supply into the teletypewriter circuits. Thus, one source of supply can be used for all circuits passing through a particular panel.

Teletype panels SB-1203/UG and SB-1210/UGQ (fig. 11-7) are used for interconnection and transfer of teletypewriter equipment aboard ship. The SB-1203/UG is a general-purpose panel; whereas, the SB-1210/UGQ is intended for use with cryptographic devices. The colors RED and BLACK are used to identify secure and nonsecure information. Red indicates that secure (classified/encrypted) information is being passed through the panel, and black indicates

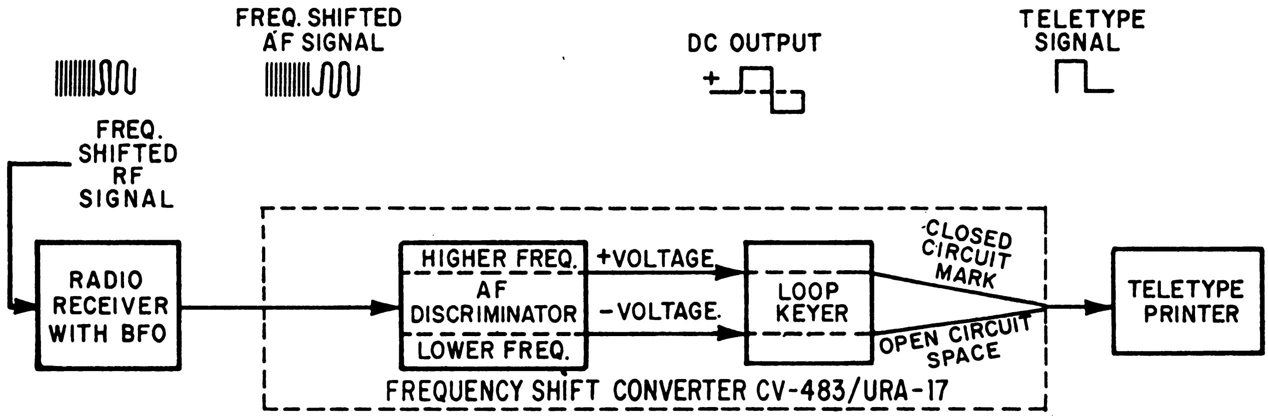


Figure 11-11.–Frequency shift receiving system simplified block diagram.

that nonsecure (unclassified/unencrypted) information is being passed through the panel.

In any switching operation between the various plugs and jacks of a teletype panel, the cord plug must be pulled from the looping jack before removing the other plug from the set (machine) jack. Pulling the plug from the set jack first opens the circuits to the channel, causing all teletype messages in the channel to be interrupted. **IT ALSO PRODUCES A DANGEROUS DC VOLTAGE ON THE EXPOSED PLUG.**

Cryptographic Equipment

Cryptographic equipment is used to ENCRYPT (encode) and DECRYPT (decode) messages that require security handling. To encode or decode any message, the sending and receiving cryptographic equipment must be compatible.

Remote Transmitter Control

The remote transmitter control unit (fig. 11-7) is mounted close to the teletype keyboard, and permits remote control of the transmitter. It has a transmitter power on-off switch, a power-on indicator lamp, a carrier-on indicator lamp, and a three-position rotary selector switch. For RFCS operation, the operator sets the switch to CFS SEND for transmitting and to CFS REC for receiving. The TONE S/R position is used for both transmitting and receiving AFTS signals.

Transmitter Switchboard

The transmitter switchboard (SB-863/SRT) (fig. 11-7) is used in this system to connect the remote transmitter control unit to the transmitter that is to be used to transmit the signal.

Transmitter

The transmitter (fig. 11-7) is used to transmit the teletype signal. Whoever tunes the transmitter for RFCS operation must be sure that the carrier frequency is properly set to ensure that the correct frequency is obtained at the output of the transmitter.

RFCS RECEIVE SYSTEM

The RFCS receive system (fig. 11-10) is used to receive the transmitted signal and translate it back to a usable teletype output.

Antenna Filter

The antenna filter (fig. 11-10) is connected to the antenna and receives the rf signal from the antenna. It filters out any unwanted rf signals so that only the band of frequencies desired will be passed on to the receiver.

Radio Receiver

The radio receiver (fig. 11-10) receives the rf signal passed on by the antenna filter and translates it to an audio signal.

Receiver Transfer Switchboard

The receiver transfer switchboard (fig. 11-10) is used to connect the receiver to any one of the converter units that are connected to it. This allows a wide selection of equipment to be connected to the same receiver.

Converter/Comparator Group

The converter/comparator group (fig. 11-10) is used with receivers in either space or frequency diversity operation. When diversity operation is not required, each converter can be used separately with a single receiver.

Figure 11-11 is a simplified block diagram that shows the basic function of converting the frequency-shift rf signal into a signal for controlling the dc loop of the TTY. The frequency shifts of the af output from the receiver are converted into dc pulses by the af

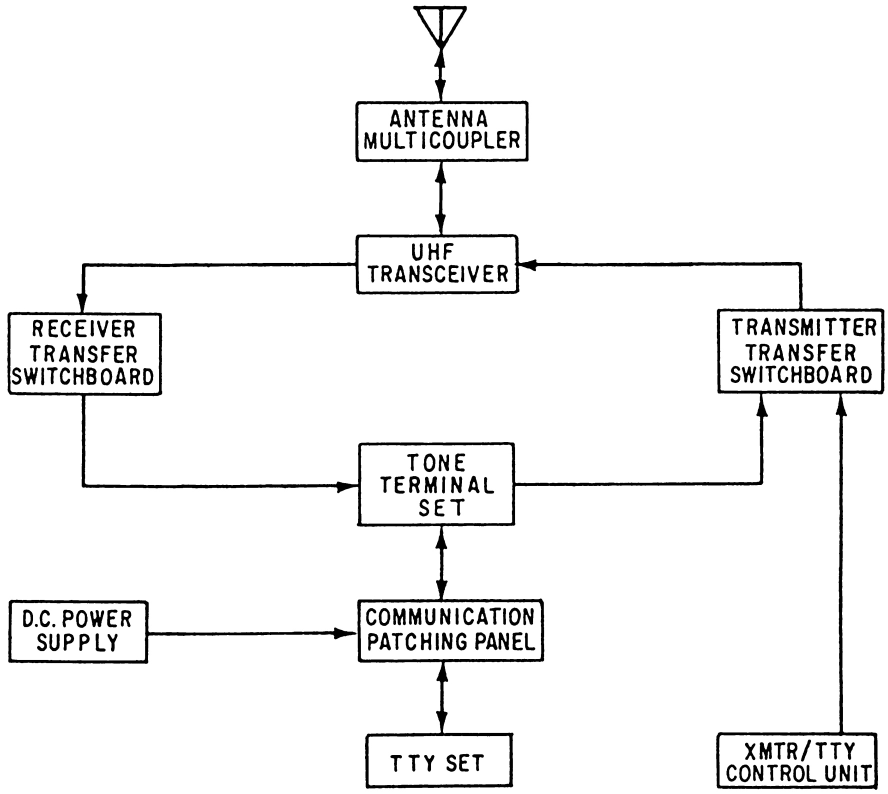


Figure 11-12.–Half-duplex AFTS teletype system.

discriminator. The dc pulses are fed into the loop keyer, which opens and closes the dc loop of the TTY according to the mark and space characters received.

The comparator section of the converter/comparator compares the strength of the signals from the receivers in diversity operation. Signals from each converter are fed into a comparator circuit, which compares the signals and allows only the stronger signal to be fed to the communication patching panel for patching to the TTY.

Communication Patch Panel

The communication patch panels (fig. 11-10) serve the same function on the receive side of the RFCS system as they did on the transmit side; that is, to route the dc signal to the proper crypto equipment, and to route the decoded teletype signal from the crypto equipment to the selected teletype equipment.

Crypto Equipment

The crypto equipment (fig. 11-10) is used to convert the coded signal that was transmitted to a decoded signal that can be printed out in its original state.

Teletype

The teletype equipment is used to convert the dc signal received from the communication patch panel to a printed copy of the original transmitted message. The teletype equipment shown contains a page printer only; therefore, it is used for receive only and does not have the capability to transmit.

AFTS SYSTEM

A simplified block diagram of a half-duplex (send or receive) uhf AFTS system is shown in figure 11-12. A half-duplex communication circuit permits unidirectional communication between stations. Communication can be in either direction, but cannot occur simultaneously. The term half-duplex is qualified by adding *send only, receive only,* or *send or receive.*

Signal Flow

On the transmit side (fig. 11-12), dc signals from the TTY set are fed to the communication patching panel where they are patched to the tone terminal set. The tone terminal set converts the dc signals into audio tone-shift signals, which are patched to the transmitter section of the transceiver through the transmitter transfer

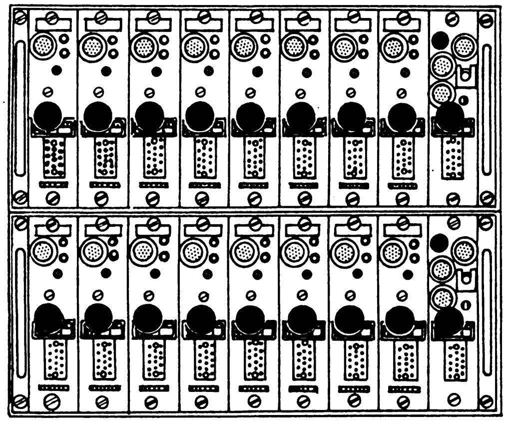


Figure 11-13.–Telegraph Multiplex Terminal AN/UCC-1D(V).

switchboard. The audio tone-shift signals modulate the rf carrier generated by the transmitter. The rf tone-modulated signals are then radiated by the antenna.

On the receive side, the rf tone-modulated signals are received at the antenna and patched via the multicoupler to the receiver section of the transceiver, where demodulation takes place. The resulting audio tone-shift signals are then patched through the receiver transfer switchboard in the tone terminal set, where they are converted back to dc signals. The dc signals are patched through the communication patching panel to the TTY set.

Tone Terminal Set

In tone modulation transmission, the teletypewriter pulses are converted into corresponding audio tones, which amplitude modulate the rf carrier in the transmitter. Conversion to audio tones is done by an audio oscillator in the tone converter.

An internal relay in the tone converter closes the control line to the transmitter, which places the transmitter on the air when the operator begins typing a message. The control line remains closed until after the message has been transmitted.

When receiving messages, the tone converter accepts the mark and space tones coming in from an associated receiver and converts the intelligence of the tones into signals suitable to operate a relay in the converter. The make and break contacts of the relay are connected in the local teletypewriter dc loop circuit. This action causes the teletypewriter to print in unison with the mark and space signals from the distant teletypewriter.

MULTIPLEXING EQUIPMENT

The number of communications networks in operation throughout any given area is increasing. As a result, all areas of the rf spectrum have become highly congested.

The maximum number of intelligible transmissions taking place in the radio spectrum is being increased through the use of *multiplexing*. Multiplexing is the simultaneous transmission of a number of intelligible signals (messages) in either or both directions using only a single RF carrier. There are two methods of multiplexing, *time division* and *frequency division*. Both methods of multiplexing were described in chapter 10. In this section, we will describe the AN/UCC-1D, which is the most common multiplexing equipment in the fleet.

Telegraph Terminal AN/UCC-1D(V)

The AN/UCC-1D is high-level capable or low-level capable, while the AN/UCC-1 is high-level capable only. This text discusses the AN/UCC-1D.

Telegraph Terminal AN/UCC-1D(V) (fig. 11-13) is a frequency division multiplex carrier-telegraph terminal equipment for use with single-sideband (ssb) or dual-sideband (dsb) radio circuits, audio-frequency wire lines, or microwave circuits. Each of the two electrical equipment cabinets shown in figure 11-13 houses one control attenuator (right side) and up to a maximum of eight frequency shift keyers or eight frequency shift converters, or any combination of both.

Since the control attenuator, keyers and converters are solid-state, integrated circuit plug-in modules, the number of channels may be varied by increasing or decreasing the total number of modules. Depending upon the number of modules and the configuration used, the terminal can provide up to 16 narrow-band channels within a 382-3017 Hz bandwidth. For example, if the unit in figure 11-13 is considered to have keyers in the top cabinet and converters in the bottom cabinet, the system is capable of transmitting different information on eight channels. Each keyer represents a channel on the transmit side and each converter a channel on the receive side.

Each frequency-shift keyer accepts a dc telegraph signal input from an external loop, and generates the appropriate audio-frequency mark/space frequency-shift output. The individual keyers each contain two

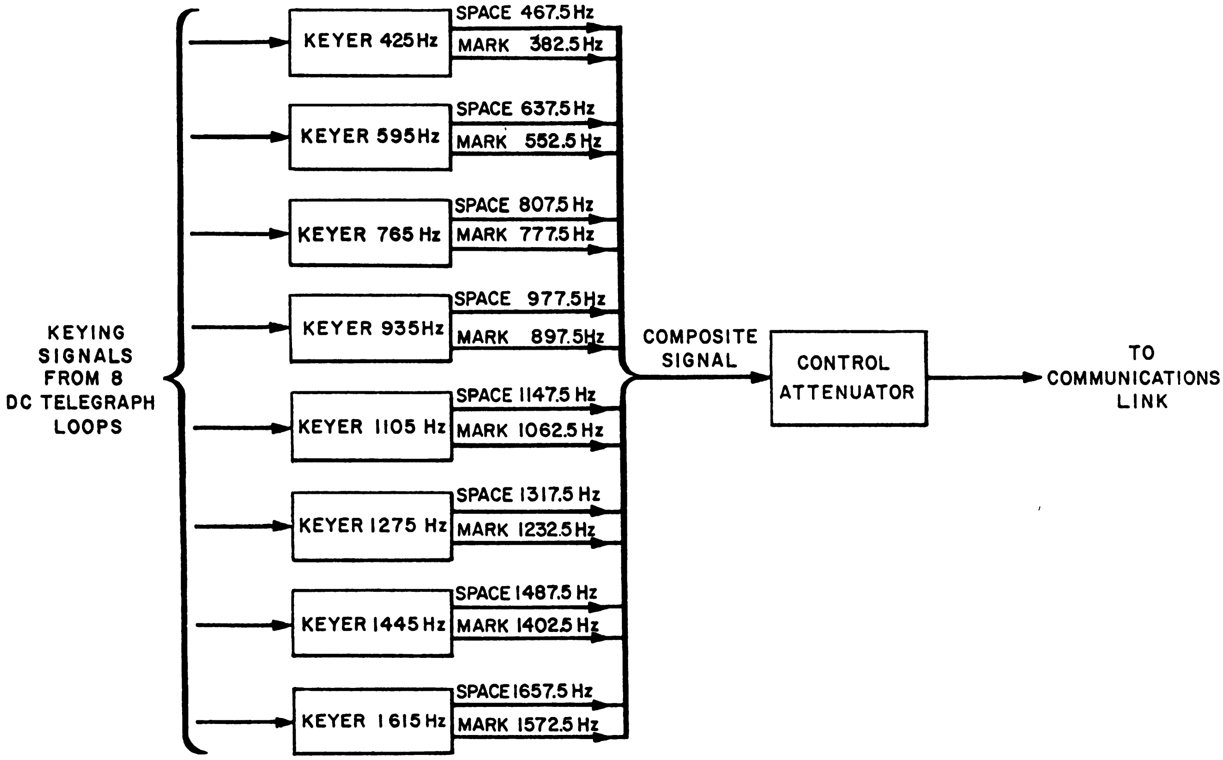


Figure 11-14.–Keying frequencies of the AN/UCC-1D(V).

oscillators operating on opposite sides of a center frequency. For example, in figure 11-14, the center frequency for keyer number one is 425 Hz, the mark frequency is 382.5Hz, and the space frequency is 467.5 Hz. These audio frequency mark/space outputs are referred to as tones; thus keyer number one has a one channel, two-tone output. (The mark and space frequencies may be reversed in local equipment manuals. Figure 11-14 represents frequency assignments based on inter-service usage.)

The input from the TTY set on channel 1 will determine which frequency is gated from the keyer to the group attenuator. Each individual channel works in the same way, accepting an input from the TTY set patched to that channel and providing an output audio-frequency mark/space frequency-shifted signal (tone) according to the input. The individual tones are combined at the keyers into a composite tone package. The control attenuator ensures that the composite tones remain at a constant amplitude for modulating the transmitter.

At the receiving end of the communication link, the telegraph terminal reverses the process performed at the transmitting end and applies the information on each of the channels to the TTY set connected to that channel's converter.

In this circuit configuration, each channel has an input from a different TTY. If for some reason (atmospheric conditions, poor reception at a particular frequency, and so forth) this channel fades and the information on it is lost or distorted, the information must be retransmitted. To aid in preventing this, diversity switches that will permit the use of more than one channel for the same intelligence have been provided. In position ONE, only the normal channel is used; in position TWO, a single teletypewriter signal provides input for two adjoining keyers; in switch position FOUR, four keyers are connected to the same input loop. The switches on all keyers must be in the same position to provide the same intelligence to the selected combination of channels.

When identical intelligence is transmitted on two or four channels, it is less likely to be lost or distorted. At the receiving end, two or four corresponding converters may be used. The converter having the stronger signal input provides the signal to be used by the receiving teletypewriter.

In the shipboard multiplexing system consisting of 16 channels, two channels normally carry the same intelligence. This process is called *twinning*. The twinned channels have a center frequency separated by 1360 Hz (e.g., 425-1785, 595-1955, 765-2125).

LOW-LEVEL TELETYPE (TTY)

In the past, TTY keying signals typically operated at 120 volts 60 mA (milliamperes) line current. Because it was possible for unauthorized electromagnetic detection of this high level signal, a method of operation using nondetectable signals became important. Low-level keying, at much lower voltages of plus or minus 6 volts at 20 micro-amps, and the use of gold contact points essentially eliminated detectable emissions. This also reduced the safety hazard to personnel working with these circuits.

For older ships with TTY equipment that has been modified to operate low level, there are a great many TEMPEST requirements (outlined in MIL-STD-1680) that require your careful observation. TEMPEST will be addressed later in this chapter.

FACSIMILE

Facsimile (FAX) is a method for transmitting still images over an electrical communication system. The images, called *pictures* or *copy* in facsimile terminology, may be weather maps, photographs, sketches, typewritten or printed text, or handwriting. Military use of FAX is primarily limited to transmission and reception of weather maps. Its tactical uses are limited due to the length of time between transmission and reception. For tactical needs, we use a variety of computer systems.

As an EMO, you will encounter a variety of commercial FAX machines that use modems and telephone lines. At the time of this printing, there was no tactical military use for these FAX machines.

TEMPEST

Compromising emanations (CE), generally referred to as TEMPEST, are *unintentional data-related or intelligence-bearing signals which, if intercepted or analyzed, can disclose the classified information transmitted, received, handled, or otherwise processed by electrical information processing equipment or systems.*

Classified Information Processing Systems, although commonly associated with communications systems, also include any equipment or system that processes classified information in an electrical form. Such systems include, but are not limited to, computers and word processors, Mode 4 IFF, AN/SLQ-32 countermeasures sets, Tomahawk weapons systems, LAMPS III sonar systems, SSES, OUTBOARD, and any closed circuit television system used for classified briefings and programs. Certain countermeasures are taken to ensure against CE such as:

1. Equipment designs in which CE is suppressed
2. Approved installation criteria that limit interaction between classified and unclassified signal lines, power lines, grounds, equipment, and systems
3. Low-level keying and signaling (discussed earlier in this chapter)
4. Shielded enclosures for equipment installations
5. Proper/shipboard grounding of equipment including proper ground straps

The Navy uses MIL-STD-1680 (SHIPS), *Installation Criteria for Shipboard Secure Electrical Information Processing Systems* as the definitive guidance for TEMPEST. You must have a thorough working knowledge of the requirements outlined in MIL-STD-1680 (SHIPS) to be able to ensure that all system modifications are properly installed and inspected. TEMPEST familiarization courses are taught at all MOTU locations and EMOs are required to attend this training. Additionally, Type Commander instructions contain certain specific requirements relating to TEMPEST. Each command, activity, and contracting officer responsible for the design, development, procurement, installation, inspection, testing, evaluation, operation, maintenance, or repair of equipment or systems, which are or will be used to electrically process classified information, must take necessary actions to fulfill the responsibilities for TEMPEST.

Within the confines of communications centers, discussions are often centered on a RED patch panel or a BLACK equipment system. The RED and BLACK designations are defined in the following paragraphs.

RED CRITERIA

The RED designation is applied to all cryptographic equipments, subscriber terminal equipments, and interconnecting conductors involved in processing classified plain language information. The designation also applies to primary power circuits, dc circuits, control wiring, and ground conductors serving cryptographic equipments and subscriber terminal equipments, that are designated RED.

The RED designation is also applied to junction boxes, terminal boxes, distribution frames, conduit, ducts, cable racks and hangers, patching and switching panels, cabinets, power distribution panels (both ac and dc) and other ancillary devices serving the conductors and equipments mentioned above. To provide direct correlation with other agency definitions, RED wiring terminology is as follows:

Primary Red

Any conductor intended to carry classified plain language terminating in RED equipment or the RED side of cryptographic equipment is designated as *primary red.*

Secondary Red

Any conductor, other than PRIMARY RED, that connects to RED equipment, the RED side of cryptographic equipment, or the RED side of isolation devices, that does not intentionally carry classified information, but because of the coupling mechanism with the RED equipment *might* carry compromising information, is designated *secondary red.* Some examples are indicator lines, control lines, and timing lines. Power distribution panels and grounding systems serving RED conductors and equipment are also designated secondary red.

Black Criteria

The BLACK designation is applied to all conductors and equipment involved in handling or processing unclassified plain language and/or encrypted information in electrical form. It is also applied to all facilities and circuits that are not designated RED.

COMMUNICATIONS SECURITY(COMSEC) EQUIPMENT

COMSEC equipment requires special handling during repair and maintenance procedures. You may wish to consult the *Communications Security Publication Memoranda (CMS-5),* which provides guidance on repairing and maintaining COMSEC equipment and supporting material.

Cryptographic equipment is divided into two general types: basic, and related equipment and devices. Basic cryptographic equipment is nonpaper material that has a direct function in the encryption process. It includes on-line transmitters and receivers, IFF units, and off-line encrypt/decrypt equipment. Related cryptographic equipment and devices are also nonpaper items that do not have direct encryption/decryption process functions but relate to the process. This includes power units, remote units, extender cables, repair/maintenance/modification kits, and cabinets.

Most information in CMS-5 is classified; however, general unclassified information is provided in the following paragraphs. It is absolutely essential that you read and understand CMS-5.

REPAIR AND MAINTENANCE

Most repair and maintenance to COMSEC equipment will be done by ship's force aboard the ship that uses the equipment. Whenever the repairs or maintenance are beyond the capabilities of the ship's force or when inspections and overhauls are required, the user of the equipment must arrange, through the CMS custodian, for a Cryptographic Repair Facility (CRF) to do the work. When the COMSEC equipment is sent to or from the CRF, all procedures of the transfer must comply strictly with CMS-4.

The three general categories of COMSEC equipment maintenance are operator maintenance, intermediate (or field) maintenance, and depot maintenance.

Operator Maintenance

Operator maintenance is maintenance that is authorized for, performed by, and the responsibility of COMSEC equipment operators. This normally consists of inspecting, cleaning, servicing, preserving, lubricating, and adjusting of the equipment. It may also include minor parts replacement not requiring highly technical skills. Operators should receive indoctrination and training from MOTU activities or their own COMSEC equipment repair personnel on how to do this work, while referring to related KAM or KAO (cryptographic operating manuals) for specific instructions.

Intermediate (or Field) Maintenance

Intermediate maintenance is maintenance that is authorized for and performed by designated maintenance activities in direct support of using organizations or by qualified COMSEC equipment repair personnel attached to a using command or activity. It is normally limited to replacement of unserviceable parts, subassemblies, or assemblies by cleared personnel who graduated from a cryptorepair school for a specific model or type of COMSEC equipment. This is generally the highest level of shipboard COMSEC equipment maintenance.

Depot Maintenance

Depot maintenance involves a major overhaul or complete rebuilding of parts, subassemblies, or the equipment itself. This maintenance is intended to augment stocks of serviceable equipment or to support lower levels of maintenance by using more extensive shop equipment and personnel of higher technical skill than are available in organizational or field maintenance activities. Overhaul of ship COMSEC equipment should normally be done by a CRF.

CMS custodians are responsible for ensuring that all of the equipment they hold is complete and operational at all times. Emphasis should be placed on determining defects and correcting them, and, when replacement parts are not carried or have been used up, on the expeditious submission of requisitions to the supply system. MILSTRIP forms should not be accumulated for one-time preparation and lot submission to a supply point at a later date or on a delayed basis. Replacement parts not on hand should be requisitioned as the defects occur.

EQUIPMENT LOGISTIC SUPPORT CONSIDERATIONS

Cryptographic equipment subassemblies and repair parts supported by the Ship's Parts Control Center (SPCC) are obtained, funded, and stocked according to NAVSUP PUB 485 for unclassified items. The procedures for ordering certain classified cryptographic equipment-related items are covered by SPCCINST 5511.24. Repairables and mandatory turn-in items are listed in NAVSUP PUB 4107 for unclassified equipment and SPCCINST 5511.24 for classified equipment. These instructions include procedures for the exchange of defective items for operational items through the Navy Supply System. All EMOs and cryptographic maintenance personnel should be thoroughly familiar with these documents.

Generally, subassemblies and repair parts for cryptographic equipment supported by SPCC are included in allowances and load lists. In establishing allowances, the contents of repair kits are taken into consideration. SPCC furnishes two or more copies of APLs to each ship or station concerned with cryptographic equipment. Maintenance personnel must obtain one set of the appropriate APLs from the supply officer and retain the APLs for ready reference when they order replacement parts.

Although the cryptographic equipment maintenance manuals (KAMs/SAMs) list required or suggested general-purpose electronic test equipment and special tools, these items are not normally supplied with the cryptographic equipment issued through the CMS. The lists in the associated manuals are provided for guidance only. Commands holding cryptographic equipment must obtain the required general-purpose test equipment and support materials in the same manner as they do other general equipment and support materials.

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Installation Criteria for Shipboard Security Electrical Information Processing Systems, MIL-STD-1680, Naval Sea Systems Command, Washington, D.C., 1984.

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CHAPTER 12

RADAR THEORY AND EQUIPMENT

OVERVIEW

In this chapter, we discuss basic radar theory, as well as some of the radar and associated systems in the fleet.

OUTLINE

Basic radar

Principles

Types of radar

Sets

IFF

Switchboards

Radar systems

PALS

Repeaters

AIMS Mk XII

RADAR THEORY AND EQUIPMENT

Radar is an acronym for *Radio Detection and Ranging*. Shipboard radar systems are used primarily for early detection of surface or air objects and to gather data, such as range, bearing, altitude and speed of targets. They are also used for general surveillance, navigation, and for controlling the ship's own aircraft and small boats.

The principle upon which radar operates is very similar to the principle of sound wave reflection. If a person shouts in the direction of a cliff, or some other sound reflecting surface, he will hear an echo of his voice. The sound waves, generated by the shout, travel through the air until they strike the cliff. There, they are reflected and returned to the originating source as an echo. The strength, or loudness, of the echo depends mainly upon the strength of the shout, the distance to the reflecting surface, the ability of the surface to reflect sound waves, and the hearing acuity of the listener.

Because sound waves travel through the air at 1100 feet per second, there is a time lapse between the instant the sound wave leaves and the instant the sound wave is heard. Therefore, the farther the distance from the cliff, the longer the time before the echo is heard. For example, if the shout were made 2200 feet from the cliff, the echo would be heard 4 seconds later, 2 seconds for the sound to travel to the cliff and 2 seconds to return.

Radar uses radio frequency (rf) electromagnetic waves to take advantage of this principle by radiating a high power rf beam from a directional antenna. A signal echo is returned from objects in the path of the beam and detected by a sensitive receiver. The echoes are then presented visually on an indicator (screen). The radar system gives an indication of target distance (range) by measuring the time between the transmission of the signal and the return echo; and an indication of target direction by the bearing of the directional antenna. Naval ships have a high radar cross-section due to their large mass of metal; but more important, radar reacts specifically to any L-shaped metallic or semi-metallic object. Naval ships are loaded with L-shaped objects. Today's stealth technology uses nonmetallic materials, such as graphite, to absorb radar waves and radical shapes to reflect radar waves (rf) in other directions, rather than toward the sending unit. Applications of this

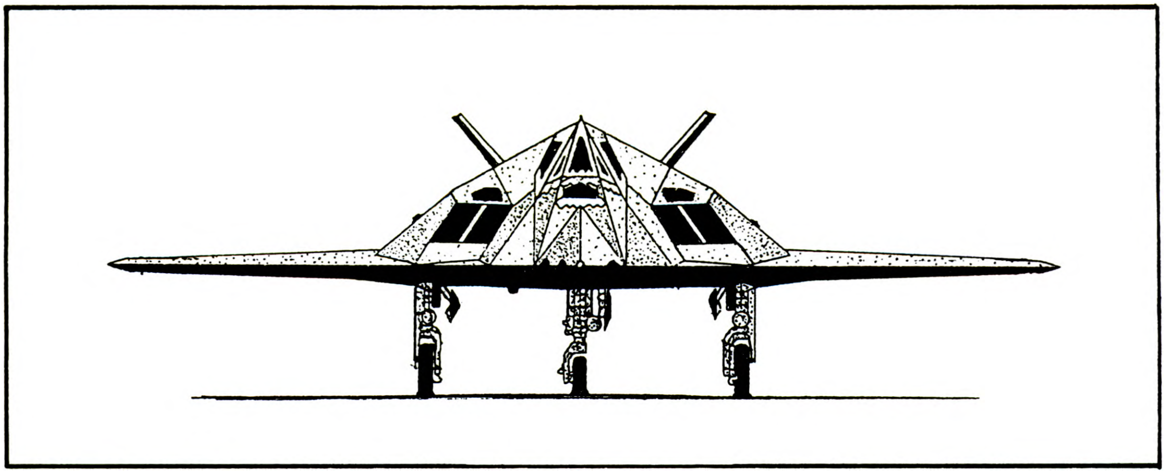

Figure 12-1.–Stealth technology–view A.

new technology are shown in figure 12-1, views A and B.

DETERMINING TARGET POSITION

The visual data required to determine and track a target's position is supplied by an indicator, which is a specially designed cathode-ray tube installed in a unit known as a *plan position indicator (ppi).* Bearing, range, and (for aircraft) altitude are necessary to determine target position. No single indicator, however, furnishes all three bits of information. In general, two scopes must be used–one for bearing and range, and one for range and altitude. With the addition of an IFF interrogator, altitude information is available at any PPI watchstation. Additionally, modern technology is allowing standard repeaters to be replaced by "consoles," which can provide bearing, range, and altitude information.

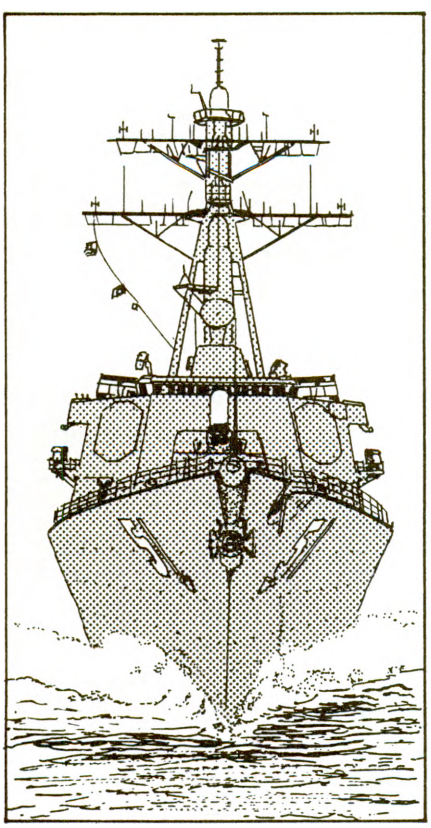

Figure 12-1.–Stealth technology–view B.

BEARING

The antennas of most radars are designed so that they radiate energy in one lobe that can be moved only

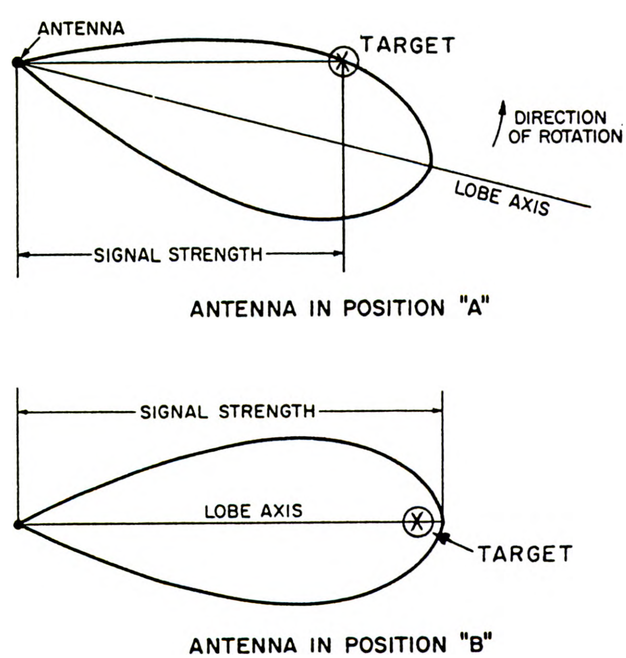

Figure 12-2.–Determination of bearing.

by moving the antenna itself. The general shape of a lobe is shown in figure 12-2. The shape of the lobe is such that the echo signal strength varies more rapidly with a change of bearing on the sides of the lobe than near the axis. Therefore, the echo signal varies in amplitude as the antenna rotates. At antenna position A, the echo is relatively small, but at position B, where the lobe axis is aimed directly at the target, the echo strength is maximum. Thus, the bearing of the target can be obtained by training the antenna to the position at which echo is greatest. In actual practice, however, the antenna is seldom manipulated in this manner. To do so might inform an enemy unit that it has been detected. Such practice also denies remote indicators full use of the radar for search purposes. However, this technique is widely used in weapons control and guidance radar systems and can be done either manually or automatically.

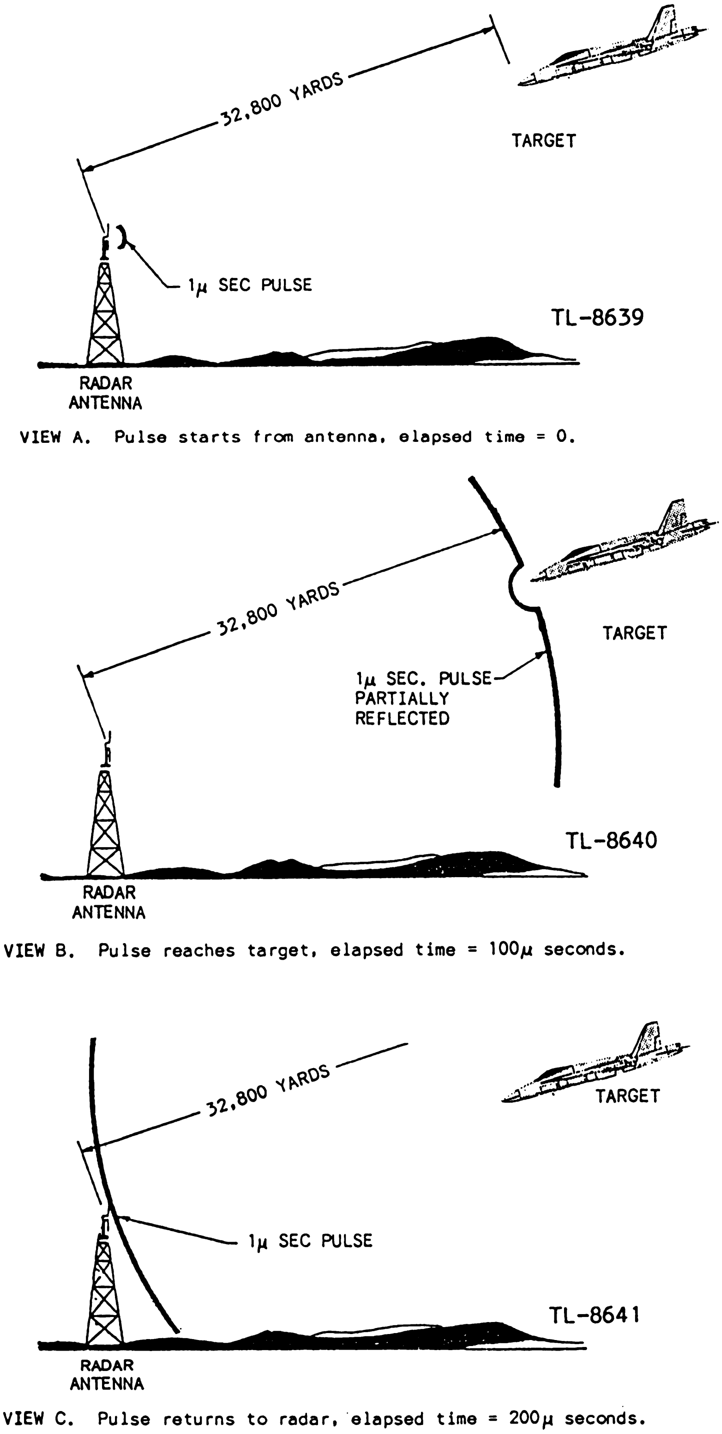

Figure 12-3.–Determination of range: A. Pulse starts from antenna, elapsed time = 0; B. Pulse reaches target, elapsed time = 100 μseconds; C. Pulse returns to radar, elapsed time = 200 μseconds.

RANGE

The successful use of pulse modulated radar systems depends primarily on our ability to measure distance in terms of time. Radio frequency energy radiated into space travels at the speed of light; that is, a constant 186,000 miles per second, 162,000 nautical miles per second, or 328 yards per microsecond. When it strikes a reflecting object, it is merely redirected, with no loss in time.

The constant velocity of radio frequency energy is used in radar to determine range by measuring the time required for a pulse to travel to a target and return. For example, assume that a 1-microsecond pulse is transmitted toward an object that is 32,000 yards away. Figure 12-3, view A, shows conditions at the instant the pulse is radiated. When the pulse reaches the target, it has traveled 32,800 yards at 328 yards per microsecond. Therefore 100 microseconds have elapsed. View B shows the pulse arriving at the target. The pulse is then reflected, and energy is returned over the same path. Since the return trip is also 32,800 yards, the required time of travel is again 100 microseconds. View C shows the pulse returned to the radar system. The total elapsed time is 200 microseconds for a distance traveled of twice the actual range of the target. For determining range therefore, the velocity is considered to be one half of its true value, or 164 yards per microsecond. In the example, range = time × 164 = 200 × 164 = 32,800 yards.

ALTITUDE

Altitude can be determined by using either height-finding radar or fade charts.

Figure 12-4.–Frequency scanning.

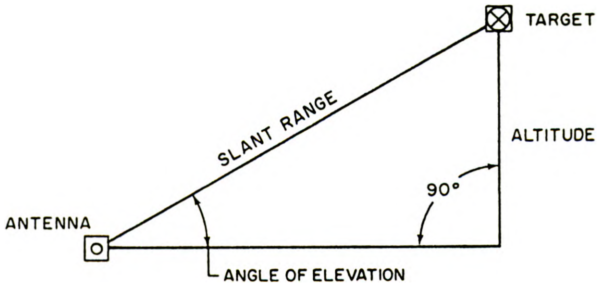

Figure 12-5.–Determination of altitude.

Height-Finding Radar

Height-finding radar uses a very narrow vertical beam, which is moved up and down either electronically or mechanically to pinpoint targets. The electronic method, shown in figure 12-4, produces a frequency scanning pattern along the vertical plane. Lines originating at the antenna depict the number of beam positions required to ensure complete coverage. Each beam position corresponds to a slightly different radiated frequency, which is set at a specific angle or step in relation to the base of the antenna. When the antenna base is stable, the initial radiated frequency sets up the top beam. A slight change in frequency activates the second beam, and the process continues until the entire plane is covered. When the antenna base is unstable, error signals are introduced by components of the system. A change then results in the transmitted frequency. This change compensates for ship's pitch and roll and ensures that the vertical plane is searched completely.

Height-finding radar provides the two mathematical components that are used to determine the altitude of an aircraft, *angle of elevation,* and *slant range.* The slant range of an aircraft is the distance of the aircraft from the radar antenna, measured along the radar beam (fig. 12-5). When both the angle of elevation and slant range are known, the altitude of the aircraft can be found by solving the basic triangle problem. The solution may be by calculation, by reference to a graph, or by a computer built into the radar.

To find the altitude by calculation, multiply the slant range by the sine of the angle of elevation.

Altitude found in this way is not the true height of the airplane above the earth because the calculation is based on the assumption that the earth is flat. However, most height finding radars have a circuit that adds a figure corresponding to the error due to the curvature of the earth at the range of computation.

Fade Charts

When height-finding radar is not installed, fade charts can be used to estimate aircraft altitude. This technique uses a combination of air search radar fade zones and reception zones.

Positions of lobes and nulls in an antenna pattern remain the same as long as antenna height and radar frequency are unchanged; thus, a given radar installation will have an unchanging radiation pattern. This makes it possible to plot the positions of lobes and nulls on a chart that may be used as an aid in determining the altitude of aircraft targets. To use a fade chart, a radar operator must notice the ranges at which an aircraft disappears in null areas. By applying these ranges to the chart, the operator can estimate the aircraft's altitude.

Data for fade charts is determined experimentally by having an aircraft fly at several constant altitudes, while an operator records its observed signal strengths and ranges.

RADAR DETECTING METHODS

Up to this point, only the pulse-modulation method of transmission has been used to show how a target is detected and tracked. Although this is the most common method, two other methods are sometimes used in special application radars. These are the *continuous-wave method,* and the *frequency-modulation method.*

Continuous Wave

The continuous-wave (cw) method uses the *Doppler effect* to detect a target. The frequency of a radar echo is changed when the target is moving toward or away from the radar transmitter. This change in frequency is known as the Doppler effect. It is similar to the effect at audible frequencies when the sound from the whistle of an approaching train appears to increase in pitch. The opposite effect (a decrease in pitch) occurs when the train is moving away from the listener. The radar application of this effect involves measuring the difference in frequency between the transmitted and reflected radar beams to determine both the presence and speed of the moving target. This method works well with fast-moving targets, but not well with those that are slow moving or stationary.

Frequency Modulation

In the frequency-modulation (fm) method, the transmitted frequency is varied continuously and periodically over a specified band of frequencies. At any given instant, the frequency of energy radiated by the transmitting antenna differs from the frequency reflected from the target. This frequency difference can be used to determine range. Moving targets, however, produce an additional frequency shift in the returned signal because of the Doppler effect. This additional frequency shift affects the accuracy of range measurement. Thus, this method works better with stationary or slow-moving targets than with fast-moving targets.

Pulse Modulation

Radars using pulse modulation transmit energy in short pulses that vary in duration from less than 1 to 200 microseconds, depending upon the type of radar. Echoes (energy reflected from a target) are amplified and applied to an indicator that measures the time interval between transmission of the pulse and reception of the echo. Half the time interval then becomes a measure of the distance to the target. Since this method does not depend on the relative frequency of the returned signal or on the motion of the target, difficulties experienced in the cw and frequency modulation methods are not present. The pulse modulated method is used almost universally in military and naval applications. Therefore, it is the only method discussed in detail in this text.

BASIC RADAR SYSTEM

Although modern radar systems are quite complicated, you can understand their operation by learning the functions of the blocks in the pulsed radar system diagram shown in figure 12-6.

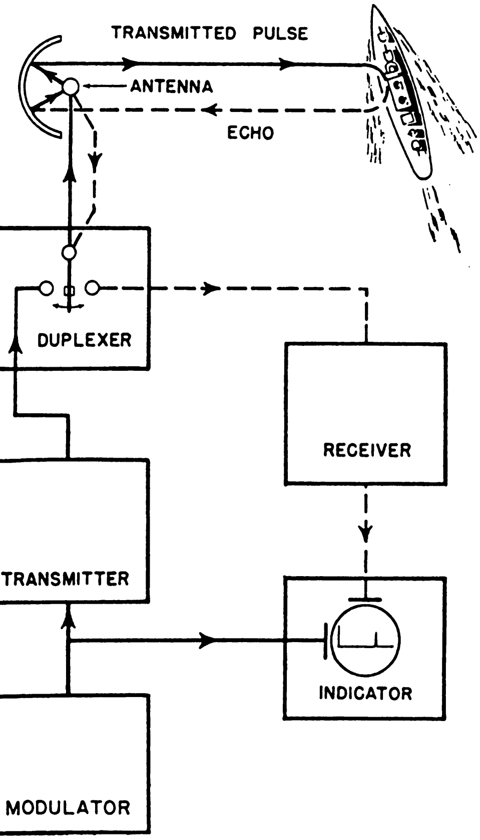

Figure 12-6.–Block diagram of a fundamental radar system.

The heart of the radar system is the *modulator*. It generates all the necessary timing pulses (triggers) for use in the radar and associated systems. Its function is to ensure that all subsystems making up the radar system operate in a definite time relationship with each other. It also ensures that the intervals between pulses, as well as the pulses themselves, are of the proper length. Some of the more common pulses furnished by the modulator include transmitter trigger, receiver gate, indicator trigger, associated Identification Friend or Foe (IFF) System trigger, and Electronic Warfare (EW) blanking trigger. The rate at which the transmitter is triggered is called the pulse repetition rate (prr) or pulse repetition frequency (prf).

The *transmitter* supplies rf energy, often at extremely high power, for short intervals of time. A pulse transformer in the transmitter increases the voltage of the pulse received from the modulator and sends it to an oscillator, which acts as an impedance matching device. The oscillator radiates at the designed transmission frequency of the radar for the duration of the pulse and transmits its energy to the antenna assembly through a duplexer and a transmission line. In some radar sets, especially air-search and height-finding, the magnetron is replaced by an output power tube, usually referred to as a power amplifier (pa).

The *duplexer* permits the use of a common transmission line and a single antenna for transmitting and receiving. The duplexer consists of two electronic switches, the transmit-receive (tr) and the antitransmit-receive (atr). The tr switch blocks the path to the receiver each time the transmitter is fired, preventing the high-powered pulse from damaging the receiver. The atr switch directs the received signal to the receiver while blocking it from the transmitter, keeping the signal from being dissipated in the magnetron during the receive interval. Thus, the duplexer not only provides coupling to the antenna system, but also prevents damage to the receiver system, and loss of the return echo in the transmitter.

The radar *antenna* system takes the rf energy pulse from the transmitter and radiates it as a directional electromagnetic beam. It also picks up the returning electromagnetic echo and passes it on to the receiver as an rf pulse with a minimum of loss.

The *receiver* amplifies the weak rf echo and converts it to a video signal. Modern radar receivers are highly sensitive superheterodyne receivers.

The radar *indicator* converts the video output of the receiver to a visual display of range and bearing (or in the case of height finding indicators, range and height). Indicators are discussed later in this chapter.

FACTORS AFFECTING RADAR PERFORMANCE

A few internal characteristics of radar equipment that affect range performance are peak power transmitted, pulsewidth, pulse repetition rate, transmission line efficiency, height of the antenna, and receiver sensitivity. Among the external factors are skill of the operator; size, composition, angle, and altitude of the target; weather conditions; and possibly ECM activity.

MAXIMUM RANGE

In general, the maximum range that can be measured on an indicator is limited by the *pulse repetition rate (prr)*. This is because with each transmitted pulse the indicator is reset to zero range. Therefore, if the time between transmitted pulses is shorter than the time it takes the transmitted pulse to reach the target and return, the indicator will have been reset and started as a new sweep; thus indicating a false range upon reception of the echo. For example, the interval between pulses is 610 sec with a repetition rate of 1640 pulses per second. Within this time the radar pulse can go out and back a distance equal to 610 sec × 164 yards per sec, or 100,000 yards, which becomes the scope's sweep limit. Echoes from targets beyond this distance appear at a false range. Whether an echo is a true target or false target might be determined simply by changing the prr.

The *pulsewidth (pw)* also affects the maximum detection range. The wider the pulse, the greater the average power out, resulting in a greater detection range of small targets. Air search radars usually have a much greater pw than surface search radars.

The more **sensitive** the receiver, the weaker the echo required to produce a target indication. As the receiver sensitivity is increased, which is reflected in a higher minimum discernable signal (MDS), the range at which a particular target can be detected is increased.

In general, the larger a target, the greater the range at which it can be detected. Land, particularly high, steep cliffs, can be detected at a much greater range than any other type of target, except, perhaps, high-altitude aircraft. Similarly, a group of aircraft can be detected at a greater range than a single aircraft because of the larger reflecting area. Targets at high altitudes can be detected at a longer range than those at low altitudes simply because it is possible for the radar pulse to reach them.

Another factor affecting the maximum range is *antenna height*. The distance in nautical miles to the radar horizon (disregarding propagation phenomena) is approximately 1.25 times the antenna height (measured in feet). To determine the detection range of a target, use the formula

$$1.25\sqrt{h_1} + 1.25\sqrt{h_2}$$

where h_1 is the height of the transmitting antenna, and h_2 is the height of the target.

The *antenna beamwidth* also affects the maximum detection range. A narrow, more concentrated beam has a greater range capability that a wide beam since it provides higher energy density per unit area.

Still another factor that affects the maximum detection range is the *antenna rotation rate*. The slower an antenna rotates, the greater the reliability of detection at long range. When the antenna is rotated at 10 revolutions per minute (rpm), the beam of energy strikes each target for one-half the time it would if the rotation were five rpm. The number of strikes per antenna revolution is called "hits per scan." During this time, a sufficient number of pulses must be transmitted to return an echo that is strong enough to be detected. Long-range search radars normally have a slower antenna rotation rate than radars designed for short-range coverage.

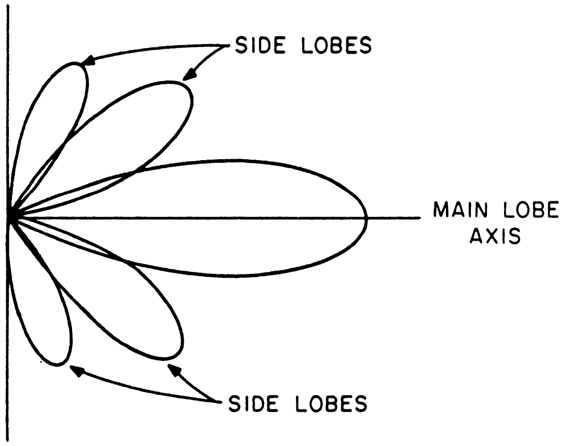

Figure 12-7.–Side lobes.

MINIMUM RANGE

The closest range at which radar can detect a target is controlled primarily by the length of the transmitted pulse. Some of the energy of the transmitted pulse leaks directly into the receiver. This overloads and blocks the receiver. At the end of the transmitted pulse, the receiver begins to recover, but recovery is not instantaneous. As long as the receiver is blocked, a saturation signal appears on the indicator, preventing echo pulses from being seen. Modern radar receivers have recovery times measured in hundredths of a microsecond, allowing targets that are at a range just slightly greater than half the transmitted pulsewidth to be displayed. The theoretical minimum range is (pw × 164) yards. It varies from actual minimum range only, the range associated with duplexer recovery time.

When the high-powered radar is operated within a few miles of land, targets cannot be tracked into a short range because side lobe (fig. 12-7) echoes clutter the first mile or two of the scope. Because targets within the area covered by sea return (false return of signals from the nearby sea) usually produce very strong echoes; however, the receiver gain may be reduced considerably so that actual echoes will stand out from the sea return. Sensitivity-time control (stc) is a modification of the receiver in which receiver gain is reduced for the first few thousand yards of each sweep and then restored to normal for the remainder of the sweep. The reduced gain at short range provided by this modification decreases sea return and prevents side lobe echoes from obscuring the start of the trace.

The minimum range to which high-flying airplanes can be tracked depends on vertical coverage of the radar antenna. In most search radars, little energy is radiated directly overhead or at large elevation angles. The minimum range of a radar depends principally, therefore, on the duration of the transmitted pulse and the duplexer recovery time.

ANOMALOUS PROPAGATION

Anomalous means a deviation from the general rule or a condition that cannot be easily classified or explained. In other words, anomalous propagation is a general term applied to all nonstandard radar or radio propagation. It is the net effect of certain variables that may result in extremely long or short ranges (particularly in radar), often changing from one to the other or back to normal in a matter of a few hours or days.

Anomalous propagation is caused by changes in atmospheric conditions, principally in temperature and moisture content. Under normal conditions, radar energy travels in a near line-of-sight path, with possibly some bending.

Under normal, or standard, conditions the temperature and moisture content of the atmosphere decrease slowly and regularly from the surface of the earth to the higher altitudes. At a certain height above the surface, depending on the height of the body of warm air, the temperature will be greater and the moisture content will be less than at the surface. This results in a sharp temperature inversion and a pronounced decrease in moisture content above the layer of cool air. Under these conditions, radar waves are refracted more than normal and tend to follow the surface of the water as if they were in a "duct," whose upper and lower boundaries were the warm, dry air and the surface water. Therefore, surface targets and low flying aircraft may be detected at greatly increased ranges because of the duct formed between the water and the warm air mass.

Radar surface coverage can likewise be affected adversely; for example, when the duct is formed in the atmosphere itself instead of along the surface, particularly when the duct angles upward. In this case the duct formed in the strata of warm air will have no connection with the surface of the water. If the duct tilts upward, the trapping of the energy in the duct may increase high-angle coverage but seriously reduce low-angle or surface coverage.

Yet another problem exists because of radar "holes" that are caused by atmospheric conditions. Targets previously undetected could suddenly appear at a very close range, or even go totally undetected except for visual means.

Another phenomena is radar "ghosts" or false targets. These can be caused by atmospheric conditions, clouds, sea return, and even birds. These false targets have been know to cause great concern to operators who are unable to identify these "false" targets.

Occasionally, a process called *multipath* may add confusion to the evaluation of radar coverage and the identification of ghosts. Multipath occurs when two signals, a direct one and a bounced or sea-reflected one, return from a target. If the path of a target causes a land mass or island to come between the target and the radar temporarily, the reflected signal may be interrupted, leading to drastic changes in radar range, and the target may disappear. This may likely lead to the erroneous conclusion that the radar had been tracking a ghost when the target actually was real.

These anomalous propagations may cause great concern about whether or not the radar equipment is functioning properly. It is very important to ensure that the equipment is operating properly before poor performance is blamed on atmospheric conditions. If accurate records of equipment performance are kept, you can more easily inspect them and ensure that the equipment is up to normal operating efficiency when anomalous propagation is suspected. Overall performance can be checked by the use of an echo box. This test unit gives a complete check of transmitter and receiver performance; and in some instances includes a check of the antenna and transmission line as well. A preferred method of checking radar system performance is measurement of output power with a power meter and a measurement of receiver sensitivity with a signal generator. Radar performance figure checks, usually PMS checks, are the most reliable test of radar systems.

TARGET RESOLUTION

The *target resolution* of a radar is its ability to distinguish between targets that are very close together in either range or bearing. Weapons control radar, which requires great precision, should be able to distinguish between targets that are only yards apart. Search radar is usually less precise and only distinguishes between targets that are hundreds of yards or even miles apart. Resolution is usually divided into two categories: RANGE RESOLUTION and BEARING RESOLUTION.

RANGE RESOLUTION

Range resolution is the ability of a radar to resolve between two targets on the same bearing, but at slightly different ranges.

The principal factors that affect range resolution are width of the transmitted pulse, amount of receiver gain, and the range scale in use on the indicator. A high degree of range resolution requires a short pulse, lower receiver gain, and a short-range scale.

When two targets are on the same bearing, the minimum distance they must be separated to show as two echoes is slightly greater than one-half the pulse length. This is illustrated in figure 12-8.

In view A of the illustration, the transmitted pulse is just striking the near target. In view B, energy is reflected from the near target, while the front of the transmitted pulse continues toward the far target. At C, the transmitted pulse is striking the far target and, simultaneously, the reflected energy from the near target has traveled 164 yards back toward the radar; hence, the reflection process at the near target is half completed. In D, the echoes are traveling back toward the radar from both targets. In view E, the leading edge of the echo from the far target has returned as far as the near target so that it coincides with the trailing edge of the first echo. In F, an echo of twice the normal width returns to the radar. When the echoes reach the antenna, energy is delivered to the set during a period of 2 sec (microseconds) rather than 1 sec, so that a single wide target shows on the indicator. Therefore, the theoretical range resolution of a radar system can be calculated from the following formula:

$$\textit{range resolution} = \frac{pw\ (\mu sec)}{2} \times 328\ \textit{yards per}\ \mu sec$$

The above formula is often written as: range resolution = pw × 164 yds/µsec. Although pulsewidth is the primary factor in determining range resolution, the amount of receiver gain used also affects the resolution. Echoes from two targets that are close together may merge into a single indication when the gain setting is high, but they may separate into individual blips when the gain is reduced.

A third important factor in determining the range resolution of the radar set is the range scale used. On a long-range scale, a separation of a few hundred yards will not be apparent. In fact, two adjacent blips will seem to blend into one. If these same echoes can be displayed

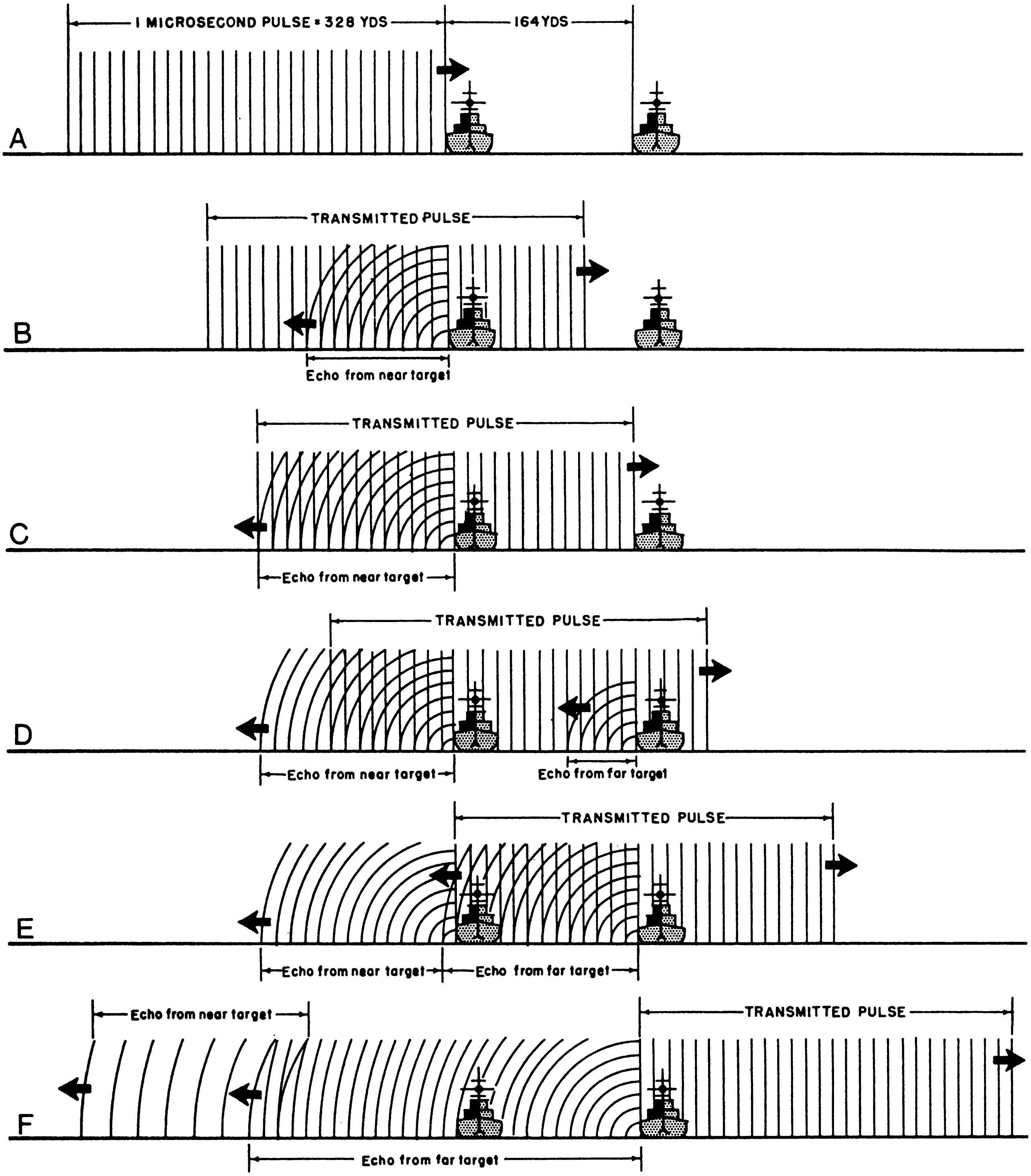

Figure 12-8.–Minimum target separation required for range resolution.

on a short-range scale, or on an off-center ppi, a small separation will be visible.

BEARING RESOLUTION

Bearing, or azimuth, resolution is the ability of a radar system to separate objects at the same range but at different bearings. The degree of bearing resolution depends on radar beamwidth and the range of the targets. Range is a factor in bearing resolution because the radar beam spreads out as range increases. A radar beam is defined in width in terms of *half-power points.* All the points off the centerline of the beam that are at one-half the power level at the center are plotted to define beamwidth.

Two targets at the same range must be separated by at least one beamwidth to be distinguished as two objects.

TYPES OF RADAR SETS

Due to different design parameters, no single radar set has been produced that can perform all of the many radar functions required by combatant ships. As a result, the modern warship has several radar sets, each performing a specific function. A shipboard radar installation may include surface search, navigation radar, air search radar, a height finding radar, and various fire control radar.

SURFACE-SEARCH AND NAVIGATION RADARS

The primary functions of a surface search-radar are the detection and determination of accurate ranges and bearings of surface targets and low-flying aircraft, while maintaining a 360° search for all targets within line-of-sight distance from the radar antenna.

Since the maximum range requirement of a surface-search radar is primarily limited by the radar horizon, higher frequencies are used to permit maximum reflection from small target-reflecting areas such as ship mast-head structures and submarine periscopes. Narrow pulsewidths are used to permit a high degree of range resolution at short ranges, and to achieve greater range accuracy. High pulse repetition rates are used to permit maximum definition of targets. Medium peak powers can be used to permit detection of small targets at line-of-sight distances. Wide vertical beamwidths permit compensation for pitch and roll of ownship and detection of low flying aircraft. Narrow horizontal beamwidths permit accurate bearing determination and good bearing resolution.

The following are some applications of surface-search radars:

- Indicate the presence of surface craft and help determine their course and speed
- Coach fire control radar onto a surface target
- Provide security against attack at night, during conditions of poor visibility, or from behind a smokescreen
- Aid in scouting
- Obtain ranges and bearings on prominent landmarks and buoys as an aid to piloting, especially at night and in conditions of poor visibility
- Facilitate station keeping
- Detect low-flying aircraft
- Detect certain weather phenomena
- Detect submarine periscopes
- Control small craft during boat or amphibious operations

Navigation radars fall into the same general category as surface-search radars. As the name implies, navigation radars are used primarily as an aid for navigating and piloting the ship. This type of radar has a shorter operating range and higher resolution than most surface-search radars.

AIR-SEARCH RADARS

The primary function of an air-search radar is to detect aircraft targets and to determine their ranges and bearings over relatively large areas while maintaining a complete 360° surveillance from the surface to high altitudes. Air-search radars have the following general characteristics:

1. Relatively low radar frequencies–permits long-range transmissions with minimum attenuation.

2. Wide pulsewidths and high peak power–aid in detecting small targets at great distances.

3. Low pulse repetition rates–permit greater maximum measurable range.

4. Wide vertical beamwidth–helps ensure detection of targets from the surface to relatively high altitudes, and to compensate for pitch and roll of the ship.

5. Medium horizontal beamwidth–used to permit fairly accurate bearing resolution while maintaining 360° search coverage.

Applications of air-search radars include the following:

1. Warning of approaching aircraft and missiles before they can be sighted visually, so that:

a. the direction from which an attack may develop may be determined

b. fighters may be launched in time if an air attack is imminent

c. antiaircraft defenses may be brought to the proper degree of readiness in sufficient time

2. Allowing the movements of detected enemy aircraft to be constantly observed and controlling Combat Air Patrol (CAP) aircraft to a position suitable for an air-to-air intercept

3. Providing security against night attack and attacks during conditions of poor visibility

4. Providing a means to control aircraft on a specific geographic track (such as an antisubmarine barrier or search and rescue pattern)

HEIGHT-FINDING RADARS

The primary function of height-finding radar (sometimes referred to as three-coordinate or dimensional 3-D radar) is to compute accurate ranges, bearings, and altitudes of aircraft targets detected by the air search radar. Height-finding radar is also used by the ship's air controllers to direct fighter aircraft during the interception of air targets.

The main differences between the air-search radar and the height-finding radar are that the height-finding radar has a higher transmitting frequency, higher power output, a much narrower vertical beamwidth, and requires a stabilized antenna for altitude accuracy.

Applications of height-finding radar include the following:

1. Obtaining range, bearing, and altitude data on enemy aircraft and missiles to assist in the control of CAP to a suitable intercept position
2. Detecting low-flying aircraft
3. Determining range to distant land
4. Tracking aircraft over land
5. Detecting certain weather phenomena
6. Tracking weather balloons
7. Providing input to fire control for director control

Although electronics division personnel (ETs) do not normally maintain fire control radars, characteristics and limitations of those radars are included here. The switch to combat systems organization may find you , and your ETs, in the Combat Systems Department.

Tracking Radars

Radar that provides continuous positional data on a target is called *tracking radar.* Most tracking radar systems used by the military are also fire-control radar; the two names are often used interchangeably.

Fire-control tracking radar systems usually produce a very narrow, circular beam. Fire-control radar must be directed to the general location of the desired target because of the narrow-beam pattern. This is called the **DESIGNATION** phase of equipment operation. When the radar beam is in the general vicinity of the target, the radar system switches to the **ACQUISITION** phase. During acquisition, the radar system searches a small volume of space in a prearranged pattern until the target is located. When the target is located, the radar system enters the **TRACK** phase of operation. Using one of several possible scanning techniques, the radar system automatically follows all target motions. The radar system is said to be *locked on* to the target during the track phase. The three sequential phases of operation are often referred to as **MODES** and are common to the target-processing sequence of most fire-control radars.

Typical fire-control radar characteristics include a very high prf, a very narrow pulsewidth, and a very narrow beamwidth. These characteristics, while providing extreme accuracy, limit the range and make initial target detection difficult.

Missile-Guidance Radar

A radar system that provides information used to guide a missile to a hostile target is called GUIDANCE RADAR. Missiles use radar to intercept targets in three basics ways. First, beamrider missiles follow a beam of radar energy that is kept continuously pointed at the desired target. Second, homing missiles detect and home in on radar energy reflected from the target. The reflected energy is provided by a radar transmitter either in the missile or at the launch point and is detected by a receiver in the missile. Third, passive homing missiles home in on energy that is radiated by the target. Because the target's position must be known at all times, a guidance radar is generally part of, or associated with, a fire-control tracking radar. In some instances, three radar beams are required to provide complete guidance for a missile. The beam-riding missile, for example, must be launched into the beam and then must ride the beam to the target. Initially, a wide beam is radiated by a capture radar to gain (capture) control of the missile. After the missile enters the capture beam, a narrow beam is radiated by a guidance radar to guide the missile to the target. During both capture and guidance operations, a tracking radar continues to track the target.

Applications of fire control radars for other than gun and missile control include:

1. Detecting low-flying aircraft
2. Assisting in radar navigation
3. Tracking weather balloons
4. Furnishing range and bearing data for calibrating search radars

RADAR EQUIPMENT

As stated previously, the modern warship has several radars. Each radar is designed to perform a particular function, but it also may be capable of performing other functions. For example, most height-finding radars can be used as secondary air-search radars, and in emergencies, fire control radars have served as surface-search radars.

Because there are so many different models of radar equipment, the radars and accessories described in this chapter are limited to those common to a large number of ships in the active fleet, and to those that are replacing older equipment currently installed in the fleet.

SURFACE-SEARCH RADAR/NAVIGATION RADAR

As mentioned earlier, the principal function of surface-search radars is to detect surface targets and low-flying aircraft and determine their range and bearing. The most common surface-search radars in use today are the AN/SPS-67(V)1 (fig. 12-9), AN/SPS-10(F) (fig. 10-10), AN/SPS-55 (fig. 10-11), and the AN/SPS-64(V) (fig. 10-12).

Radar Set AN/SPS-67 (V)1

The AN/SPS-67 (V)1 radar is a two-dimensional (azimuth and range) pulsed radar set primarily designed for surface operations with a secondary capability of anti-ship-missile (asm) and low-flyer detection. The radar set operates in the 5450- to 5825-MHz frequency range, using a coaxial magnetron as the transmitter output tube. The transmitter/receiver is capable of operation in a long (1.0 sec), medium (0.25 sec), or short (0.10 sec) pulse mode to enhance radar performance for specific operational or tactical situations. Pulse repetition frequencies (prf) of 750, 1200, and 2400 pulses per second are used for the long, medium, and short pulse modes respectively. Special features and processing circuits incorporated in the radar include:

- Automatic Frequency Control (AFC)
- Automatic Tuning
- Fast Time Constant (FTC)
- Interference Suppression (IS)
- Anti-Log Circuit (ALC)
- Main Bang Suppression (MBS)
- Sensitivity Time Control (STC)
- Video Clutter Suppression (VCS)
- Built-in-Test Equipment (BITE)
- Sector Radiate (SR)
- Ship's Head Marker (SHM)
- Video Gain Control (VGC)

The AN/SPS-67(V)1 radar will be the primary surface-search and navigation radar with limited air search capability, and will eventually replace the existing AN/SPS-10 series radars on some ship classes.

The construction of the radar set is primarily solid-state, with the exception of the transmitter magnetron and the receiver tr device. Miniature and microminiature technology are used extensively throughout the radar set. Standard electronic module (SEM) architecture is incorporated in the set design to the maximum extent possible. (The SEM program, established within the Navy Material Commands, provides standardization of modular plug-in cards for all electronic systems.) The radar set includes a built-in test equipment (BITE) subsystem that will locate 80% of the failures, to a maximum of four modules, within the Video-Processor, and the receiver transmitter. Faults are indicated on light-emitting diode (LED) index indicators, and the condition of each indexed test point is displayed on readout indicators as *GO, MARGINAL,* or *NO-GO.* In addition, the BITE subsystem provides the maintenance operator with an interactive test mode, which permits the selection of a series of sensor test points for monitoring purposes, while making level or timing event adjustments. Power and VSWR are monitored on an on-line basis. The BITE subsystem is designed to have its own self-check mode, which is performed automatically on a periodic basis. The BITE circuitry will not degrade the performance of the system during normal operation, or in the event of a failure in the BITE circuitry.

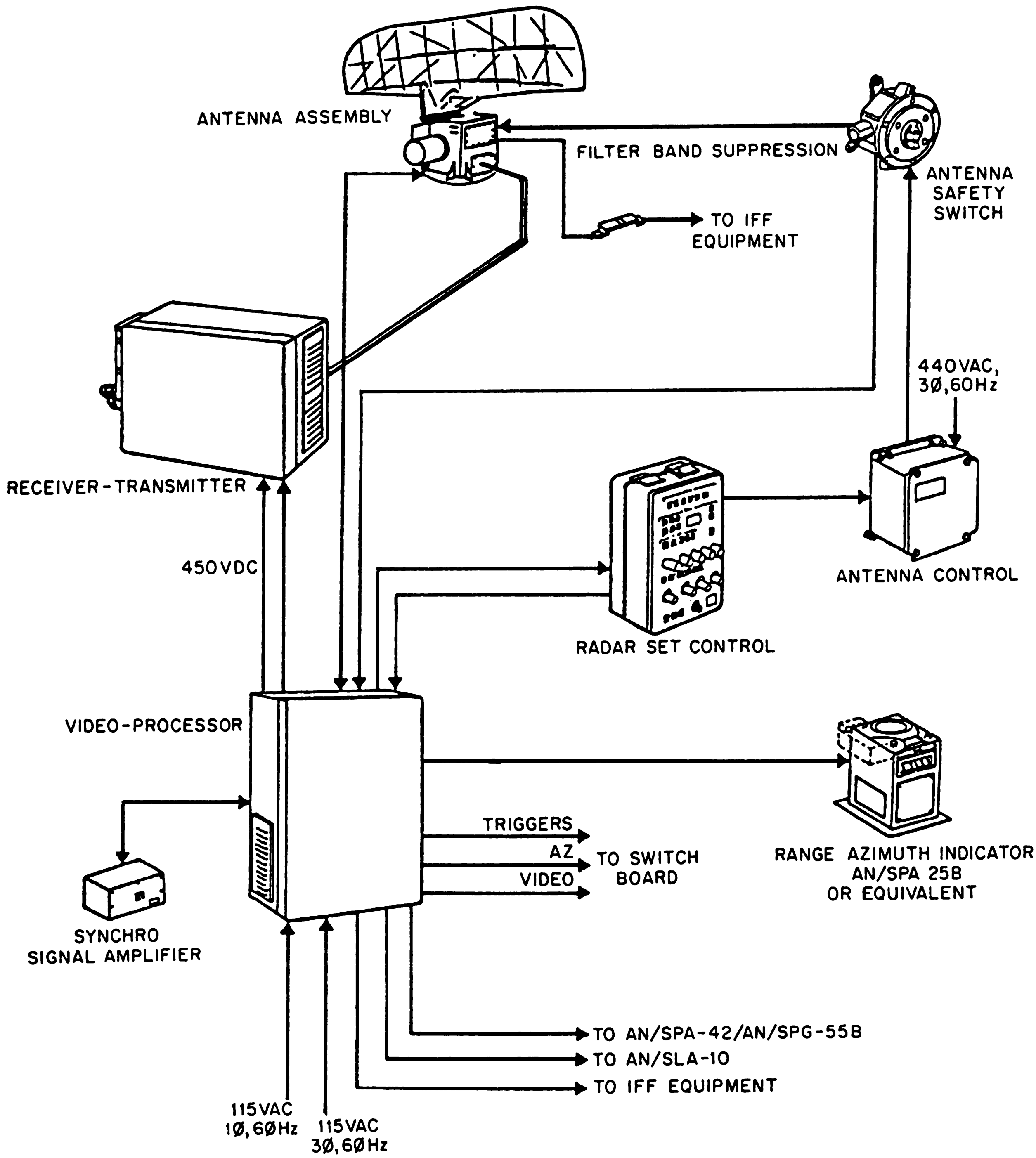

Figure 12-9.–AN/SPS-67(V)1 functional diagram.

The major units of the AN/SPS-67(V)1 are described below (see figure 12-9).

RADAR SET CONTROL, UNIT 1–The radar set control is a bulkhead-mounted unit that contains a SEM rack, a power supply, and the controls and indicators necessary to operate the radar set in all modes of operation. It has lighted pushbutton switches and indicators, potentiometers, and a 3-digit LED display.

RECEIVER-TRANSMITTER, UNIT 2–The receiver-transmitter is a bulkhead-mounted unit that contains all of the system's microwave components, a SEM rack, and subassemblies. Cooling air enters and exhausts via louvered openings and is forced through the unit by two blowers.

VIDEO PROCESSOR, UNIT 3–The video processor is a bulkhead-mounted unit that contains the

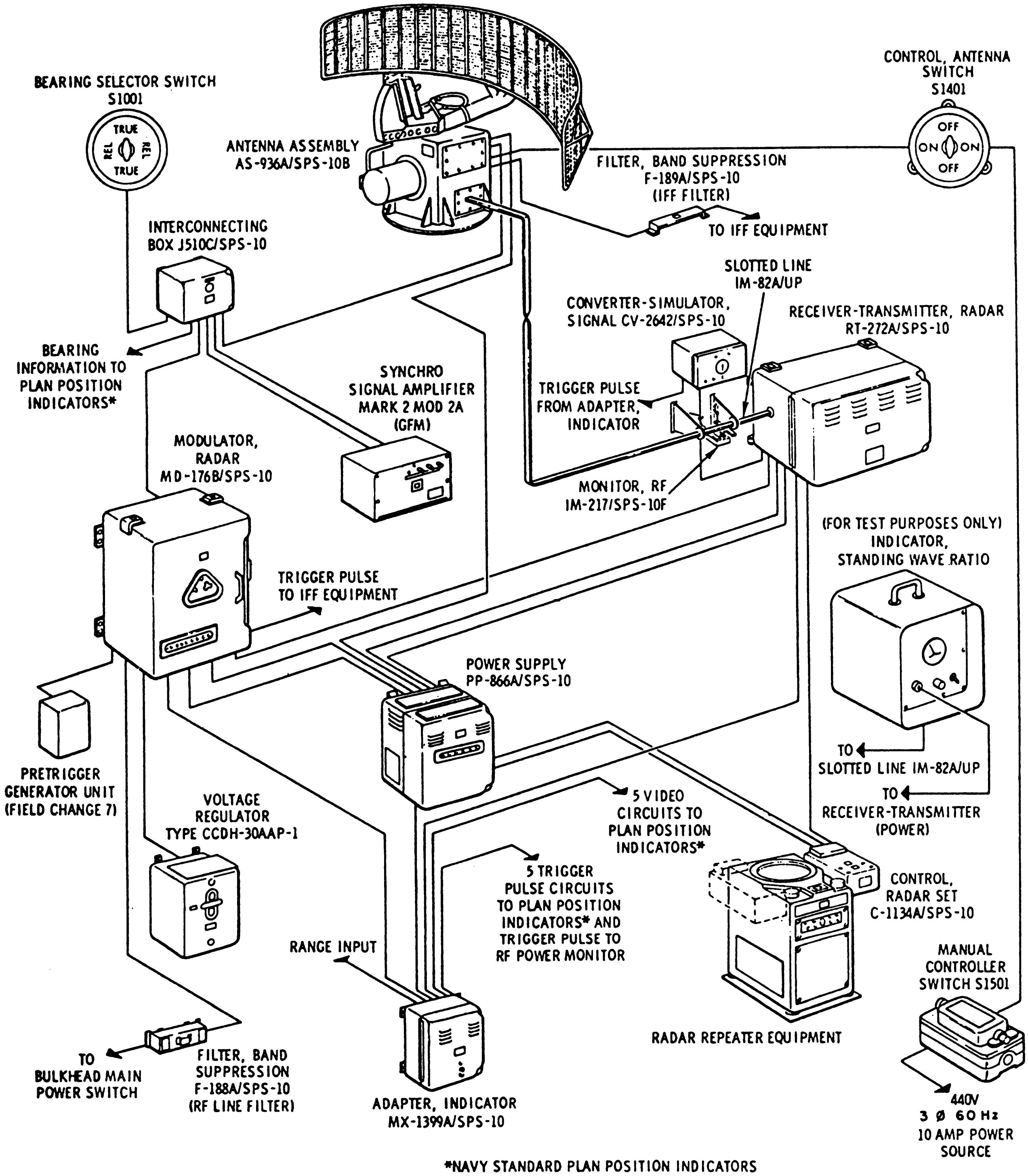

Figure 12-10.–Radar Set AN/SPS-10F.

two SEM racks, two control panels, plug-in power supplies and some chassis-mounted parts. Cooling air enters and exhausts via four louvered openings and is forced through the unit by two blowers.

ANTENNA CONTROLLER, UNIT 4–The antenna controller provides remote control of the prime power to the antenna. It consists of a 3-phase, remotely actuated power relay and a thermal relay located in a housing. An overload indicator and a manual overload reset button are located on the front panel.

ANTENNA SAFETY SWITCH, UNIT 5–The antenna safety switch protects maintenance personnel

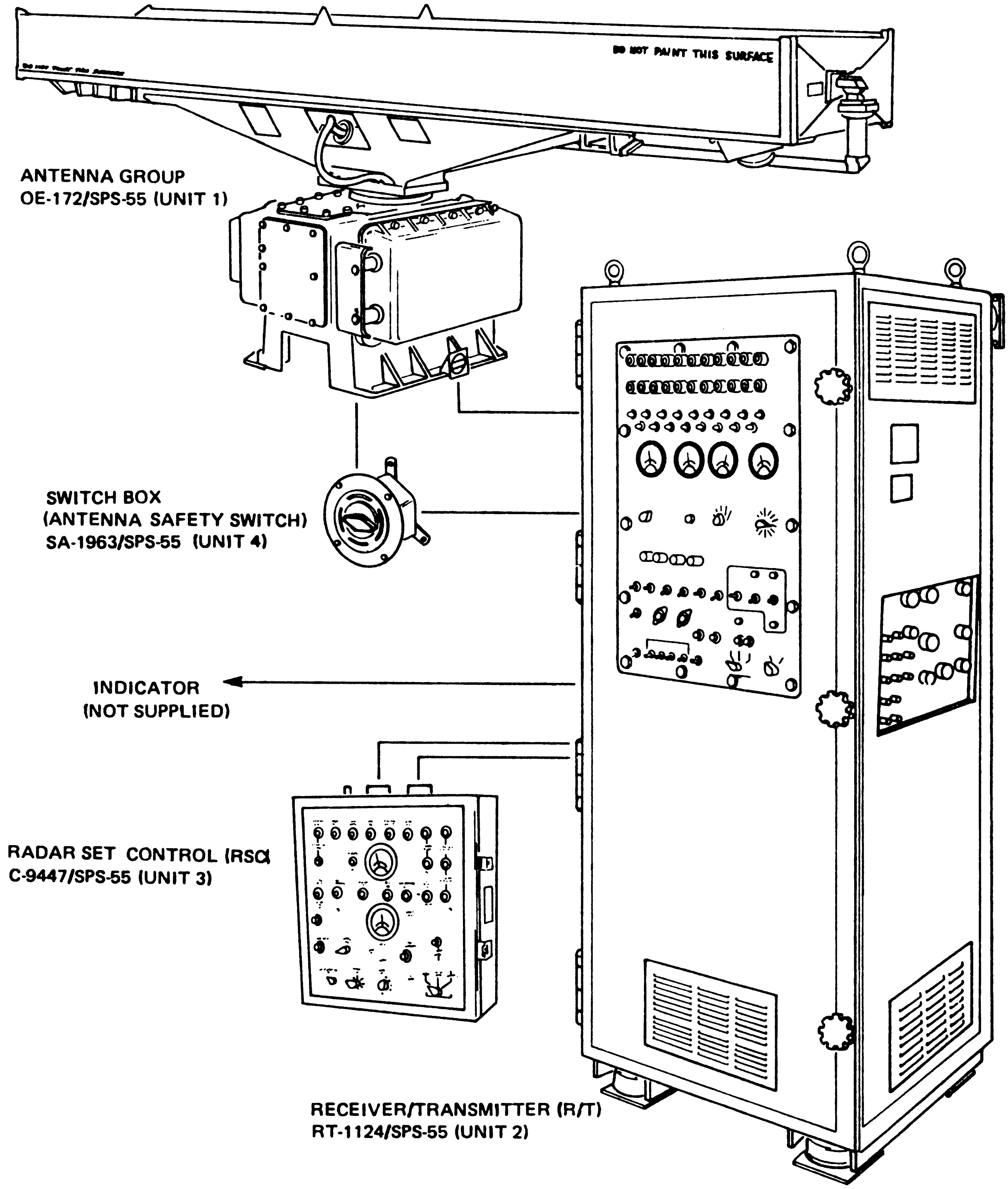

Figure 12-11.–Radar Set AN/SPS-55.

from electrical shock, radiation exposure, and antenna rotation while they work on the antenna by interrupting power to the antenna and inhibiting the radar transmitter. It is mounted near the antenna.

ANTENNA ASSEMBLY, UNIT 6–The antenna radiates the pulses of microwave energy from the magnetron and directs the echo signals to the receiver through the waveguide.

IFF BAND SUPPRESSION FILTER, UNIT 7–The IFF band suppression filter is connected to the IFF equipment and minimizes interference from the radar set.

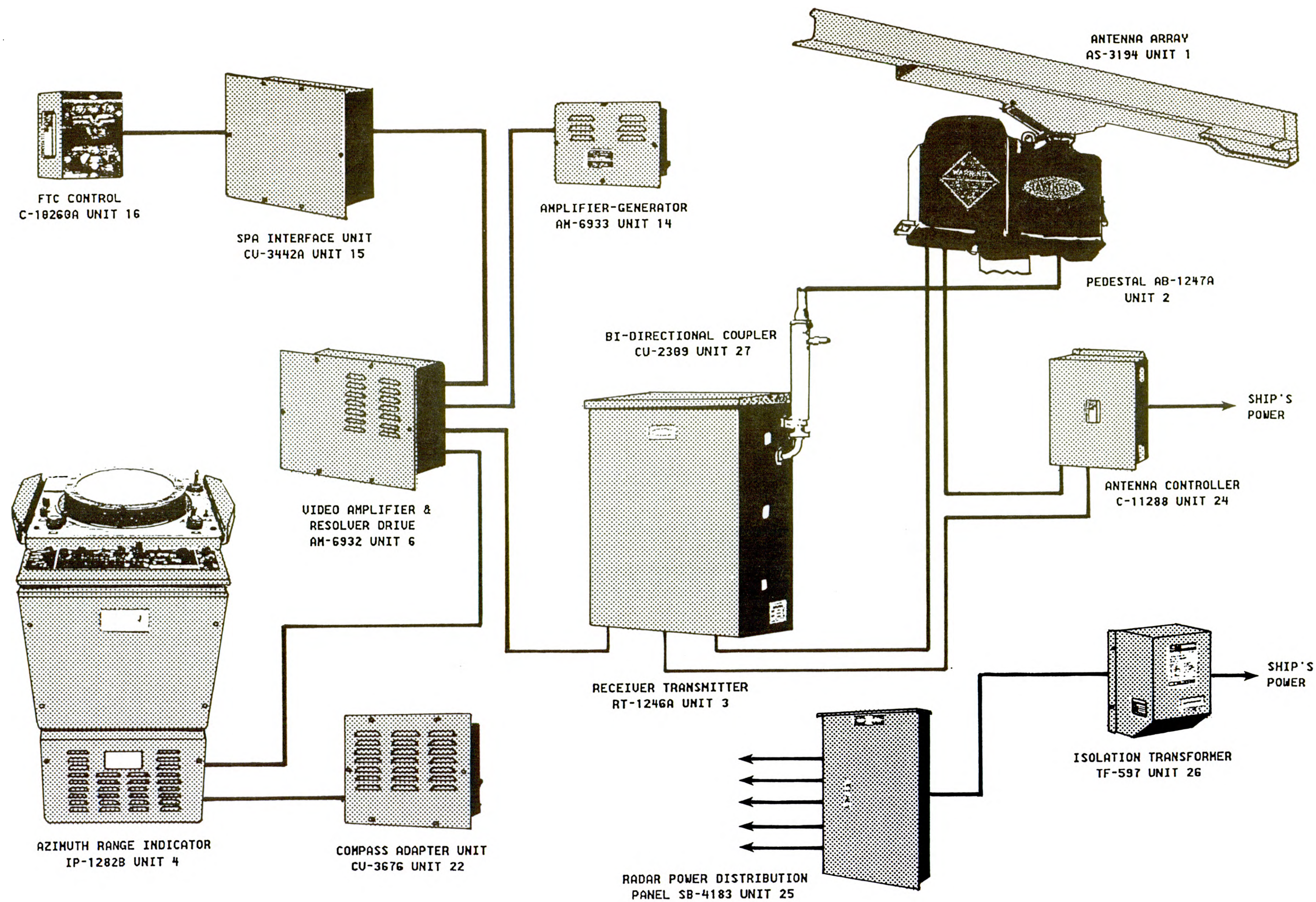

Figure 12-12.–Radar Set AN/SPS-64(V)9.

The AN/SPS-10F and its associated components are shown in figure 12-10. Its operation is similar to that of the AN/SPS-67(V)1. For additional information, refer to the appropriate technical manual.

The AN/SPS-67(V)1 radar set is compatible with the following equipment:

- Blanker/Video Mixer Group AN/SLA-10
- IFF Equipment
- Indicator Group AN/SPA-25, or equivalent
- Mk 27 Synchro Signal Amplifier or equivalent
- Multiplexed Unit for Transmission Elimination (MUTE)

The AN/SPS-67(V)1 has the following advantages over the AN/SPS-10F.

- Low Flier Detection
- 3 Selectable Pulsewidths
- Jitter Mode for Increased ECM capability
- Sector Radiate
- Easier to troubleshoot and maintain due to the use of SEMs
- Transmitter and receiver can be automatically tuned

There are currently two other configurations of the AN/SPS-67(V):

AN/SPS-67(V)2–Identical to the AN/SPS-67(V)1 with exception of the antenna. This variant uses a standard surface-search antenna.

AN/SPS-67(V)3–Enhanced from previous configurations, this radar has a signal processing unit that provides digital moving target indicator (DMTI) capability. The function of the DMTI circuitry is to automatically cancel unwanted fixed echoes (sea clutter, clouds, rain, etc.) and display only moving target signals.

Radar Set AN/SPS-55

The AN/SPS-55 is a solid-state, surface-search and navigation radar capable of detecting targets from as close in as 50 yards, out to 50 miles and beyond, with good target resolution. Figure 12-11 illustrates the major assemblies of the radar and their relationship to each other. Radar Set AN/SPS-55 consists of four major units: antenna group, radar receiver/transmitter, radar set control, and box switch.

The system generates two pulsewidths (selectable), a 0.12 microsecond pulse at a pulse repetition rate of 2250 pulses per second and a 1.0 microsecond pulse at a pulse repetition rate of 750 pulses per second, which is variable in the swept mode of operation by ± 5% over a two and one-half hour period. The rf frequency is tunable from 9.05 to 10.0 GHz with a minimum peak power out of 130 kilowatts (measured at the magnetron). The antenna, rotating in azimuth at 16 rpm, forms a beam narrow in azimuth (1.5°) and broad in elevation (-10° to +10° centered on the horizon.) Return target echoes are amplified and detected by the receiver and applied to a ppi indicator where range and azimuth information can be determined easily.

The target information can be displayed in either of two modes, a "relative" mode where zero degrees bearing on the ppi represents the heading of the ship or a "true" mode where zero degrees bearing represents true North. A ship's heading marker indicates the bow of the ship in either case.

The radar set uses several signal processing circuits to improve operation under certain prevailing conditions. These are as listed in the following paragraphs.

FAST TIME CONSTANT (FTC) CIRCUIT–Reduces clutter by displaying only the leading edge of the echo returns.

SENSITIVITY TIME CONTROL (STC) CIRCUIT–Reduces receiver gain at close-in ranges where clutter is strong, while allowing a gradual return to normal gain at longer ranges where clutter is less.

SECTOR RADIATE CAPABILITY–Allows the operator to limit radiation to a selectable azimuth segment to minimize interference from other ships' radars or ECM.

AN/SPS-64(V)9

The AN/SPS-64(V)9 (fig. 12-12) system combines high transmitter power, high pulse repetition rate, narrow antenna beamwidth, a sensitive receiver, and a digitally enhanced display to provide a bright, accurate, and clearly defined radar presentation. The system is capable of driving one or more AN/SPA-25 indicators, of providing a blanking signal to the AN/SLA-10, and of accepting standard gyro inputs. This versatile navigation radar system is used on a wide variety of naval vessels.

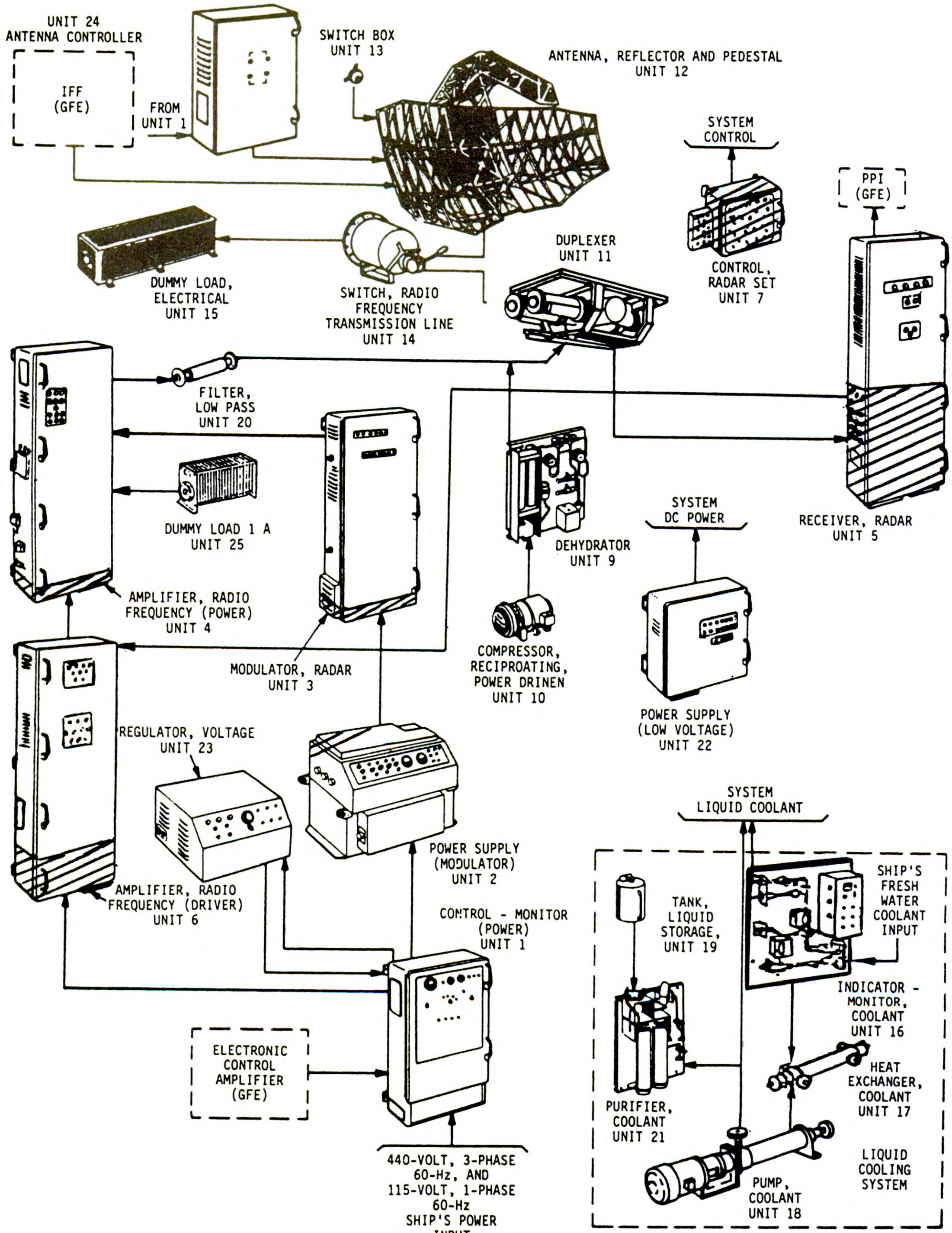

Figure 12-13.–Radar Set AN/SPS-40 B, C, D.

The IP-1282B indicator contains a 12-inch cathode-ray tube display which, due to a unique signal processor, provides a bright, daylight viewing display. Indicator control functions provide for selectable range scales out to 64 nautical miles, fixed range rings for target range estimation, digital LED readouts of exact target range and bearing, and the ability to offset ownship's position on the display. With a gyro input, the indicator can provide true or relative bearing displays.

The RT-1246A receiver/transmitter operates on a fixed frequency of 9375 MHZ and has a peak power output of 20 KW. The antenna can rotate at speeds up to 33 RPM, which provides a high degree of target resolution and allows target information to be updated every two seconds.

MISCELLANEOUS SURFACE NAVIGATION RADARS

There are a variety of small radar sets that are used for relatively short-range surface-search and navigation purposes. The maximum range of these sets is generally 36 miles or less. The low power consumption and small size make them ideal for small craft where space and generator capacity are limited; however, they may also be found installed aboard large ships such as carriers. The indicating units of these radars are normally located on the bridge or in the pilot house, depending upon the vessel in which they are installed. Two of these radars are the CRP-3100 and the LN-66.

Prior to installing any type of commercial radar equipment on board, be sure the type commander concurs, as many of these radars will actually degrade the performance of other installed electronics and weapons systems.

AIR-SEARCH RADARS

The primary functions of air-search radars are to detect aircraft targets at long ranges and to determine their range and bearing. The most widely used two-coordinate radars in the fleet are the AN/SPS-40 and the AN/SPS-49. These radar sets use ppi display indicators for determining range and bearing.

The main design features of the two-coordinate air-search radars are basically the same. They may, however, vary in frequency, range, type of antenna, and in design detail. All of these radar sets use a moving target indicator (mti) to discriminate between stationary objects and moving targets.

All of two-coordinate air search radars transmit long pulses from a generated narrow pulse and then receive and compress the long pulse back into a narrow pulse. This minimizes the peak power requirements of the radar set without impairing the range resolution. These modified shaped pulses also reduce interference with other shipboard electronic equipment.

Radar Set AN/SPS-40 B, C, D

The AN/SPS 40 B, C, D is a high power, long-range, two-dimensional (2-D) early warning air search radar designed for use aboard destroyer escort size or larger Navy ships. It operates on the 422.4 - 447.5 MHZ frequency range and has a power output of 200 - 300 KW and is capable of ranges up to 250 nautical miles. Target range and bearing video signals are displayed on plan position indicator (PPI) units. Normal radar operation is performed from the radar set control located in the combat information center (CIC). In addition, remote-local switching permits operation of the radar set from the equipment room. An integral IFF and radar feed antenna is used, thereby eliminating the requirement for having a separate antenna for each function. A typical AN/SPS-40 is depicted in figure 12-13.

The AN/SPS-40 B , C, D provides two modes of operation; the long-range mode (LRM), and the low flier detection mode (LFDM). In the long-range mode, the transmitted signal is expanded to 60 microseconds and the received signal is compressed to 1.0 microsecond. In the low filter detection mode, the transmitted signal is a 3 microsecond pulse, the antenna speed is increased from 7.5 to 15 RPM, and the pulse repetition frequency (prf) of the radar set is changed on alternate antenna scans. The narrow pulse enables targets to be detected at short range.

Pulse expansion techniques permit operation at a lower transmitted peak power but with the same average power as conventional systems, without sacrifice of range detection performance and range resolution. These techniques permit the use of antijamming techniques, reducing the susceptibility of the radar set to jamming.

The set also contains moving target indicator (MTI) systems, providing target discrimination against clutter from sea or shore return. Moving target indicator systems distinguish between reflections (clutter) from stationary objects whose frequency spectrum duplicates that of the transmitter, and moving targets whose spectrum is doppler shifted.

Radar Set AN/SPS-40 B, C, D with DMTI

In radar set AN/SPS-40 B, C, D with field change 8 installed, a digital moving target indicator (DMTI) automatically eliminates unwanted clutter, selecting only objects moving with some minimal radial velocity as targets. Ship and antenna scanning motion, cause the radar beam to shift to a slightly different range and azimuth on each pulse, thereby changing the relative phase relationship on a pulse-to-pulse basis, and causing the echoes from stationary objects to appear to the receiver as minor moving targets. The DMTI processor compensates for motion by examining the video returns of clutter for pulse-to-pulse phase shift, signal periodicity, and by establishing amplitude thresholds.

The DMTI provides this radar system with a substantial improvement in the ability to detect targets flying over land, and small targets in a strong clutter environment. The heart of the AN/SPS-40 B,C,D with DMTI is the receiver. The receiver provides the radar with three major functions: signal generation, signal processing, and timing synchronization. As a signal generator, the receiver provides the transmitter with the low power radar pulse to be amplified by the transmitter and radiated into space by the antenna. As a signal generator, the receiver performs MTI processing of the received radar returns. As a timing synchronizer, the receiver provides triggers to switch the radar units between transmit and receive operations.

Radar Set AN/SPS-40 E

The AN/SPS-40 E uses the same DMTI processing and pulse compression/expansion techniques described above. The main difference between this model and the others is that it is equipped with a solid-state transmitter (SSTX) and an improved cooling system. It also incorporates built-in testing features that aid in troubleshooting and fault isolation.

Radar Set AN/SPS-49(V) (Very-Long-Range Radar)

The AN/SPS-49(V) radar (fig. 12-14) is a narrow beam, very-long-range, two-dimensional (2-D), air search radar that primarily supports the AAW mission in surface ships. The radar is used to provide long-range air surveillance regardless of severe clutter and jamming environments. Collateral functions include air traffic control (atc), air intercept control (aic) and antisubmarine aircraft control (asac). It also provides a reliable backup to the three-dimensional (3D) weapon system designation radar. The AN/SPS-49(V) radar is, or will be, installed in most medium to large naval ships.

The AN/SPS-49(V) radar operates in the frequency range of 850 - 942 MHZ. When in the long-range mode, the AN/SPS-49 can detect small fighter aircraft at ranges in excess of 225 nautical miles. Its narrow beamwidth substantially improves resistance to jamming. The addition of coherent side lobe canceller (CSLC) capability in some AN/SPS-49(V) radars also provides additional resistance to jamming/interference by cancelling the jamming/interference signals. The moving target indicator (MTI) capability incorporated in the AN/SPS-49(V) radar enhances target detection of low-flying high speed targets through the cancellation of ground/sea return (clutter), weather and similar stationary targets. In the 12 RPM mode of operation, this radar is effective for the detection of hostile low flying and "pop-up" targets.

Features of this set are as follows:

- Solid-state technology with modular construction is used throughout the radar, with the exception of the klystron power amplifier and high power modulator tubes. Digital processing techniques are used extensively in the automatic target detection (ATD) modification.

- Performance monitors, automatic fault detectors, and built-in-test equipment (BITE), and automatic on-line self-test features enhance the availability and maintainability of the radar.

There are currently eight configurations of the AN/SPS-49(V) as described below:

VARIANT	DESCRIPTION	SHIP CLASS
AN/SPS-49(V)1	With Coherent Sidelobe Canceller (CSLC) that electronically cancels jamming	BB, CV, CVN, CG, DDG-993, LHD-1 DDG-37, DD-997, LSD-41
AN/SPS-49(V)2	Without CSLC	FFG-7
AN/SPS-49(V)3	(V)1 system modified to interface with a Radar Video Processor (RVP)	CGN-9
AN-SPS-49(V)4	(V)2 system modified to interface with RVP	FFG-7
AN/SPS-49(V)5	(V)1 system modified to provide an automatic target detection (ATD) capability and improved ECCM features	New Threat Upgrade (NTU)
AN/SPS-49(V)6	(V)3 system with double shielded cables and a modified cooling system	CG-47
AN/SPS-49(V)7	(V)5 system with a (V)6 cooling system	AEGIS Platforms
AN/SPS-49(V)8	(V)5 system enhanced to include the AEGIS Tracker modification kit	AEGIS Platforms

AIR-SEARCH THREE-COORDINATE RADARS

Among the height-finding radars currently installed aboard Navy ships, the most common are the AN/SPS-52, AN/SPS-48, and the AN/SPY-1. These

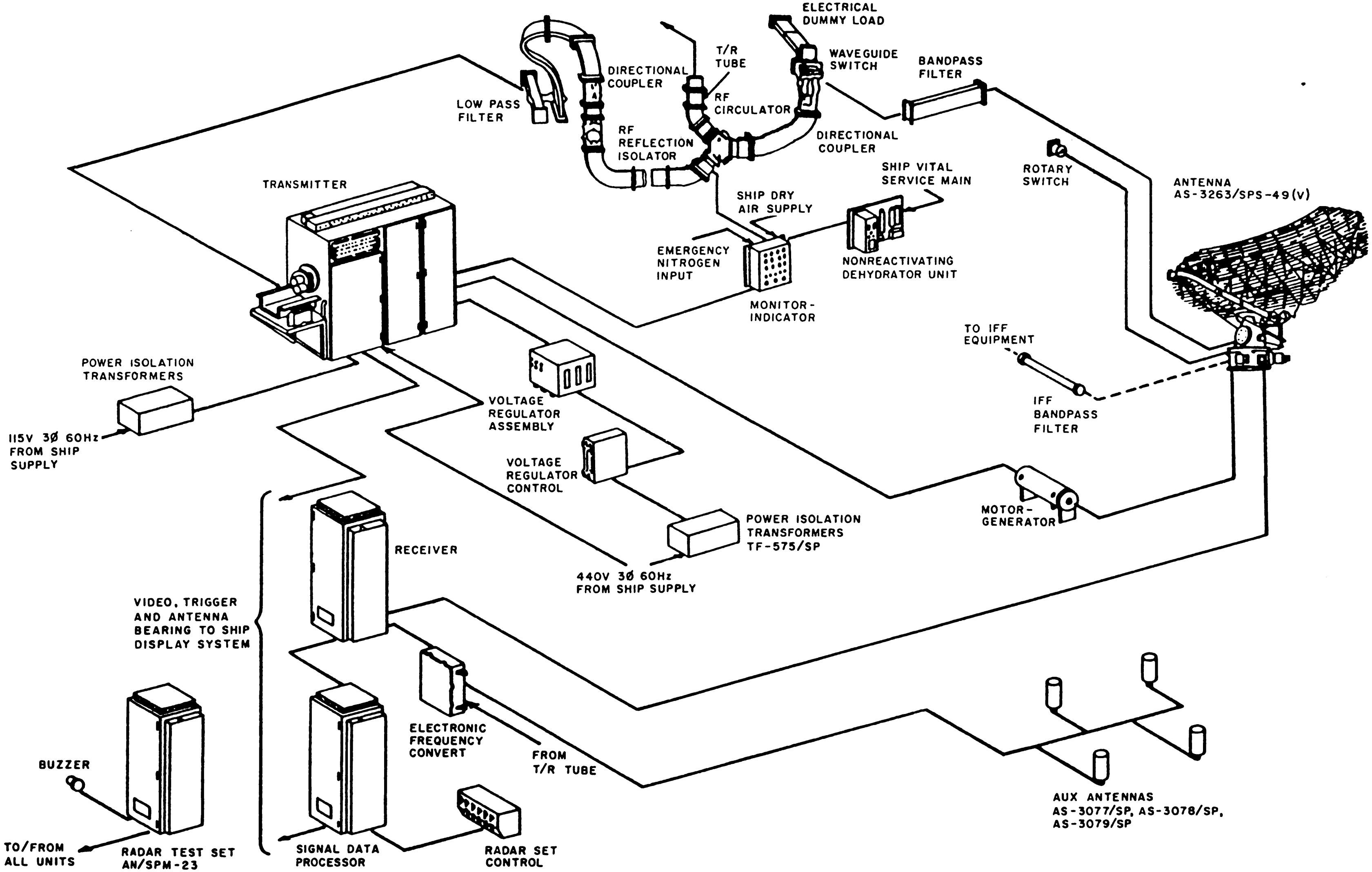

Figure 12-14.–Radar Set AN/SPS-49(V) relationship of units.

radars are normally the primary source of target information for weapons systems.

The three-coordinate radar functions much like the two-coordinate system, but provides an elevation search pattern in addition to horizontal and vertical search patterns.

Most radars present only range and bearing, so their beams are narrow in azimuth and broad in the vertical plane. The beams of height-finding radars are quite narrow vertically, as well as horizontally.

Azimuth is provided as the antenna rotates continuously at speeds varying up to 15 rpm. The antenna may be controlled by the operator for searching in a target sector.

Air-search, three-coordinate radars determine altitude by scanning the vertical plane in discrete increments (steps). This may be done mechanically or electronically (the most frequently used method.) In electronic scanning, the radiated frequency is changed in discrete increments, causing the radar beam to be radiated at different elevation angles. Each elevation angle or step has its own particular scan frequency. A computer can then electronically synchronize the radiated frequency with the associated scan angle to produce the vertical height of a given target.

The three-coordinate radars also use a range height indicator (rhi) in addition to the ppi used with the two-coordinate radars.

CARRIER-CONTROLLED APPROACH (CCA) AND GROUND-CONTROLLED APPROACH (GCA) RADAR

CCA and GCA radar systems are essentially shipboard and land-based versions of the same radar. Shipboard CCA radar systems are usually much more sophisticated systems than GCA systems. This is because of the movements of the ship and the more complicated landing problems. Both systems, however, guide aircraft to a safe landing under conditions of zero visibility. By means of radar, aircraft are detected and observed during the final approach and landing sequence. Guidance information can be supplied to the pilot as verbal radio instructions, or to the automatic pilot.

Three CCA systems currently are installed aboard carriers in the active fleet. They are models AN/SPN-42, AN/SPN-43, and AN/SPN-44.

Radar Set AN/SPN-42

The AN/SPN-42 is a computerized automatic carrier landing system (ACLS) radar that provides precise control of aircraft during their final approach and landing. The equipment can automatically acquire, control, and land a suitably equipped aircraft on aircraft carriers under severe ship motion or weather conditions.

A new ACLS system coming to the fleet is the AN/SPN-46, which incorporates the latest technology, improving reliability and operability.

Radar Sets AN/SPN-43, -43A

The AN/SPN-43 provides azimuth and range information from 50 miles to a minimum range of 250 yards at altitudes from radar horizon to 30,000 feet. Special indicators in the Carrier Air Traffic Control Center (CATCC) enable operators to direct aircraft along a predetermined azimuth to a point approximately one-quarter mile from touchdown. At this point the aircraft is "handed-off" to the final approach controller who uses the AN/SPN-42

Radar Set AN/SPN-44

The AN/SPN-44 is a range-rate radar set that computes, indicates, and records the speed of aircraft making a landing approach to a carrier. Both true and relative speed are indicated.

RADAR INDICATORS

The purpose of a radar indicator (repeater) is to act as the master-timing device in analyzing the return radar system video, and provide that information to various locations physically remote from the radar set. Each indicator has the ability to select the outputs from any desired radar aboard the ship. This is done by the use of a radar distribution switchboard. The switchboard contains a switching arrangement which has inputs from each radar (and associated IFF system) aboard ship and provides outputs to each repeater. The radar desired is selected by turning a switch on the repeater. For the repeater to present correct target position data, it must have the following inputs from the radar selected:

1. Trigger pulses–The trigger (timing) pulses from the radar ensure that the sweep on the repeater starts from its point of origin each time the radar transmits. As discussed earlier, the repeater displays all targets at their actual range from the ship based on the time lapse

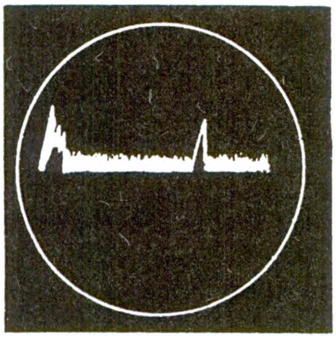

Figure 12-15.–Presentation of the "A" scope.

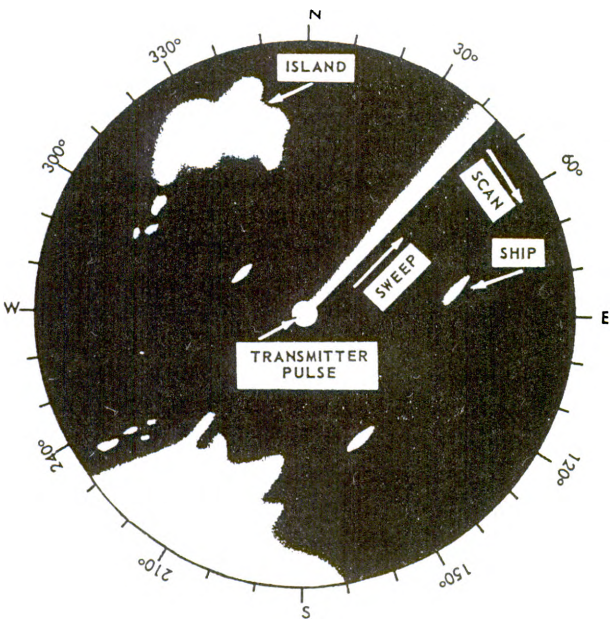

Figure 12-16.–Presentation on the ppi scope.

between the instant a pulse is transmitted and the instant a target echo is received.

2. Video–The returning echo is applied to the repeaters from the radar receiver.

3. Antenna information–The angular sweep position of a plan position indicator (ppi) repeater must be synchronized to the angular position of the radar antenna to display contact bearing (azimuth) information.

The three most common types of displays are as follows:

1. "A" scope, range-only indicator
2. PPI scope, range-azimuth indicator
3. RHI scope, range-height indicator

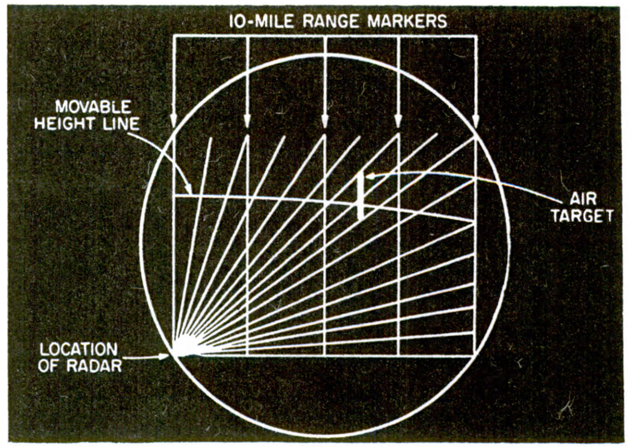

Figure 12-17.–RHI presentation.

The "A" scope (fig. 12-15) is not normally considered a radar repeater, but rather an auxiliary display. Its use is limited because of range-only capability.

The ppi scope (fig. 12-16) is by far the most used radar repeater. It is a polar coordinate display of the surrounding area, with ownship represented by the origin of the sweep, which is normally located in the center of the scope, but may be offset from center on some sets. The ppi uses a radial sweep pivoting about the center of the presentation, resulting in a maplike picture of the area covered by the radar beam. A relatively long-persistence screen is used so that targets remain visible until the sweep passes again.

Bearing is indicated by the target's angular position in relation to an imaginary line extending vertically from the sweep origin to the top of the scope. The top of the scope is either true North (when the radar is operating in true bearing), or ship's heading (when the radar is operating in relative bearing).

The range-height indicator (rhi) scope (fig. 12-17) is used with height-finding radars to obtain altitude information. The rhi is a two-dimension presentation indicating target range and altitude. The sweep of an rhi originates in the lower left side of the scope and moves across the scope, to the right, at an angle the same as the angle of transmission of the height-finding radar. Targets are displayed as vertical blips and the operator determines altitude by adjusting the movable height line to the point where it bisects the center of the target blip. Target height is then read directly from the altitude dials (counters). Vertical range markers are provided to estimate target range.

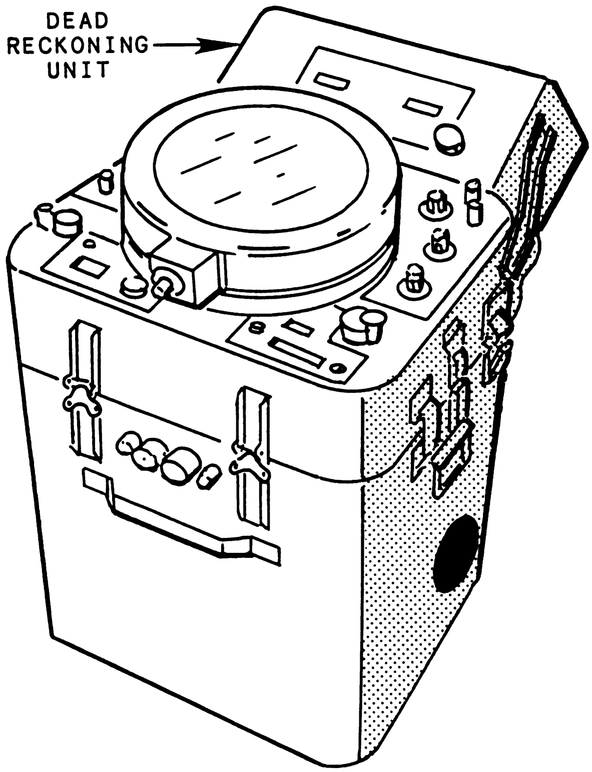

Figure 12-18.–Range-Azimuth Indicator AN/SPA-25 with dead reckoning auxiliary unit attached.

Many repeaters on Navy Tactical Data System (NTDS) equipped ships are being replaced with multipurpose consoles; however repeaters are still irreplaceable on ships not equipped with NTDS and as a backup to the consoles on NTDS ships. NTDS Consoles are addressed further in chapter 14.

Several types of radar repeaters currently installed on Navy ships are described below.

REMOTE INDICATOR AN/SPA-25 A, B, C, D, E, F

Although there are several models of the AN/SPA-25, with exception of the AN/SPA-25G which will be described later, they all perform in the same manner. The only difference is the technology of their circuit components. The earlier models use large components and electromechanical devices; whereas the newer models rely more on solid-state electronic technology.

The remote indicator AN/SPA-25 (fig. 12-18) is a transistorized general-purpose plan position indicator (ppi) designed for use with any standard Navy search radar system having a pulse repetition frequency (prf) of 10 to 5000 pulses per second (pps). The indicator can

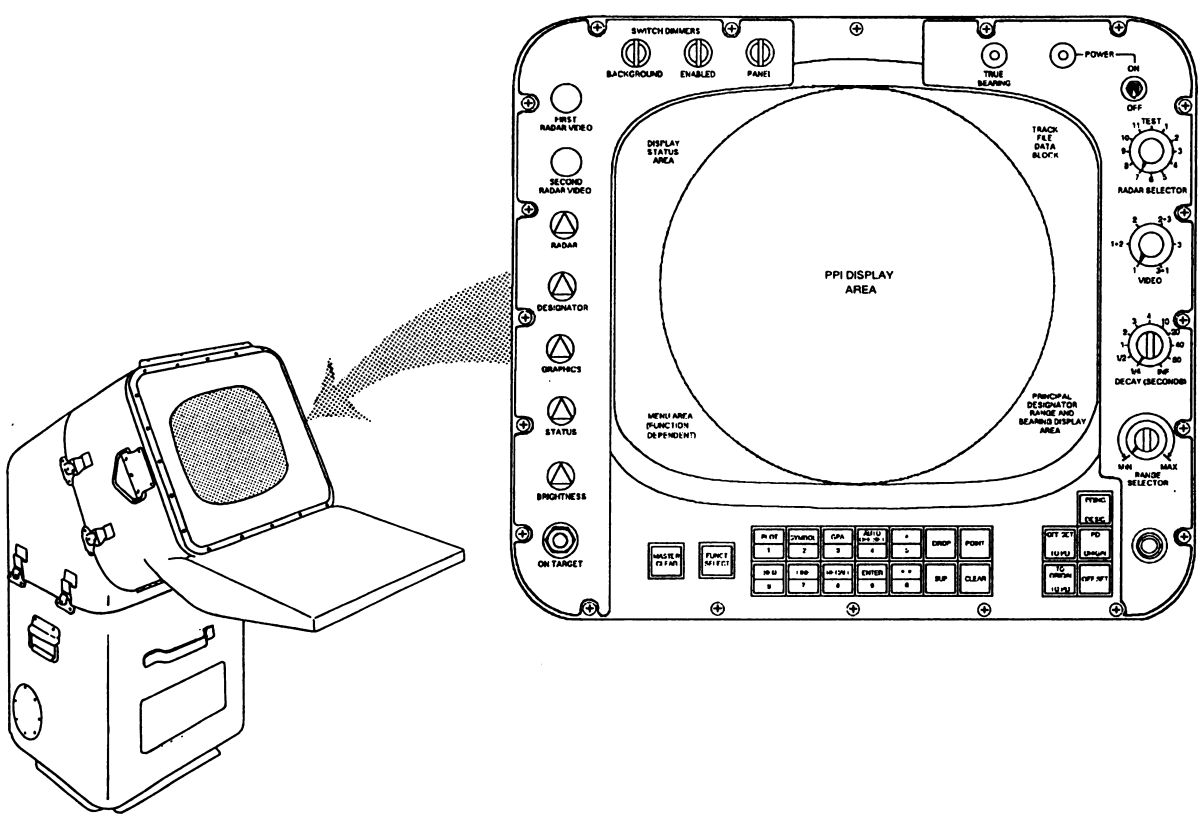

Figure 12-19.–Remote Indicator AN/SPA-25G.

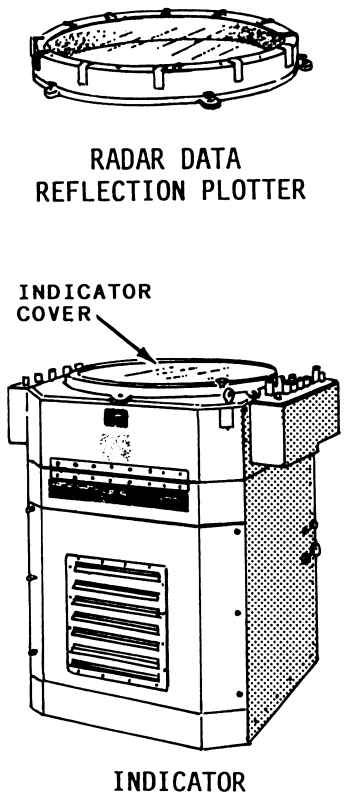

Figure 12-20.–Range-Azimuth Indicator AN/SPA-50A.

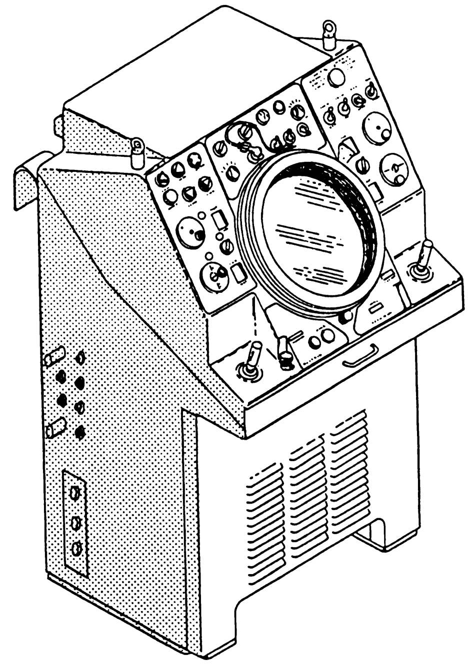

Figure 12-21.–Range-Azimuth Indicator AN/SPA-66.

display radar information from any one of several radar systems on a 10-inch cathode-ray tube (CRT). The indicator group incorporates continuous range variation from 1/2 to 300 miles.

Bearing (azimuth) may be determined in two ways, by using (a) the electronic cursor and azimuth scale or (b) the electronic cursor and a direct-reading electronic readout. Range may be determined in two ways, by using (a) the range rings or (b) the electronic range strobe and a direct-reading electronic readout. The range strobe can be used on either the electronic cursor or the video sweep. When used on the video sweep, the strobe appears as a movable range strobe.

REMOTE INDICATOR AN/SPA-25G

The AN/SPA-25G is an advanced navigation, air search, and tactical situation radar indicator for both CIC and bridge environments. The unit is entirely solid state with the exception of the CRT. It increases the operator's capabilities while decreasing his work load through a unique information display and efficient man-machine interface.

The indicator solves all range, bearing and plotting tasks associated with target tracking, navigation, estimated point of arrival (EPA) and air traffic control. Formerly manual plotting and range and bearing calculating tasks are done on the AN/SPA-25G by pushing buttons, moving its stiffstick control and reading and viewing the solution(s) on the screen. This indicator may be a sit-down version resembling figure 12-19, or it may be a stand-up version as shown in figure 12-18.

REMOTE INDICATOR AN/SPA-50(A)

The AN/SPA-50 (fig. 12-20) is a large screen display (22- inch) ppi designed to display the output of any standard search radar system having a pulse repetition frequency between 15 and 5000 pps, and can display range from 4 to 400 nautical miles. The SPA 25 and 50 are used primarily with surface-search radars. At the time of this printing an enhanced AN/SPA-50 was in development.

REMOTE INDICATOR AN/SPA-66

The AN/SPA-66 is a general-purpose ppi (fig. 12-21). It is normally used to support AAW operations, but may be used as an ordinary ppi if necessary. This indicator can be connected to other AN/SPA-66s, with one acting as the master station and the others linked to it.

IDENTIFICATION, FRIEND OR FOE (IFF) EQUIPMENT

IFF equipment is used with search radars to permit a friendly craft to identify itself automatically before approaching near enough to threaten the security of other friendly craft. The basic steps of this identification are *challenge, reply,* and *recognition.* Two sets of IFF equipment are used to perform the identification process. These are the interrogator (recognition) and transponder (identification) sets, which are described below.

AIMS MARK XII IFF SYSTEM

AIMS is an acronym for *Air Traffic Control Radar Beacon; Identification Friend or Foe, Mark XII Systems.* The Mark XII system is capable of challenging in five different modes (1, 2, 3/A, 4 and C). Each mode is assigned a specific function. Modes 1, 2, and 4 are assigned for military use only. Modes 3/A and 3C are assigned for civilian and military use.

The various modes have the following uses:

Mode 1–Used as directed by field commands. Thirty-two response codes are available.

Mode 2–Used to identify a specific airframe or ship. Four thousand ninety-six response codes are available.

Mode 3/A–Within CONUS; used as identity codes for air traffic control. Outside CONUS; used as identity codes for purposes assigned by operational commanders. Four thousand ninety-six response codes are available.

Mode 4–Used for secure identification of friendly platforms. The reply for this mode is generated automatically according to a preset cryptographic key list.

Mode C–Used to determine the altitude of aircraft. This is automatically derived from the aircraft's altimeter.

There are basically four operational uses for IFF equipment as follows:

1. Antiair Warfare (AAW) uses Modes 1, 2, 3/A, & 4 to provide complete identification of airborne platforms.

2. Air Control uses Modes 2, 3/A, & C to provide necessary data for control of friendly aircraft.

3. Air Traffic Control (ATC) uses Modes 2 and 3/A for departure and approach of carrier aircraft.

4. Surface Identification uses Modes 1, 2, 3/A, & 4 for complete identification of friendly surface platforms.

Additionally, the transponder provides the shipboard interrogator operator with special warnings, both audible and visual, upon receipt of any of the following special purpose replies:

1. Emergency–indicates aircraft in trouble

2. Communication Failure–indicates aircraft with inoperative communications equipment

3. Special Purpose Identification (Identification of Position)–manually activated special response by aircraft upon verbal request by ground/ship air control operator

AIMS MARK XII EQUIPMENT

The Mark XII IFF system includes all of the Mark X equipment, such as interrogators, transponders, and decoders, plus additional equipment such as interrogator side lobe suppression (ISLS) switches and drivers, defruiters, and crypto computers.

The interrogator transmits a coded challenge in the form of a pulse pair on the frequency of 1030 MHZ. The spacing between the pulses is determined by the mode of operation. The transponder is a receiver-transmitter combination that automatically replies to a coded challenge. The reply is a series of coded pulses, which are transmitted omnidirectionally at a slightly different frequency than the interrogator frequency (1090 MHZ).

The receiver section of the transponder receives and amplifies signals within its bandpass, decodes correctly coded signals, and automatically keys the transmitter to send certain prearranged reply signals on its designated transmit frequency. The receiver section of the interrogator receives the coded reply signals from the transponder of the target craft and processes the reply for display on an indicator. The coded reply from a friendly craft is normally displayed on the ppi scope just beyond the radar blip as a dashed line, as shown in figure 12-22. Naval Tactical Data System (NTDS) display consoles use symbology and numerics to indicate the transponder responses.

The interrogator operates in a manner similar to a radar transmitter and receiver. Bearing information is obtained by using a small directional antenna attached to or rotated in synchronization with the air-search radar antenna (Note: Some radars have IFF antennas integrated into their antennas). Range information is obtained by determining the time lapse between the

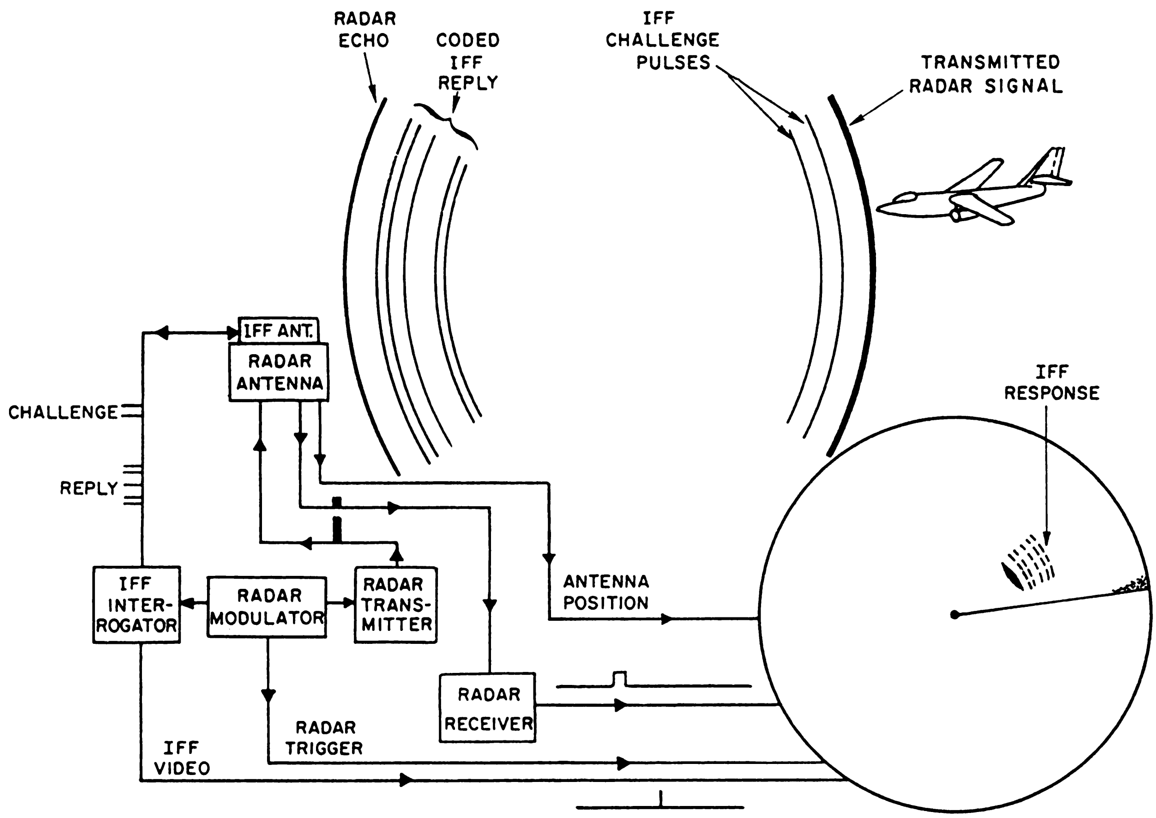

Figure 12-22–Fundamentals of IFF operation.

transmission and the reception of a reply. IFF synchronization triggers are normally received from the modulator of the radar set with which the IFF equipment is being used.

The IFF interrogator operates at fairly low peak power (1 to 2 kilowatts). High output power is not required, as the pulses transmitted by the interrogator do not have to return to the transmitting unit. Instead, they are transmitted on a one-way trip to the target. After the transmitted pulses are detected by the friendly target's transponder, a different set of pulses is transmitted by the target's transponder for the return trip.

A ship may have one or more interrogator sets, but will have only one transponder. Normally, interrogators and transponders aboard ship function independently, with the only interconnection between the two being a suppression (blanking) signal to inhibit the transponder from replying to the ship's own interrogators. Current IFF systems will be discussed in greater detail later in this text.

INTERROGATIONS AND REPLIES

Air traffic control and code monitoring for friendly aircraft and surface craft are done by the use of sif modes (Modes 1, 2, and 3/A). These modes (and Mode C) interrogations consist of two pulses spaced at a characteristic interval for each pulse, with a third pulse added for ISLS operation.

Each Mode 1, 2, or 3/A transponder reply (fig. 12-24) is a binary code contained between two bracket (framing) pulses, which are present in every reply, regardless of code content. Each reply code corresponds to a unique four-digit decimal code. The desired reply code for each mode is dialed into the transponder by means of thumbwheel switches. For Mode 1 replies, the first digit may be any number from 0 to 7, inclusive, and the second digit any number from 0 to 3 inclusive, with the remaining two digits normally 0. For Mode 2 and 3/A reply codes, each of the four reply digits may assume any value from 0 to 7, inclusive.

Mode C replies are also binary codes contained between bracket pulses similar to those for the sif modes. Mode C replies may represent any altitude from -1000 feet to +26,700 feet in 100 foot increments, the Mode C reply being derived from an encoder linked to the aircraft altimeter. Shipboard transponders are wired to reply to Mode C interrogations with back pulses only (Code 0000). Modes 1, 2, 3/A and C replies cannot in themselves be separated according to mode. The fact

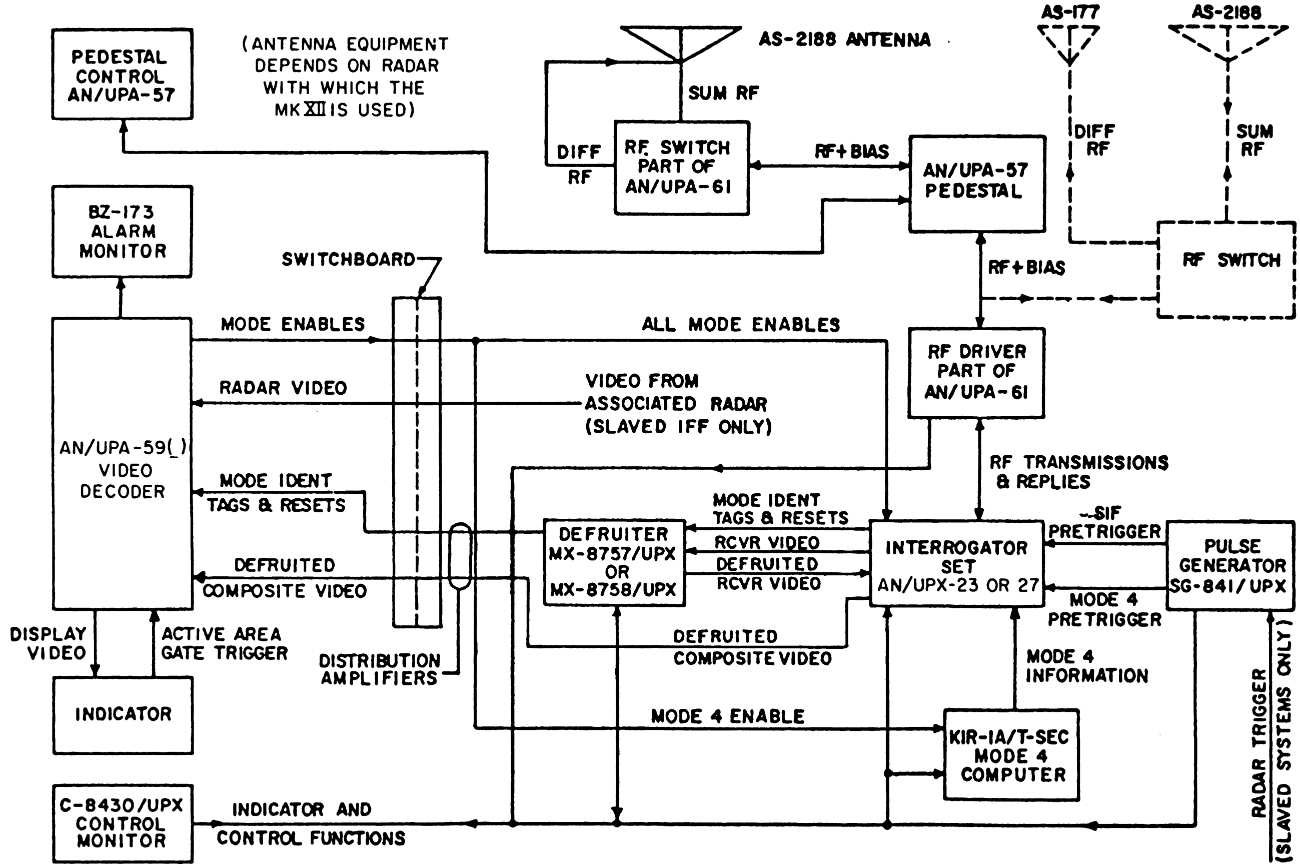

Figure 12-23.–Mark XII IFF system interrogator section.

that the interrogator "knows" which mode it has interrogated allows replies to be separated and identified with the proper mode.

Secure identification of friendly aircraft and surface vessels by the Mark XII system is provided through the use of Mode 4. Mode 4 interrogations are encoded multipulse trains, which consist of four (sync) pulses and an ISLS pulse, followed by up to 32 information pulses. Upon receipt of a valid Mode 4 interrogation, the transponder section processes the interrogation and sends out a time-coded three pulse reply. The interrogator section also converts the reply to one pulse, and time decodes it for presentation on the indicators if it is a valid reply.

Military emergencies for Modes 1 and 2 are called 4X (four train) emergencies. Mode 3/A military emergency replies consist of a combined 4X and 7700 code. A Mode 3/A civilian emergency reply is simply a 7700 code, without the 4X code. In addition, a Mode 3/A, 7600 reply code designates a radio communications failure for both civilian and military replies. There are no emergency replies for Mode C or Mode 4.

When desired, a transponder can be made to transmit an identification of position (I/P) reply for Modes 1, 2, or 3/A interrogations. This reply is decoded to mark on an indicator a particular aircraft with which the interrogator system operator has voice communication. A pilotless aircraft containing a transponder will transmit an X-pulse reply to Modes 1, 2, or 3/A interrogations. The X-pulse reply consists of a normal mode reply code plus an additional pulse occupying the center position of a reply train. X-pulse replies are unique to pilotless aircraft. (Mode C replies will not contain an X-pulse.)

INTERROGATOR SECTION

A simplified block diagram of the interrogator section of a representative Mark XII IFF system is shown in figure 12-23. The major units of the interrogator section (with the exception of the video decoder group) are usually mounted in a rack, as shown in figure 12-24, and located in the radar equipment room.

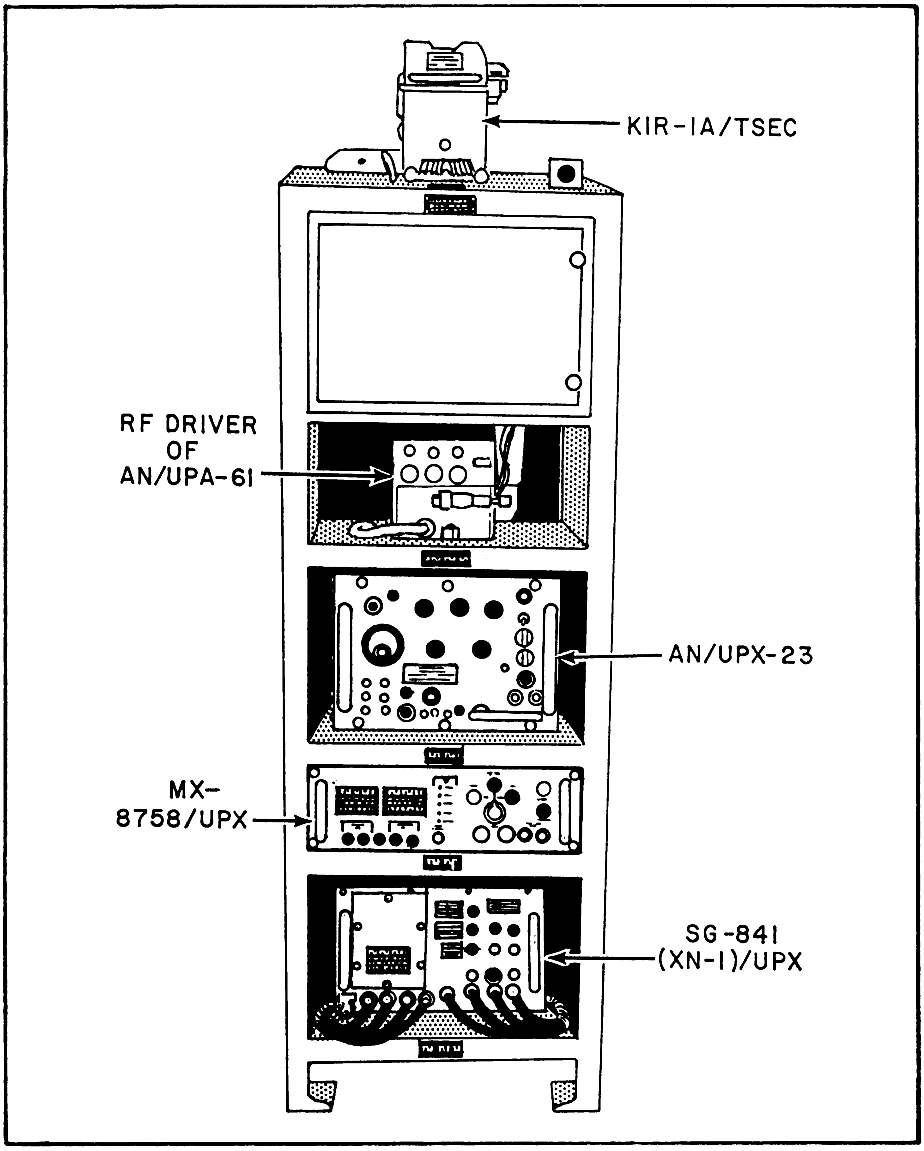

Figure 12-24.–Mark XII IFF interrogator equipment.

Interrogator Set AN/UPX-23

The AN/UPX-23 interrogator set provides rf interrogations for the various modes, receives the transponder replies to these interrogations, and processes them into proper video signals for use by the decoders and indicators. This equipment is normally used with a radar set, to which its operation is synchronized.

Cryptographic Computer KIR-1A/TSEC

The *computer* encodes the Mode 4 challenges for transmission by the interrogator, and decodes the Mode 4 transponder replies received by the interrogator. The code changer key, KIK-18, is used to insert the Mode 4 code into the computer.

Defruiter

The *defruiter* (Interference Blanker MX-8757/UPX or MX–8758/UPX) removes nonsynchronous transponder replies and receiver noise from the IFF video. The nonsynchronous replies (termed "fruit") are generated by omnidirectional transmissions from transponders answering to interrogators other than the one receiving the reply, and are not legitimate replies.

Pulse Generator

The *pulse generator* provides the IFF system pretriggers which initiate IFF challenges for the enabled modes. For "slaved IFF" systems, the pretrigger generator synchronizes IFF interrogations with the associated radar, and for "black IFF" systems, the

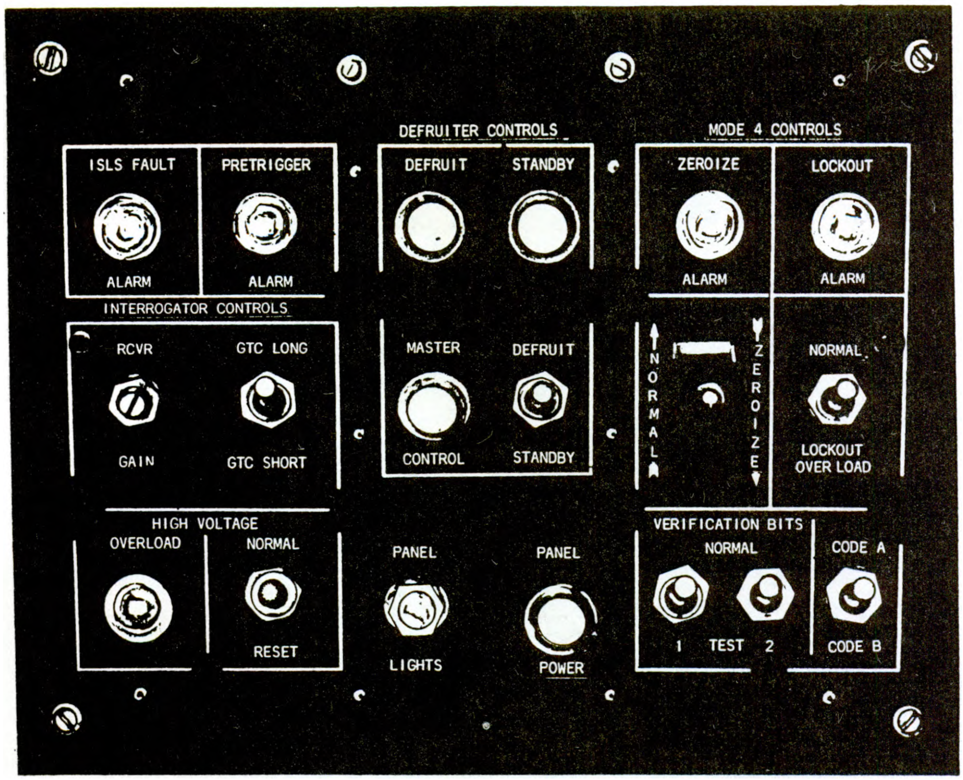

Figure 12-25.–Control monitor front panel.

pretrigger generator produces triggers internally. (Slaved IFF systems are IFF systems that are associated with radar systems, and black IFF systems are those systems not associated with radar systems.)

RF Switching Group AN/UPA-61

The AN/UPA–61 provides Interrogator Side Lobe Suppression (ISLS) and RF switching operation for the Mark XII system. Targets at close ranges to an interrogator set will reply to side and back lobes of the antenna as well as the main antenna beam. This causes the target to appear for nearly 360° close to the origin of display (ring around). The function of ISLS is to prevent ring-around by inhibiting transponder replies to interrogations from the side lobes of the IFF antenna.

Control Monitor

The *control monitor* serves as a remote control and a remote monitor for the interrogator section. The front panel of the control monitor is shown in figure 12-25.

Video Decoder AN/UPA-59

The *video decoder,* AN/UPA-59, processes the pulse coded replies received by the interrogator set and provides video output to an indicator. The AN/UPA-59 has a variable configuration. The most common configuration uses a video decoder, an intratarget data indicator, and an alarm monitor.

The video decoder provides control signals for the interrogator to indicate challenges in the various modes, and accepts reply video for decoding and processing. (Mode 4 reply video is fed directly through the decoder with no processing). The decoder also accepts radar video from an associated radar and routes this video directly to the indicator, or mixes it with IFF video for display. In addition, the decoder contains active decoding circuitry to display information for the intratarget data indicator.

The *intratarget data indicator* provides readouts of codes for Modes 1, 2, and 3/A replies, plus direct altitude readouts for Mode C replies. The *alarm monitor,* BZ-173/UPA-59(V), contains a loudspeaker and indicator lights for producing audible and visual alarms when IFF emergency signals are decoded.

Antennas

The standard Mark XII IFF system antenna is the AS-2188/UPX. This antenna has both sum and difference input jacks for radiating rf (from the AN/UPA-61 switch and driver) into the proper patterns for ISLS operation. In installations where the antenna rotary joint will not pass the switching bias, the

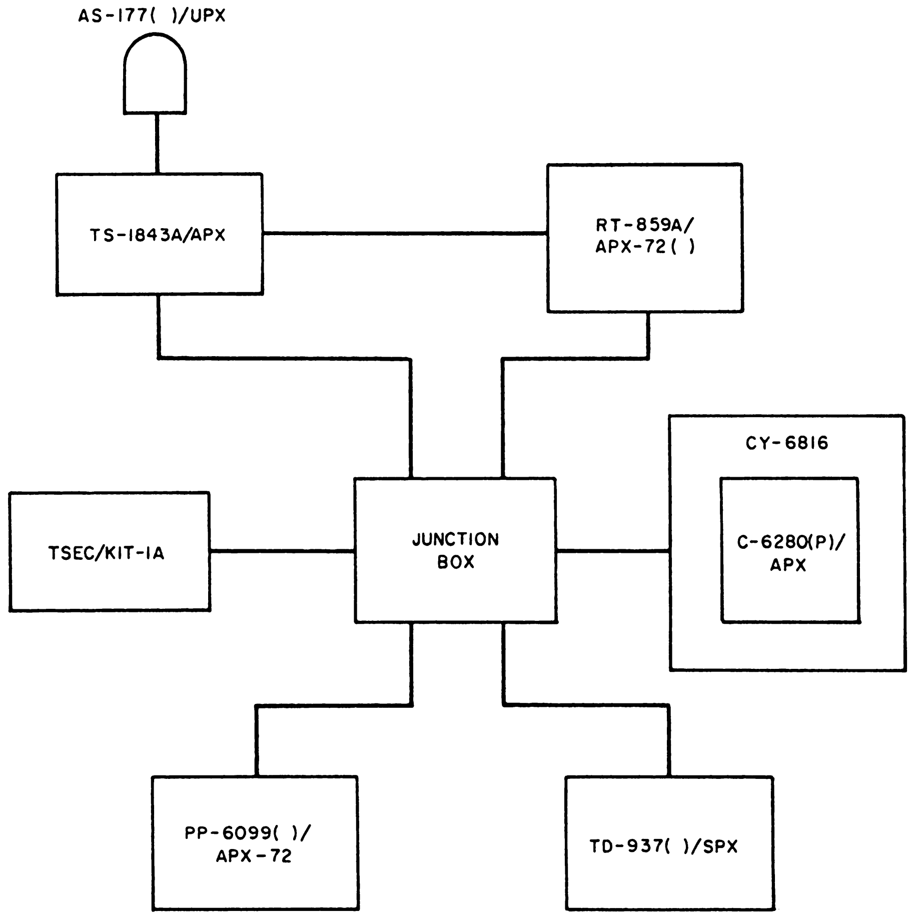

Figure 12-26.–Typical shipboard Mark XII transponder section.

AS2188/UPX will transmit a sum pattern only, with a separate AS177/UPX omnidirectional antenna transmitting the difference rf. Some installations use an integral antenna to transmit and receive both radar and IFF, with difference IFF being transmitted on a separate AS/177/UPX.

Antenna Pedestal Group AN/UPA-57

The antenna pedestal group, AN/UPA-57, is capable of self-synchronous operation at variable rotation rates up to 15 rpm. It is also capable of manual operation whereby an operator (at a ppi) can rotate the antenna to any desired position. In addition, the pedestal group may be slaved to a radar system antenna. This application is used for radars that cannot have the IFF antenna mounted on the radar antenna, but are otherwise compatible with the IFF system. The pedestal group consists of a control power supply unit, a manual pedestal control unit, an antenna pedestal assembly, and a pedestal disconnect mast switch.

The *control supply unit* is located below deck and develops all of the power required for the pedestal group. When slaved to a primary radar, the control power supply unit accepts the radar synchro information (via the radar switchboard) and is capable of being slaved to rotation rates of 2 to 30 rpm. When free run operation is selected (on the front panel), the unit drives the pedestal assemble to a variable rate of up to 15 rpm. In conjunction with the manual pedestal control, the unit is also capable of positioning the antenna to any azimuth from a remote position.

The *manual pedestal control* is usually located at the ppi. Front panel controls provide for selection of slave, free run, and manual operation. The *antenna pedestal assembly* is capable of mounting the AS-2188/UPX or any other 10-foot antenna designed to mount on the same platform. The *pedestal disconnect mast switch* is located above deck and removes all power from the pedestal assembly when it is activated.

Transponder Subsystem AN/APX-72

The *transponder section* accepts challenges from other platforms and provides coded identification replies. A simplified block diagram of the most common AIMS shipboard transponder subsystem installation is illustrated in figure 12-26. This

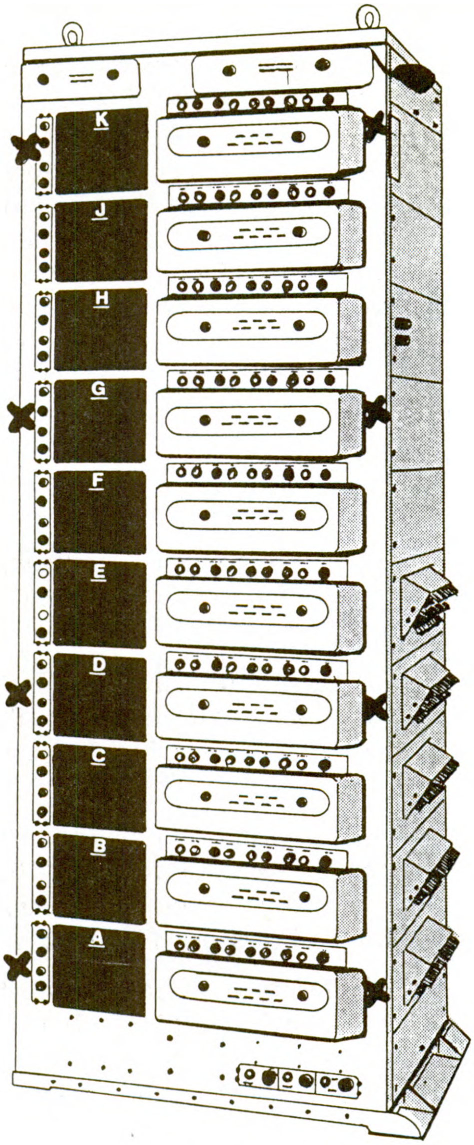

Figure 12-27.–Radar Signal Distribution Switchboard SB-1505/SP.

configuration applies to all ships carrying an interrogator system. As previously mentioned, certain noncombatant vessels do not have interrogator systems installed and will only have the transponder subsystem. This system uses the KIT-1A cryptographic computer for secure identification.

AUXILIARY EQUIPMENT

The AN/UPM-137 or AN/UPM-137A radar test set is a universal IFF test set for calibration, adjustment, and maintenance of all IFF equipment. For transponder only installations, the AN/UPM-136 is used.

RADAR DISTRIBUTION SWITCHBOARDS

The radar distribution switchboard provides a method of selecting and connecting the radar and IFF data to the various indicators, expanding shipboard target video display capabilities. The switchboard inputs are connected to the remote indicators through rotary switch assemblies. It also contains amplifier assemblies that provide sufficient video gain to drive the indicators. There are two switchboards currently used, the SB-1505/SP and the SB-4229.

RADAR SIGNAL DISTRIBUTION SWITCHBOARD SB-1505/SP

The SB-1505/SP (fig. 12-27) enables any one of 10 remote radar indicators to receive radar data from any one of 11 radar receivers. The data from one radar may be fed simultaneously to any number of channels and all channels may be in operation at the same time.

All channels function identically; therefore, to avoid repetition, only one channel is described in this section. Each channel consists of one rotary selector switch; one video and four IFF amplifiers; three trigger regenerators; two dc amplifiers; one stabilizer subassembly; one amplifier power supply (which provides dc power for the video and IFF amplifiers, trigger regenerators and dc amplifiers); and a solenoid power supply. The input terminal boards (located on the inside) and coaxial connectors for 11 radar receivers are mounted on the right side (facing the equipment) of the switchboard. The output from each radar receiver is coupled to all rotary selector switches. The channel outputs are located on the left side of the switchboard enclosure. Each channel has two output terminal boards (located on the inside) and twelve output coaxial connectors.

Each radar indicator in the system is associated with a specific channel in the switchboard. Two selector switches for remote switchboard control are located at each radar indicator (ppi). One remote switch controls the signal input level for one switchboard video amplifier. The other remote switch controls the position of the rotary-selector switch in the switchboard channel through a five-wire, two wafer, switch-position sensing system. This system orients the rotary selector switch to any one of twelve positions (there are 11 radar receiver input signal positions and an OFF position on each switch). When the remote radar selector switch and the rotary selector switch are in corresponding positions, the rotors and contacts of the switch wafers interrupt the power source to a rotary solenoid. The rotary selector switch is thus positioned to couple the selected radar signals to the remote indicator unit. Synchro and IFF control information is coupled through the rotary selector switch directly from the selected input terminal board to the output terminal board. The video, IFF, trigger, and scan signals are coupled through the rotary selector switch from the input coaxial connectors to their respective amplifier stages. The amplifier outputs are wired directly to the output coaxial connectors. The output terminal boards and connectors for each switchboard channel are identical. The switchboard input terminal boards are wired for specific radar receivers.

RADAR DISTRIBUTION SWITCHBOARD SB-4229

This radar distribution unit performs the same functions as the SB-1505/SP, with added capabilities. Additionally, this switchboard, uses electronic switching rather than electromechanical. Added capabilities include:

1. The capability of selecting one of 16 input packages. These packages consist of three radar videos, RADDS Data Stream, and IFF control with its associated video. They can be selected either locally or remotely. Additionally, these packages can be distributed to any one of nine separate radar indicators.

2. The capability of converting RADDS Data Stream back to analog for older indicators. This switchboard was primarily designed to support the AN/SPA-25G.

3. The capability to detect some types of improper operation by means of built-in testing.

RADAR SUPPORT SYSTEMS

The various radar systems described in this chapter require some form of support systems; dry air, cooling water, electrical power, and so on. These support systems are described in chapter 15.

SUMMARY

Radar systems aboard ship are probably the most sophisticated and expensive electronics you will deal with as an EMO. You must ensure that your preventive maintenance is done completely and properly. Your electronic cooling and dry air systems are absolutely essential and should be constantly checked.

One item that you need to consider is the rigging of "friendship" or Mediterranean (MED) lights. Generally the individuals who string the lights are not from electronics ratings. Either you or an electronics khaki supervisor must be topside as an observer during these evolutions. One mistake from someone who doesn't know how delicate a radar antenna is can put a multimillion radar out of commission. If an antenna such as the AN/SPS-49 has to be moved to 090 so that 500 pounds of steel cable and brow lights can be rigged, ensure the antenna is moved by hand and tagged out.

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CHAPTER 13

NAVIGATION THEORY AND EQUIPMENT

OVERVIEW

The Navy uses various navigational systems in today's fleet.. Some are permanently mounted in various locations on the earth, some use satellites, and some track the recorded movement of the ship.. As the EMO, you will be assigned maintenance responsibilities for these units.

OUTLINE

Description

Loran

Omega

SINS

Satellite navigation

TACAN

Navigation is basically a method of getting from one known point to another distant point. Methods of navigation may be subdivided into the broad categories of piloting, celestial navigation, and radio navigation. In this chapter, we will discuss radio navigation.

Radio navigation may be subdivided into terrestrial systems, such as OMEGA or LORAN, and space-based systems, such as SATNAV, TRANSIT, or NAVSTAR GPS. In all cases (except some naval gunfire support systems that provide near constant positional updates with respect to a fixed beacon or prominent landmark), there is a limit to the frequency with which fixes can be obtained. As a result, we must "dead reckon" between fixes, making assumptions about the ship's movements and estimating instantaneous positions based on those assumptions. Dead reckoning may be as basic as a DR line for course and speed on a plotting sheet or as sophisticated as inertial navigation systems that measure ships' motion in several planes and integrate the result to estimate location with very good accuracy. The common characteristic of all dead reckoning methods is that the accuracy of the estimated position can never exceed that of the navigation method used to obtain the last fix, and that the accuracy of the estimated position deteriorates over time.

Navigation data is required by the combat system, including NTDS, to ensure accuracy in target tracking. Ships' movements are automatically recorded by computer programs for such applications as gun laying calculations and Link 11 position reporting. Ships' attitudes (pitch, roll, and heading) are measured and transmitted to various display and user points. Either electronic or mathematical computer stabilization is accomplished depending on the system. Pitch and roll, for example, are used by NTDS, missile, sonar, gun, and TACAN systems for stabilization data and certain equipment reference platforms. Heading is used by the EW, direction finding, sonar and radar systems for true and relative bearing displays. Ships' navigation and attitude data is provided by various equipment, depending on the ship class.

A distinction must be made between navigation in the traditional sense, and tactical navigation. Traditional navigation and piloting are concerned primarily with safe maneuvering of the ship or aircraft with respect to natural hazards–shoals, reefs, and so forth. Tactical navigation is not concerned, directly, with maintenance of the ship in navigable waters. In fact, for purposes of tactical navigation, absolute position is unimportant except to the extent that it supports determination of the relative location of targets and cooperating, nonhostile platforms.

Tactical navigation is assumed to deal primarily with the process of fixing the location of the platform to accomplish the following:

1. Enable installed weapons systems to function against intended targets.
2. Prevent ownship loss to or interference with friendly weapons systems.

3. Enable coordination of ownship weapons systems with those of other platforms to achieve maximum effect.

Basically, electronic navigation is a form of piloting. Piloting is that branch of navigation in which a ship's position is determined by referring to landmarks with known positions on the earth. These reference points may consist of the bearing and distance to a single object, cross bearings on two or more objects, or two bearings on the same object with an interval between them.

Position in electronic navigation is determined in practically the same way as in piloting. However, there is one important difference: the landmarks from which the ship's position is determined need not be visible from the ship. Instead, their bearings and ranges are obtained by electronic means (either radar or radio).

The advantages of electronic navigation are obvious. A ship's position may be fixed electronically in fog or heavy weather that would make it impossible to obtain visual bearings. Moreover, an electronic fix may be based on stations located far beyond the range of clear-weather visibility.

This chapter deals only with electronic navigation by:

1. Long Range Aid to Navigation (LORAN)
2. Omega (vlf radio-navigation)
3. Ship's Inertial Navigation System (SINS)
4. Navy Navigation Satellite System (NNSS)
5. Navstar Global Positioning System (NAVSTAR GPS)
6. Tactical Air Navigation (TACAN)

LORAN SYSTEMS

LORAN (LOng RAnge Aid to Navigation) is a long-distance radio navigation system used by ships at sea to obtain a position fix. The LORAN system is based on the difference in the time required for pulsed radio signals to arrive at the LORAN receiver from multiple synchronized omnidirectional transmitters ashore. This system also takes advantage of the constant velocity of propagation to use the time lapse between the arrival of two signals to measure differences in distance from the transmitting stations to the point of reception. The LORAN receiving set provides a direct reading, in microseconds, of the time difference in the arrival of LORAN station signals. (Some sets automatically convert the readings to latitude and longitude.). When the time difference is measured between signals received from any two LORAN station pairs, a ship's line-of-position (lop) can be determined.

The LORAN system currently used in the fleet is LORAN C. Although most of the shipboard LORAN C systems have been or will be replaced, a brief description is provided in the following paragraphs. Many ships have commercial LORAN C equipment installed on board, at the request of the navigator. Therefore, you will need to understand the basics of how the system operates. The basics are described below. Later in the chapter, we will describe the AN/SRN-26 navigation system and explain how it uses LORAN C inputs.

The LORAN C system transmits a pulsed 100-Khz ground wave. Each master station has at least two slaves operating on the same pulse repetition rate (PRR). This allows the transmitting stations to be widely separated and permits position fixes at great distances from the transmitting stations, approximately 1200 nautical miles.

LORAN C offers more accuracy in time difference measurements because the 100-kHz rf waves that make up each pulse are superimposed as closely as possible for the time difference measurement. Additionally, readings on two station pairs can be made without receiver retuning, so these time difference measurements may be made rapidly.

The LORAN C master pulse group consists of nine pulses spaced either 500 or 1000 microseconds apart except for a ninth pulse which is separated from the eighth pulse by 600 microseconds. This ninth pulse is an indicator for master transmitting stations only. The slave pulse group transmission is a group of eight pulses separated with the same spacing as the master station,. 500 or 1000 microseconds. The LORAN C pulse groups are illustrated in figure 13-1.

LORAN C has six basic PRRs that are divided into two groups, single rate and double rate. The single rate has three basic prr's, 33-1/3, 25, and 20 Hz, that are designated H, L, and S, respectively. These rates produce pulse recurrence intervals of 30,000 microseconds for the H rate, 40,000 microseconds for the L rate, and 50,000 microseconds for the S rate, varying. The double rate is one-half the single rate, 16-2/3, 12-1/2, and 10 pulse groups per second, designated SH, SL, and SS, respectively. These rates produce pulse recurrence intervals of 60,000 microseconds for the SH, 80,000 micro-seconds for the

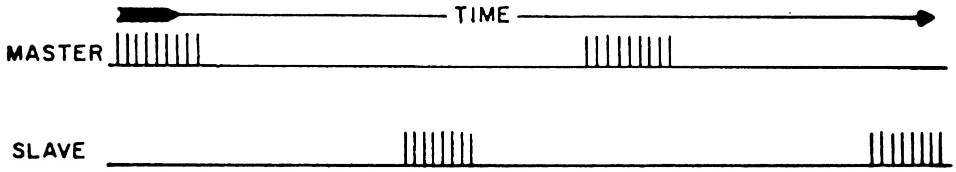


Figure 13-1.–LORAN C pulse groups.

SL, and 100,000 microseconds for the SS. Obviously, these rates are double that of a single rate.

A typical LORAN C transmitter arrangement is the star chain shown in figure 13-2,. also known as a LORAN service area. In this configuration, four stations, a master (designated M) and three slaves (designated X, Y, and Z) transmit pulse groups. The transmissions of the slave stations are timed with respect to the master station to establish an accurate basis for the time measurements.

The master station starts the action by transmitting a pulse group of nine pulses. The pulse group transmission is received by the X, Y, and Z slave stations. After a predetermined delay, the X station transmits its pulse group. After a somewhat longer predetermined delay, the Y station transmits, and after another delay, the Z station transmits. These delays permit the signals to arrive at the LORAN C receiver in the M, X, Y, and Z sequence anywhere in the service area.

The results of these transmissions are three sets of lines of position (LOPs), one set of each combination of master and slave. By measuring the difference in arrival time of the three slaves and the master, three lines of position may be located on the LORAN C chart. The intersection of the three lines of position produces a LORAN C fix.

On most modern ships, LORAN C is being supplanted by the newer Omega and NNSS installations. This is being done either in new construction or, for older ships, during overhaul.

There are many civilian varieties of LORAN C that your commanding officer may approve for use, due to low cost and nearly zero maintenance. These units offer the latest in up-to-date programming to aid the navigator and the OOD in determining the ship's position. Remember that if you, as the EMO, can provide an additional piece of electronic navigation equipment for your ship, it may make a big difference if your primary

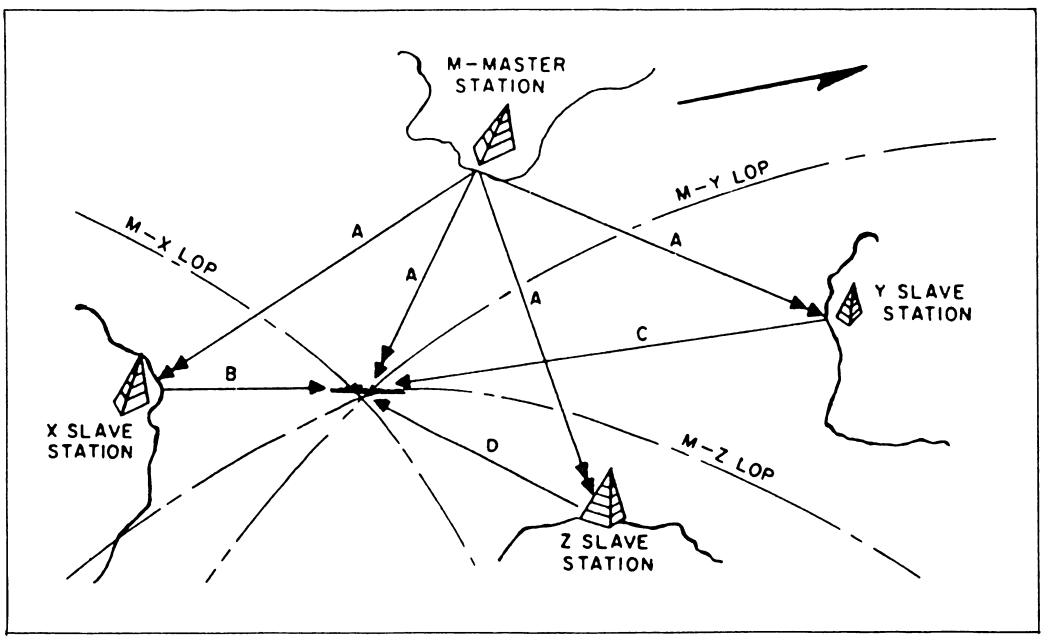


Figure 13-2.–LORAN C star chain transmitter arrangement.

electronic navigation system is down hard awaiting parts.

OMEGA NAVIGATION SYSTEM

Omega transmitting stations cover the world with their very- low-frequency (vlf) radio signals. These signals provide a worldwide, general-purpose, year-round, day and night navigation system. Ships, submarines, and aircraft using Omega can obtain position fixes with an accuracy of within 1 to 2 nautical miles (nmi). The system takes advantage of the phase stability and low attenuation characteristics of vlf radio signal propagation. There are eight Omega stations operating in strategic locations, selected for maximum global coverage. Each station, when operating at its normal rated power, has a range of approximately 8,000 nmi. Each of the eight stations is identified by a station letter designator of A through H. The transmitting stations operate in the internationally allocated vlf navigation band between 10 and 14 kHz. This vlf transmission permits Omega to provide adequate navigation signals at much longer ranges than other ground-based navigation systems operating at higher frequencies. The geographic locations of these stations are shown in figure 13-3.

PRINCIPLES OF OPERATION

The Omega system relies on the characteristics of radio waves in general and specifically on the characteristics of radio waves in the very-low-frequency range.

In general, a given phase position of a radio wave occurs periodically as each cycle is repeated; thus, any phase angle will recur in intervals of wave duration. The rate of recurrence expressed in time depends on the

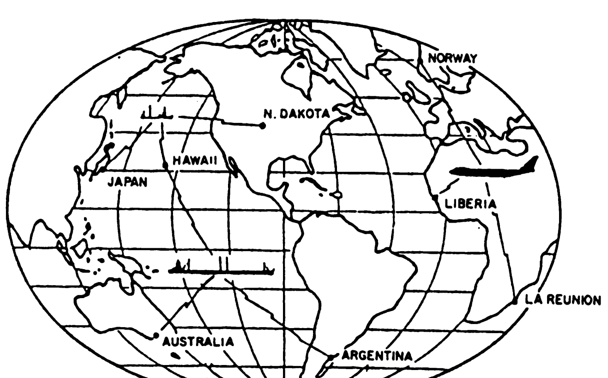


Figure 13-3.–Omega transmitter locations.

frequency; in distance, recurrence interval is directly related to wavelength. The latter phenomenon furnishes the basis for a hyperbolic system similar to that of LORAN. The Omega system, however, differs from the LORAN system in that measurement of phase relationship, rather than the time relationship between stations, is used to obtain a line of position. The system also uses a series of cesium-beam frequency standards for precise timing at each site, so that each station is effectively a master station and may be paired with one or more other stations to obtain a position fix. The time of the system is referred to as OMEGA time.

By locking Omega stations to an absolute time standard, phase is, in theory, maintained stationary throughout the transmitter's field of radiation (i.e., earth's surface). This constant phase over the earth's surface may be translated into hyperbolic lines. The lines for any two Omega stations produce a family of hyperbolas called isophase (constant phase) contours. Each contour represents a line of zero difference in phase angle between the paired station signals. Since zero phase difference between signals will occur every 180°, or half wavelength, measured differences within these "lanes" will be unique to a specific distance from either zero-phase contour line (fig. 13-4). This relationship will be constant along the length of any zero-phase delineated lane; therefore, a line-of-position within a lane may be established by measuring phase angle difference between paired stations.

Lane widths are determined by the frequency of transmission (fig. 13-5). The presently used frequencies of 10.2 kHz, 11.33 kHz and 13.6 kHz have half wavelengths (distance between contours) of 8, 7, and 6 nautical miles respectively, along the baseline. Additionally, lane boundaries of 24 and 72 nautical miles may be derived by using the ratios of the difference between 10.2 kHz and the other 2 frequencies. These broad 24-and 72-mile lanes may be used to resolve uncertainty in lane location.

LANING

One way to begin the laning process is to insert the starting lanes by using the dead reckoning (dr) position of the receiver or other navigational position fix to determine the proper lane numbers. One LOP defined by a single pair of transmitting stations cannot define one point receiver location. Two pairs of transmitting stations are required, and three or four are needed for optimum results. Useful signals from three stations can provide three pair combinations and, therefore, three intersecting LOPs. This condition is shown in

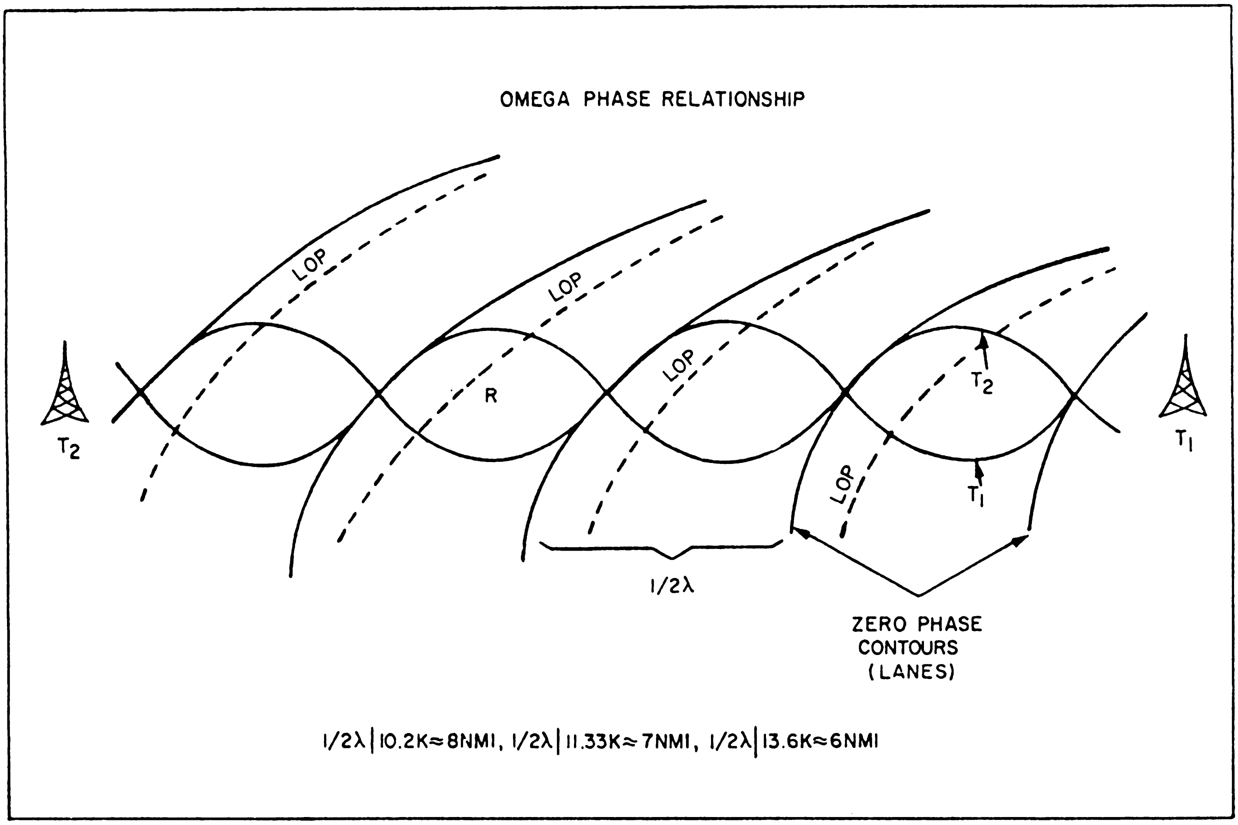


Figure 13-4.–Zero phase contours.

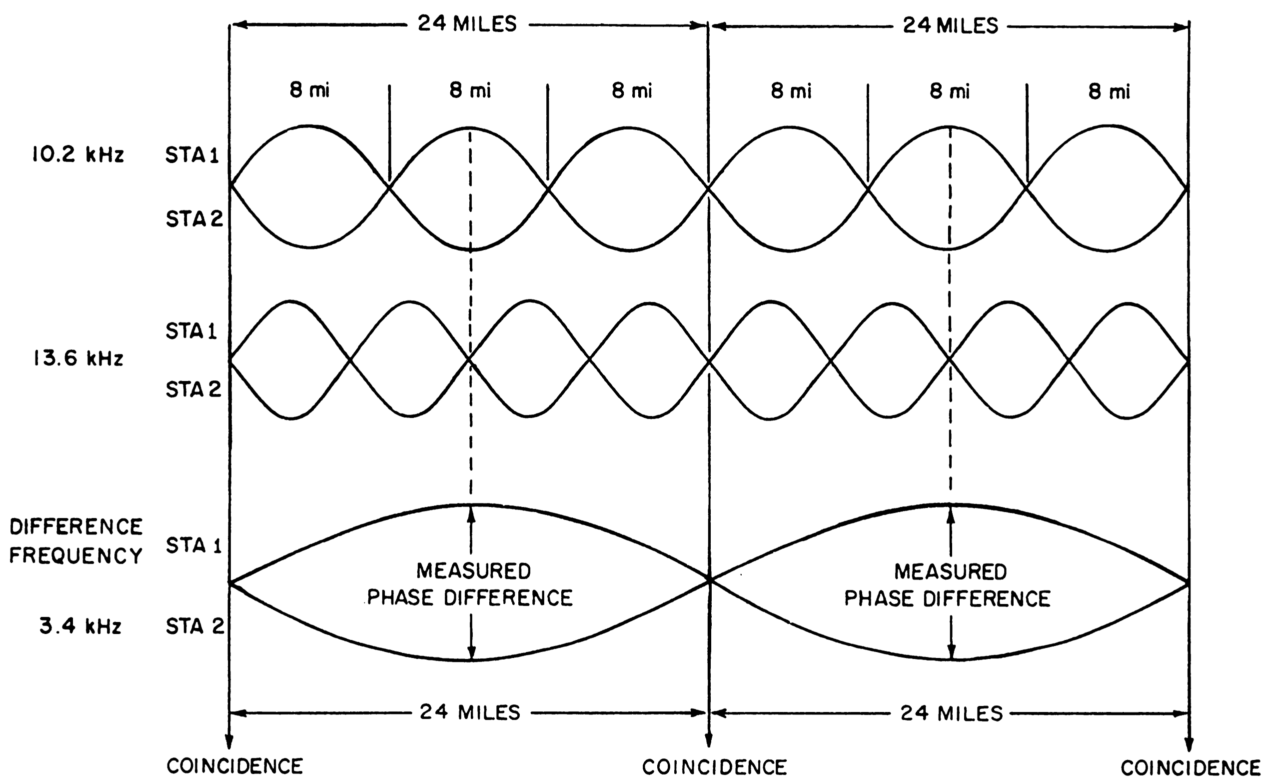


Figure 13-5.–Resolving lane ambiguity.

figure 13-6. The lanes between the respective pairs of transmitting stations have been identified and the percent of lane defining the LOP has been charted. When all three lanes have been identified and all three LOPs plotted, the receiver location R is uniquely located. The Omega station pairs are plotted in alphabetic order, A-B, B-C, C-D, and so on. The lane number increases toward the second station of the pair. The midpoint lane count between any two stations will be 900. The lane count decreases from 900 as you progress toward the second station.

An example of a dr to Omega lane position would be 38° 56'N and 74° 57.5'W changed to LOP B-D 944.79, LOP A-B 989.46, and LOP A-D 1034.19. A lane is divided into 100 parts. The distance into an Omega lane is referred to as the percent of lane. The normal receiver display will be the lane number and percent of lane measurement for each LOP selected.

Each station in the Omega system broadcasts a continuous-wave signal rather than a pulsed signal like that of LORAN. Because of the time separation between transmissions, the signal will have the appearance of being pulsed when seen on the cathode-ray tube display of the receiver. This time separation is required, since all of the eight stations transmit on the same frequencies, and a means of identifying the sources of the signals being measured is needed. Examination of the broadcasting schedule of figure 13-7 shows a periodic pattern of interrupted transmissions repeating every 10 seconds. In this format, each station has a combined position/duration relationship that is unique. While stations 1 and 6, for example, are assigned the same signal duration on the 10.2-kHz frequency, their relative positions in the order of transmissions are different and ambiguity is eliminated. Because Omega time is synchronized with, but is not identical to, Greenwich Mean Time, the identification of stations received during any 10-second cycle is possible by using a time reference from another source such as the time signals broadcast by major naval radio stations. Additionally, the relative nearness of stations will produce differing signal amplitudes when viewed on the receiver's cathode ray-tube display. This will further aid in identifying the stations being measured.

OMEGA SIGNAL PROPAGATION

The Omega system is essentially a skywave system, with the surface of the earth and the ionosphere forming a waveguide through which the transmitted signals travel (fig. 13-8). The ionosphere is a cloud of free

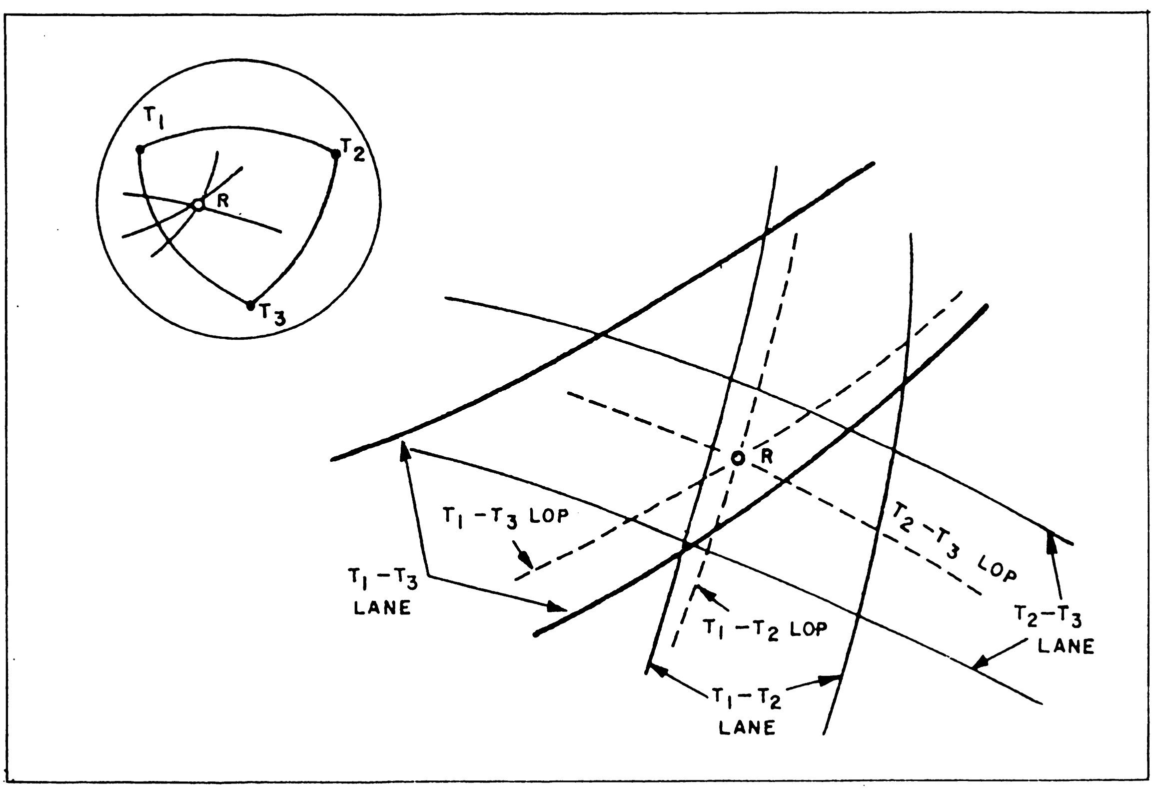


Figure 13-6.–Obtaining a position fix from three transmitting stations.

BROADCAST FORMAT BY STATION NUMBER

TRANSMISSION PERIODS	0.9	1.0	1.1	1.2	1.1	0.9	1.2	1.0	0.9
FREQ 10.2 kHz	1	2	3	4	5	6	7	8	1
11.3 kHz	7	8	1	2	3	4	5	6	7
13.6 kHz	8	1	2	3	4	5	6	7	8

0.2 SECONDS

10. SECS

START

Figure 13-7.–Broadcast format.

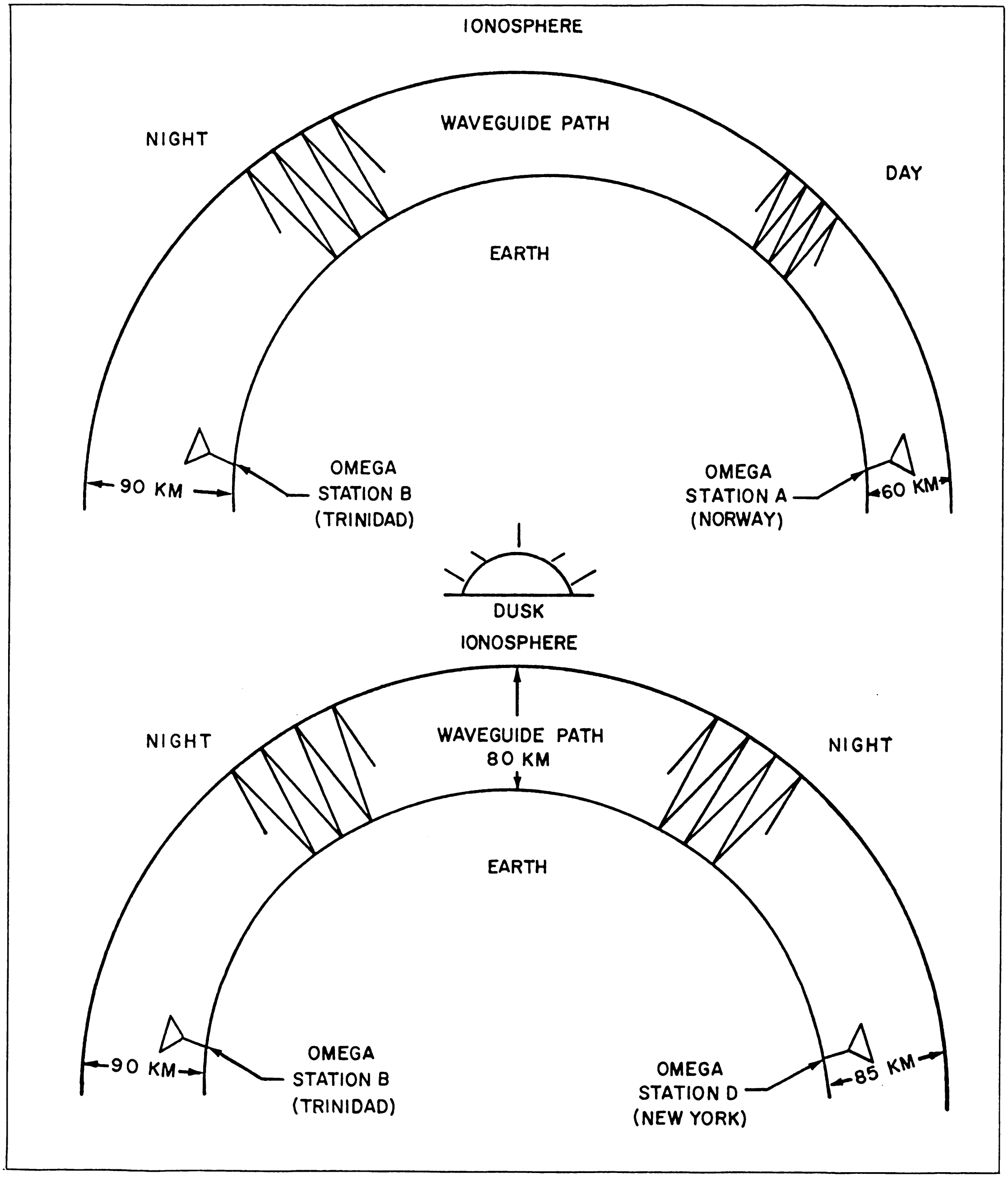


Figure 13-8.–Omega signal propagation.

electrons whose lowest region lies at altitudes of 40 to 50 miles above the earth's surface. Very-low-frequency signals, such as those of Omega, are refracted by the ionosphere and also reflected by the earth. The velocity of phase propagation will be determined by ionospheric height, surface conductivity and, to some extent, the earth's magnetic field.

Variations in the height of the ionosphere (diurnal shifts) occur between night and day. The extent of these diurnal shifts can be as much as one percent and can cause daily changes in phase propagation velocity, which in turn will result in shifts of the isophase contours generated by any pair of Omega stations. Isophase contours form an electronic lattice that may be viewed as a grid slowly shifting back and forth over the earth's surface in a daily pattern following diurnal shifts of the ionosphere. Gradual changes to this pattern will occur as the ionosphere is affected by seasonal changes. The repetitive nature of this shifting lends a high degree of predictability to lattice movement. The United States Naval Oceanographic Office computes and publishes these predictions for each pair of transmitted signals in each geographic area of the earth's surface. Skywave correction factors are provided separately and must be applied to each of the receiver line-of-position readings to convert them to common Omega geographic map grids.

SHIPBOARD OMEGA RECEIVING EQUIPMENT

The Omega Receiving Set AN/SRN-12 used to be on most ships in the fleet. The AN/SRN-12 is being phased out and will eventually be replaced by the AN/SRN-26, which will be described in this chapter.

SHIP'S INERTIAL NAVIGATION SYSTEM

The Ship's Inertial Navigation System (SINS) is a navigation system that (after initial latitude, longitude, heading, and orientation conditions are set into the system) continuously computes the latitude and longitude of the ship by sensing acceleration. This method is in contrast to the LORAN and Omega system methods, which fix the ship's position by measuring position relative to some known object. SINS is a highly sophisticated dead reckoning device.

Because SINS is completely independent of celestial, sight, and radio type navigational aids, the system has the major advantage of security over other types of navigation systems. The inertial navigation system also has the following additional advantages:

1. It is self-contained.
2. It requires minimal outside information.
3. It cannot be jammed.
4. It is not affected by adverse weather conditions.
5. It does not radiate energy.
6. It is not detectable by enemy sensors.

The basic components of an inertial navigation system (fig. 13-9) are the accelerometers, gyroscopes, servosystems, and computers (not shown). An accelerometer is a device that measures changes in speed or direction along the axis in which it lies. Its output is usually a voltage proportional to the acceleration to which it is subjected. A set of two accelerometers (oriented North-South and East-West respectively) is mounted on a gyro-stabilized platform to keep them in a horizontal position despite changes in the ship's movements. The accelerometers are attached to the platform by an equatorial mount (gimbal) whose vertical axis is aligned parallel to the earth's polar axis. This permits the N-S accelerometer to be aligned along a longitude meridian, while the E-W accelerometer is aligned along a latitude meridian.

A three-gyro-stabilized platform is maintained in the horizontal position regardless of the pitch, roll, and yaw of the ship. When the ship's heading changes, the gyro signals will cause servosystem motors to operate to keep the platform stabilized. High-performance servo systems are used to keep the platform stabilized to the required accuracy.

For relatively short periods of time, inertial navigation systems are extremely accurate. Maintaining this accuracy over long periods of time, however, requires that the system be updated periodically (reset using a position obtained by some other navigational means; i.e., electronic, celestial, or dead reckoning.)

There are several models of SINS on ships today. The Mk 3 Mod 6 system has been placed on SSN 637 class submarines and some aircraft carriers. The Mk 2 Mod 1 system is the configuration for many of the SSN 594 class submarines, while the more recent AN/WSN-1 Dual Mini SINS (DMINS) has been installed on the SSN 688 class submarines and some aircraft carriers.

The DMINS represents a considerable improvement in component size (lighter and smaller) and maintenance concept (replacement of entire units instead of individual part replacement). The DMINS is part of the central computer complex (CCC) that provides input/output and central processor unit functions via the AN/UYK-7 computers. The CCC integrates the DMINS information with other combat systems; i.e., fire control and sonar.

The AN/WSN-5 SINS is slated for installation on various surface combatants. This newer unit is a "stand-alone" system (external digital processing resources not required for alignment, reset, calibration or navigational functions), and is planned for installation on various platforms to update earlier systems.

SATELLITE NAVIGATION SYSTEMS

Satellite navigation was thought feasible after observation of Russia's first artificial earth satellite, Sputnik I. Scientists listened to the beep generated by Sputnik as it passed by and noted the Doppler-like shift in the received radio frequency signals. (The Doppler effect is an apparent change in a received frequency because of relative motion between the transmitter and receiver. If the distance between the transmitter and receiver is decreasing, the received frequency is higher than that which is actually transmitted; if the distance is increasing, the received frequency is lower than that transmitted). It was later demonstrated that accurate measurement of this Doppler shift pattern would permit the determination of a satellite orbit. From this successfully proved technique, it was further reasoned that working from a known satellite orbit, the listener's own position on the surface of the earth could be determined by observing the Doppler pattern. Following the first successful satellite launch in April 1960, the U.S. Navy Navigation Satellite System (NNSS) became an all-weather, highly accurate, fully operational navigation aid, that enables navigators to obtain accurate navigation fixes from the data collected during a single pass of an orbiting satellite.

The following paragraphs describe the Navy Navigation Satellite System and discuss some of the principles of satellite navigation.

NAVY NAVIGATION SYSTEM DESCRIPTION

The Navy Navigation Satellite System is a highly accurate, world-wide, all-weather system that enables navigators to obtain fixes approximately every 2 hours, day and night. It consists of earth-orbiting satellites, tracking stations, injection stations, the U.S. Naval

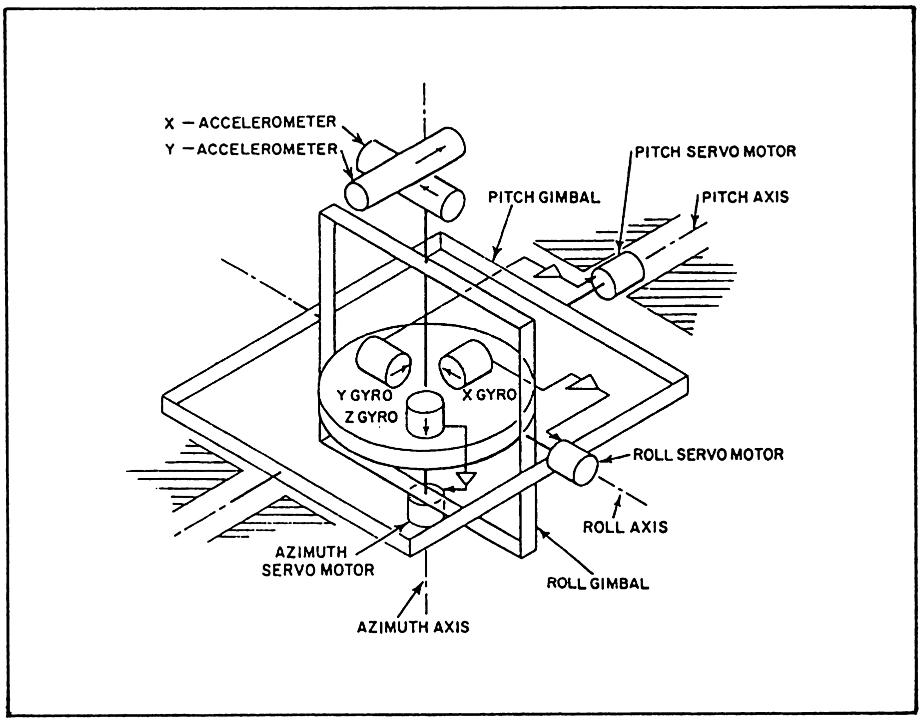


Figure 13-9.–Stable platform with inertial components.

Observatory, a computing center, and shipboard navigational equipment, as shown in figure 13-10.

Four tracking stations, spaced to monitor the polar orbiting navigational satellites, are located in Hawaii, California, Minnesota, and Maine (one in each state). Their purpose is to determine accurately the present and future orbits of each satellite. These stations have radio receiving and data processing equipment that converts the orbital and time information into a digital format and sends it, via a control center, to the computing center.

The tracking stations maintain highly stable oscillators that are continually compared against a WWV transmitted frequency standard. In addition, the Naval Observatory sends a daily message that gives the error in the transmitted standard. The Naval Observatory error is then added to the data obtained from the frequency standard and corrections are made to the station oscillators. The station oscillators are used to drive station clocks, which are compared with the time marks received from the satellite. This time data is transmitted by the tracking stations to the control center where the satellite clock error is calculated and the necessary time correction bits are added or deleted in the next injection message to the satellites.

The central computing center continually accepts satellite data inputs from the four tracking stations and the Naval Observatory. Periodically, to obtain fixed orbital parameters for a satellite, the central computing center computes an orbit for each satellite that best fits the Doppler curves obtained from all tracking stations. Then, using the computed orbital shape, the central computing center extrapolates the position of the satellite at each even 2-minutes in universal time for the 12 to 16 hours subsequent to data injection. These various data inputs are supplied to the injection stations via the control center, as are data on the nominal space of the orbits of the other satellites, commands and time correction data for the satellite, and antenna-pointing orders for the injection station antennas.

The injection stations, after receiving and verifying the incoming message from the central computing center, store the message until it is needed for transmission to the satellite. As soon as the receiving equipment at the injection station receives and locks on the satellite's signals, the injection station reads the

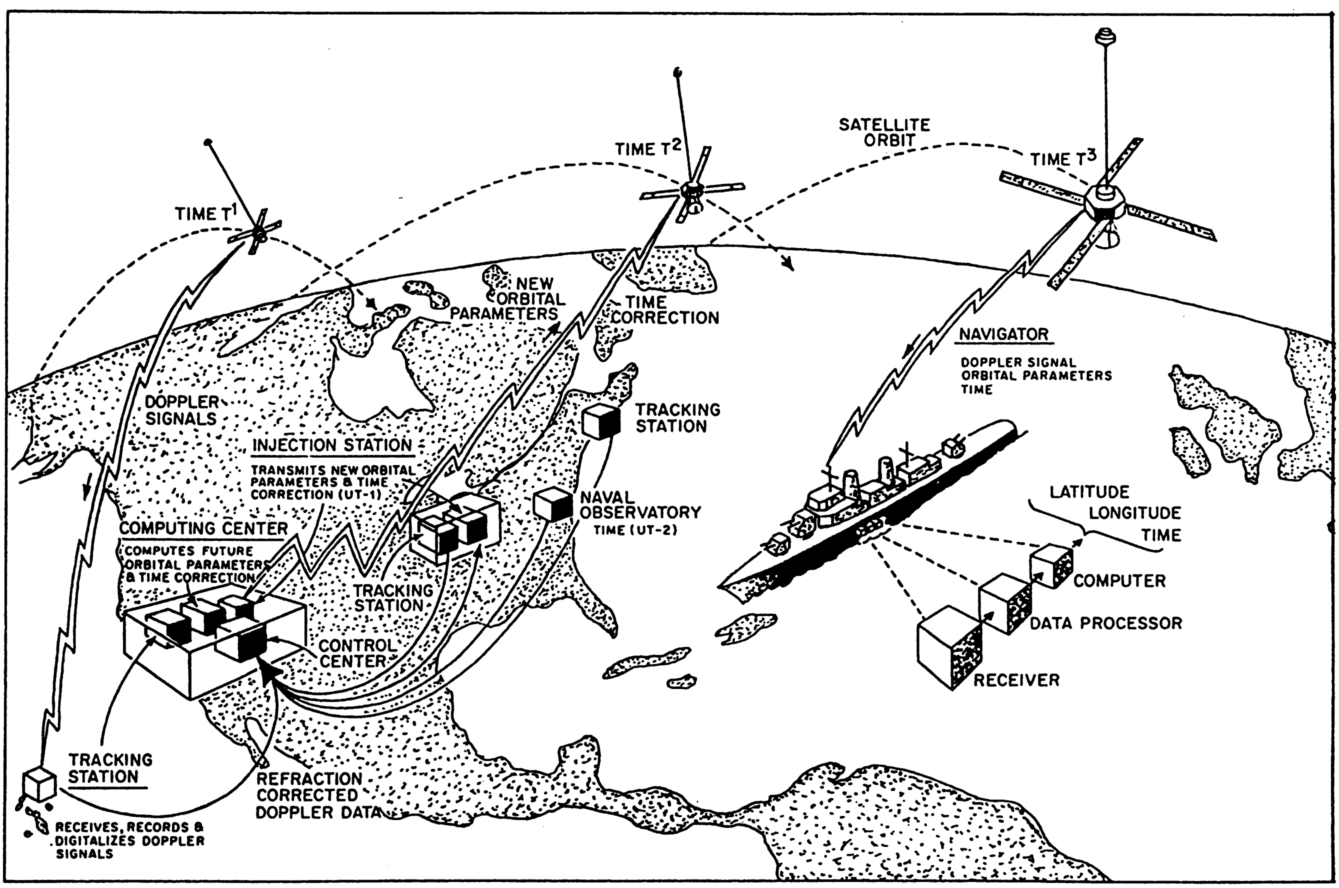


Figure 13-10.–Navy navigation satellite system.

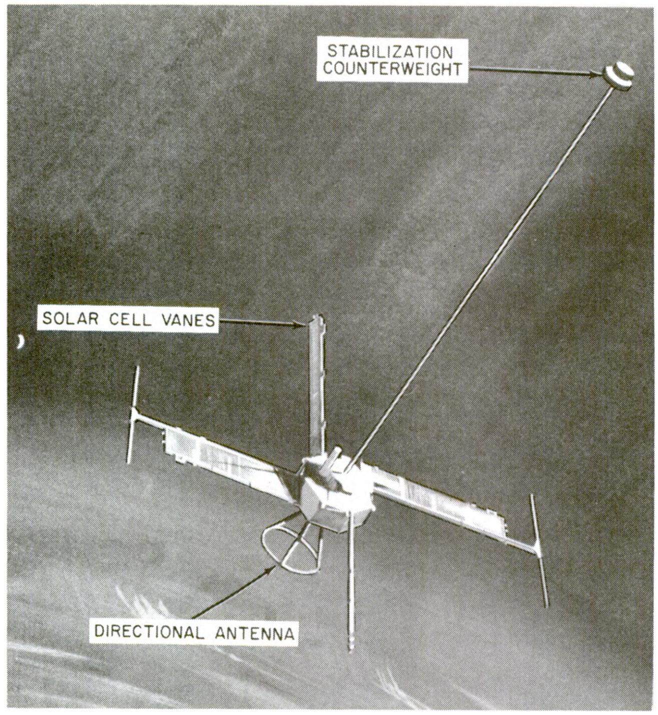
injection data and the commands from storage, then transmits them to the satellite. Transmission to the satellite is on a frequency different from those frequencies used by the satellite, and the bit data rate is much higher; therefore, injection is completed in a matter of seconds. Once data injection is completed, the satellite continues to transmit at the normal 2-minute intervals.

The system satellites are launched as nearly as possible into circular polar orbits at altitudes of from 450 to 700 miles. Typically, a system satellite (fig. 13-11) is about the size of the large snare drum used in a marching band and weighs between 110 and 160 pounds. It is solar-powered, with electrical energy collected by four solar cell vanes (blades) and stored in batteries within the satellite. A transmitting "lampshade" type directional antenna is mounted on its base, and receiving "rod" antennas are located at opposite ends of two solar blades. In orbit, the solar blades are extended to form an X with the payload in the center. A 100-foot spring steel boom, weighted at the end with a stabilization counterweight, is extended upward from the top of the spacecraft to keep the transmitting antenna always pointing at the target, earth.

Although successive models may differ, each system satellite basically contains the following components:

1. Receiver equipment to accept injection data and operational commands from the ground
2. A decoder for converting the data to digital format, plus switching logic and memory banks for sorting and storing the digital data, and pulse control circuits to cause the data to be read out at specific times in the proper format
3. An encoder to translate the digital data to phase modulation
4. Ultrastable 5-MHz oscillators and 1.5-watt transmitters to broadcast the 150- and 400-MHz oscillator-regulated frequencies that carry the data to earth

Any spot on earth rotates within range of a single circular polar-orbiting satellite at least twice a day. Therefore, a navigation satellite system is operable with one satellite. To provide more frequent availability, however, a constellation of satellites is used. For example, a constellation of five satellites criss-crossing at the poles in orbits that are equally separated as they cross the equator provides contact anywhere on earth on an almost hourly basis.



120.95

Figure 13-11.–Navigation satellite.

The satellites supply two important outputs to the fleet: the stable carrier frequencies that are generated by the satellites, and the data that they carry, which is updated by the ground system at regular intervals. The data, phase modulated on the carrier signals, contains the current satellite time and the orbital parameters of the satellite. Each satellite is designed to receive, sort, and store data transmitted from the ground, and to retransmit this data at scheduled intervals as it circles the earth.

Each 2-minute satellite broadcast typically contains "words" used for recognition and time synchronization, followed by a 400-Hz audible "beep" (or standard time marker) used by navigators to find their place in the broadcasts. The navigation data itself contains fixed and updated variable parameters describing the present orbit of the satellite. Essentially, each satellite is telling users which satellite it is, what time it is according to the satellite "clock," and the satellite's present location. With this information, the user's navigation set knows exactly where the satellite is; one of the necessary steps toward determining a precise navigational position.

While the user's navigation set is receiving data providing the satellite position, it is also measuring the Doppler shift of the satellite signals and comparing them to determine where the navigation set is located in relation to the satellite. The navigation set associates the satellite outputs in real time, and prints out a fix in a short period of time. A description of the Doppler principle involved is presented in the paragraphs that follow.

System satellites placed in circular polar orbits from 450 to 700 miles in altitude yield optimum Doppler measurability coupled with maximum coverage and long life. They circle the earth at a tangential velocity of about 5 miles per second. Stable oscillator frequencies radiating from a satellite coming toward the receiver (T1, fig. 13-12) are first received at a higher frequency than transmitted, due to the velocity of the approaching satellite. The satellite's velocity produces accordion-like compression effects that squeeze the radio signals as the intervening distance shortens. As the satellite nears its point of closest approach, these compression effects lessen rapidly, until, at the moment of closest approach (T2), the cycle count of the received frequencies exactly matches that which is generated. As the satellite passes beyond this point and travels away from the receiver (T3), expansion effects cause the received frequencies to drop below the generated frequencies proportionally to the widening distance and the speed of the receding satellite.

Radio frequencies will yield an accurate cycle-count. By counting the cycles of the received signals at precise intervals, the amount of Doppler shift can be measured. Measurement of Doppler shift is complicated by the fact that satellite transmissions must pass through the earth's upper atmosphere on their way from space to the receiver. Electrically charged particles in the ionospheric layer refract satellite radio transmissions in much the same way that a prism refracts light. To solve this problem, system satellites are designed to broadcast simultaneously on two frequencies, each of which is refracted a different amount by the ionosphere. The receiver measures the difference in refraction between the two signals and supplies a signal to the computer. The computer uses this "refraction signal" as part of its computation to obtain more accurate fixes.

The time of zero Doppler is the time of the satellite's closest approach to the receiver. The slope of the curve at that time is a measure of the slant range from the receiver to the satellite. Measurement of Doppler shift against an offset frequency is the critical factor in an equation that establishes position on earth in relation to a satellite of known orbit. At a given instant, that particular curve can be acquired at only one point on earth in relation to that satellite. Given the orbital parameters of a satellite, (with each satellite constantly transmitting its position) and the Doppler shift of the signal transmitted from that satellite, it is possible to obtain a navigational fix whenever and wherever the satellite passes within radio line-of-sight, providing that a minimum of three 2-minute messages are obtained from a satellite whose angle of closest approach is between 15° and 75° above the horizon. For more theory on satellite navigation systems, refer to *Electronics Technician 3 & 2*, NAVEDTRA 10197.

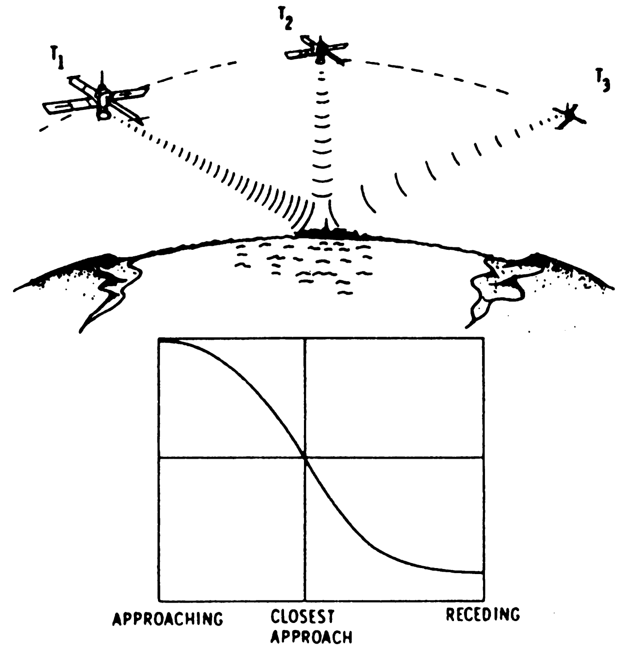


Figure 13-12.–Doppler shift relative to satellite transmitted frequency.

The two most common satellite navigation systems are the AN/WRN-5 and AN/SRN-19, which are described in the following paragraphs.

AN/WRN-5(V) SATELLITE NAVIGATION SYSTEM

The AN/WRN-5 (fig. 13-13) is a receiver-data processor-display set designed to receive and phase track signals transmitted by satellites of the Navy Navigation Satellite System (NNSS). These signals are processed to obtain navigation information, which is monitored on video displays and used elsewhere for ship navigation.

The AN/WRN-5 is designed to be used in various configurations of the equipment as described below. Each of these configurations is defined by options in external equipment used or variations in inputs and

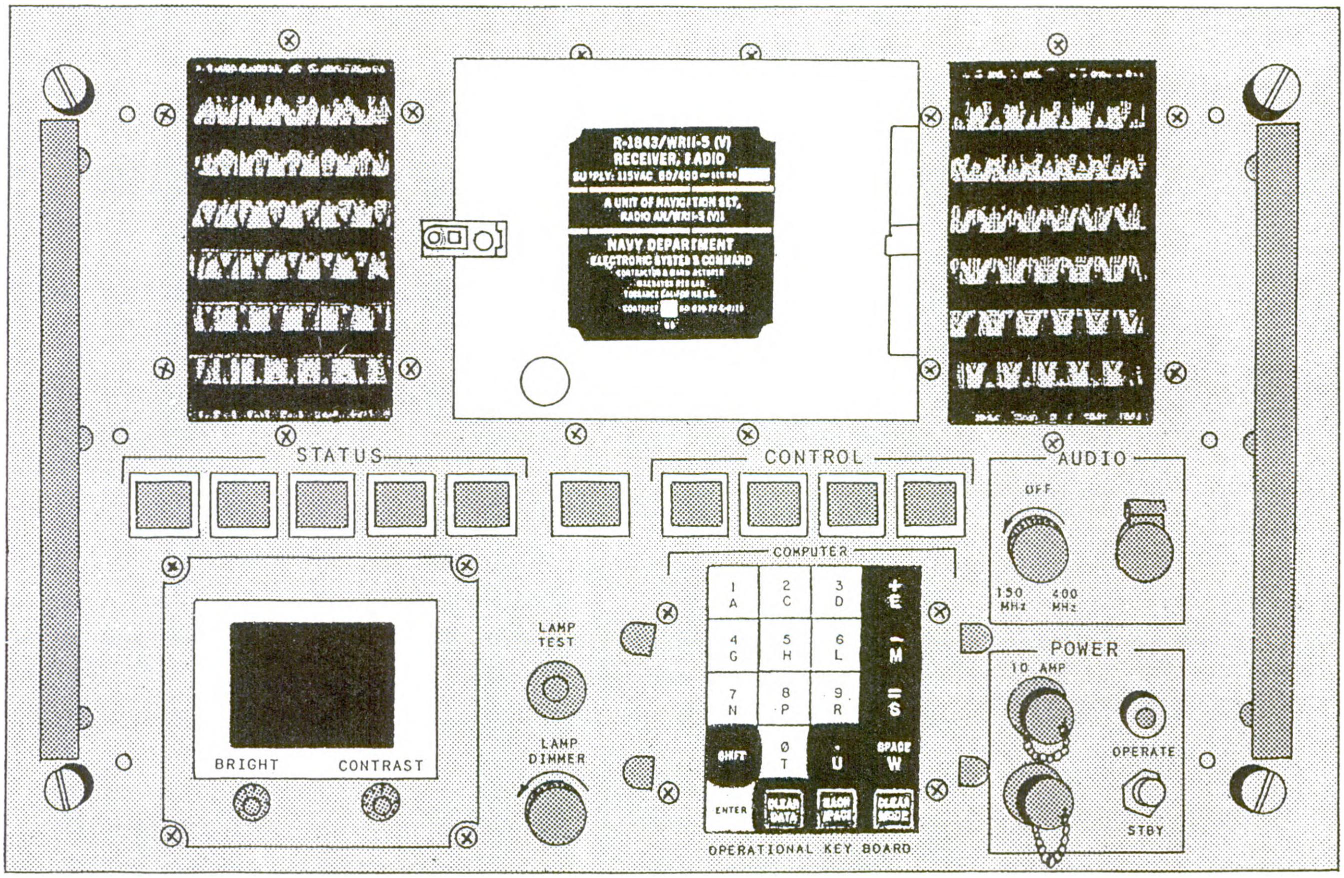


Figure 13-13.–AN/WRN-5 front panel.

outputs. The options available for alternate configurations are as follows:

1. Teleprinter, ASR-33
2. Additional Remote Video Displays(s), IP-1154(U)
3. Frequency Standard, AN/URQ-10/23 (external reference)
4. Dual Antennas (separate 400 MHz and 150 Mhz antennas)
5. Input/output bus
6. External lock indicator
7. 100-KHZ output

The functional elements of the AN/WRN-5 include the following components:

1. Preamplifier unit
2. Built-in two channel receiver
3. Built-in expanded data processor unit (XDPU) with 16K word memory
4. Front panel keyboard for operator to system interface
5. Front panel magnetic tape cassette transport with read/write capability for program loading or data recording
6. Front panel video display for system to operator input/output
7. Remote video monitor
8. Built-in synchro to digital converter for interface with the ship's speed and heading sensors to provide dead reckoning capability and accurate satellite position fixes during ship maneuvers
9. Optional addition of a teleprinter

The combination of functional elements in the AN/WRN-5 provide many capabilities including automatic storage of satellite information, time ordered alerts for up to eight satellites, and built-in/self-test. The front panel video display can provide current time, latitude/longitude, dead reckoning position (automatically updated by satellite fixes), and satellite tracking information (i.e., fix merit, and satellite alerts.)

AN/SRN-19(V)2 RADIO NAVIGATION SET

The AN/SRN-19(V)2 is an automatic shipboard navigation set that provides a continuous display of the ship's position. The ship's position, which is maintained by dead reckoning on ship true speed and heading, is periodically corrected by satellite fixes.

Specifically, the navigation set can perform the following functions:

1. After each successful satellite pass, computes and displays the present location of the ship to a nominal at-sea accuracy of 0.25 nautical mile
2. Dead reckons between satellite fixes
3. Computes and displays the great circle range and bearing from the present position to any location
4. Computes and displays the next expected rise time and elevation at the closest approach of the previously tracked satellite
5. Displays time accurate to 1 second (in 5-second increments)
6. Displays speed and heading
7. Displays set and drift
8. Displays data on tracked satellite
9. Self-tests itself and displays fault indication should a failure occur (self-test functions are limited to verification of the digital circuitry)

The AN/SRN-19(V)2 Radio Navigation Set consists of the following. major components (fig. 13-14):

ANTENNA GROUP

The antenna group consists of the antenna and the rf amplifier.

Antenna

The antenna is a linear, vertically polarized type that receives rf signals transmitted by the satellite. The antenna pattern is omnidirectional in the horizontal plane. The vertical pattern varies approximately 11 dB from 10504 to 70504 above the horizontal plane.

RF Amplifier

The rf amplifier provides initial amplification of the 400-MHz satellite signals from the antenna. The amplified signals are then connected via rf coaxial cable to the receiver for further amplification and processing.

RECEIVER-PROCESSOR

The receiver-processor contains the electronics to process rf inputs from the rf amplifier, ship EM log, gyro-compass, and receiver-processor keyboard. The receiver-processor then performs the navigational computations and provides required outputs.

Receiver

The receiver extracts, amplifies, and formats message information from the rf signal transmitted by the satellite, and measures the Doppler shift of the signal. The reconstructed Doppler shift of the satellite signal results from relative motion between the receiver and the satellite. The message data obtained by demodulation of the rf carrier describes the satellite's position at the time of transmission.

Data Processor

The data processor processes inputs from the receiver, the ship EM log, gyrocompass (through converters), and the keyboard. The processor then performs computations and provides the desired outputs

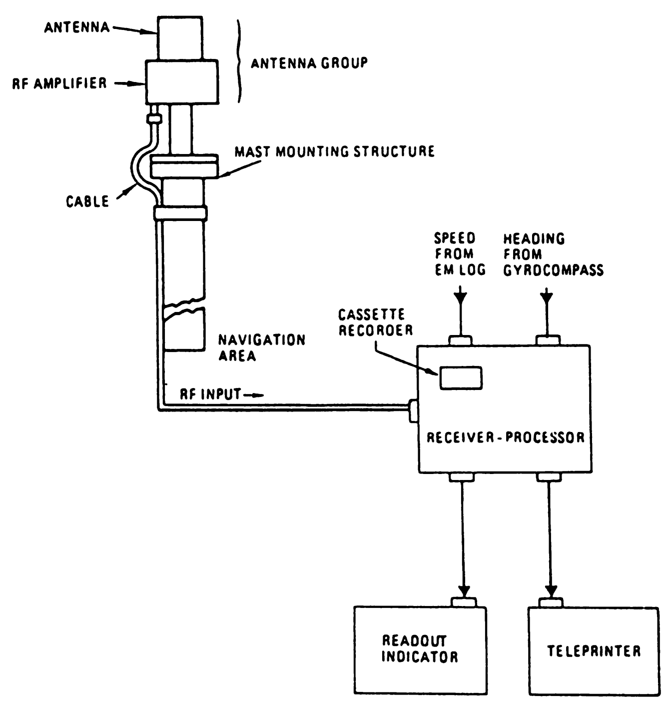


Figure 13-14.–AN/SRN-19(V)2 Radio Navigation Set simplified.

to the front panel display, readout indicator, teleprinter, and cassette recorder.

READOUT INDICATOR AND TELEPRINTER

The readout indicator and the teleprinter provide visual outputs from the system.

One final note on the AN/SRN-19 system. The equipment must be "told" where it is when it is initialized. Information on antenna height must also be entered before the system can provide an accurate fix.

NAVSTAR GLOBAL POSITIONING SYSTEM

NAVSTAR GPS will become the primary reference navigation system for surface ships, submarines, and aircraft. A joint DOD/DOT policy statement calls for the following things to happen:

1. Phase out of military use of OMEGA and overseas LORAN-C in FY94
2. Phase out of TRANSIT in FY96
3. Phase out of military use and support of VOR/DME and land-based TACAN in FY97

NAVSTAR GPS is a space-based, radio navigation system that provides continuous, extremely accurate three-dimensional position, velocity, and timing signals to users worldwide. It consists basically of satellites, ground control, and user equipment, as shown in figure 13-15.

SATELLITES (SPACE SEGMENT)

Each satellite has atomic clocks for highly-accurate timekeeping. This is one of the most important elements in NAVSTAR GPS ranging and will be discussed later. There are 21 active operational and 3 active spare satellites that are in circular orbits with a 55-degree inclination to the earth. Each satellite makes a complete

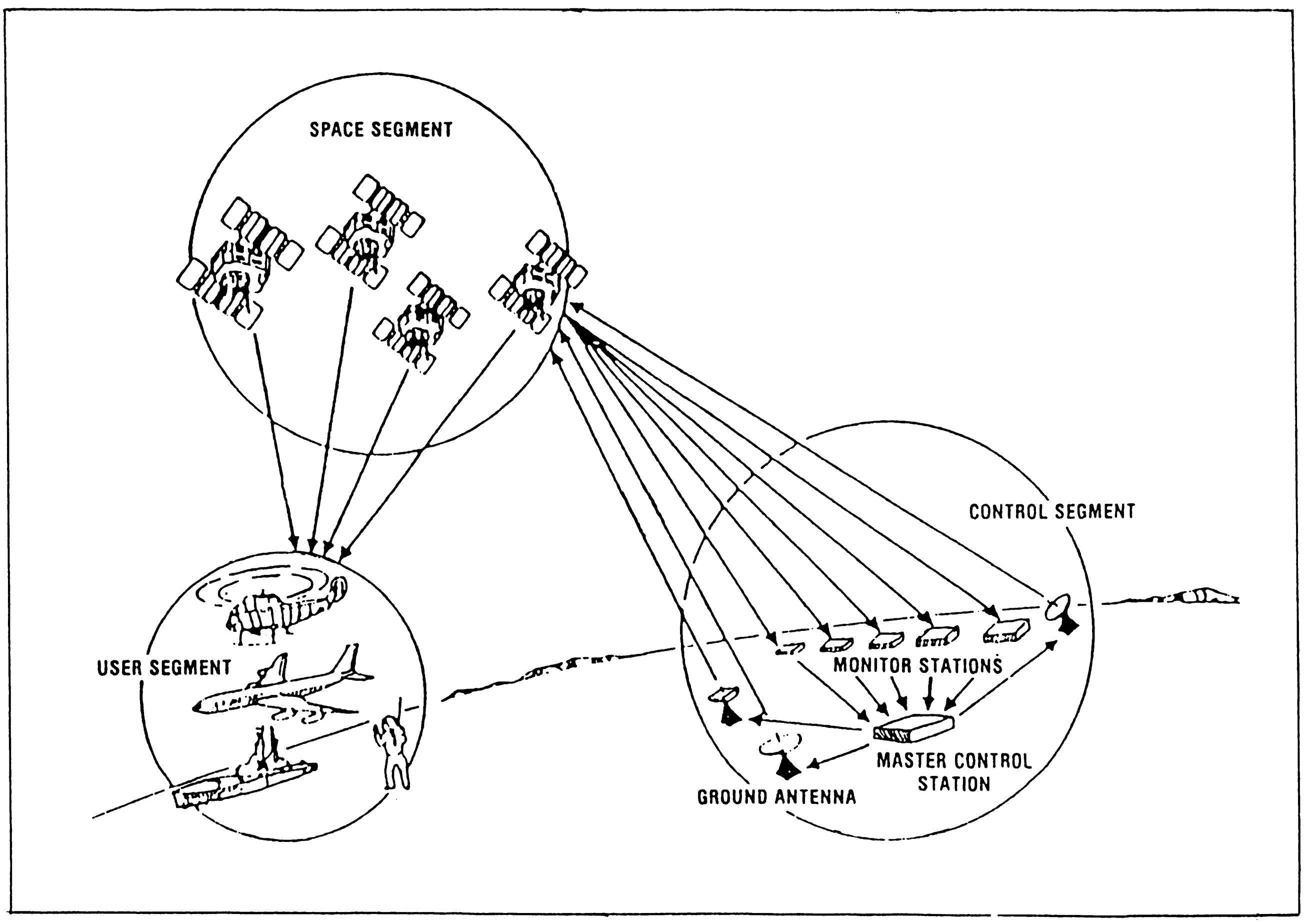


Figure 13-15.–NAVSTAR GPS major elements.

orbit of the earth every 12 hours. The transmitting frequencies are 1227.6 MHz and 1575.42 MHz using spread spectrum modulation. Each satellite is designed for a life of 7 1/2 years and is powered by solar energy supplemented by batteries.

An observer on the ground will observe the same satellite ground track twice each day; however, the satellite will become visible 4 minutes earlier each day due to a 4-minute per day difference between the satellite orbit time and the rotation of the earth. The satellites are positioned so that a minimum of four satellites are always observable by a user anywhere on earth.

The satellites transmit their signals using spread spectrum techniques, using two types of spreading functions:. Course Acquisition (C/A) code and Precise (P) code. The C/A code is available to any GPS user, military or civilian; but the P code is only available to US military, NATO military, and other users determined by the DOD.

Both P code and C/A code enable a receiver to determine the range between the satellite and the user. Since only the P code is on both frequencies, military users can make a dual-frequency comparison to compensate for ionospheric, propagation delay in the different transmission times. The C/A code user must use a model of the ionosphere that results in a lesser navigation accuracy. Superimposed on both codes is the NAVIGATION-message (NAV-msg), containing satellite ephemeris data, atmospheric propagation correction data, and satellite clock-bias information.

GROUND CONTROL (CONTROL SEGMENT)

In the control segment, satellites are tracked and their position coordinates and timing information are updated daily. The control segment includes an operations center, four monitor stations, and three ground antennas. The operations center will calculate signal accuracy. The monitor stations passively track the satellites, and the antennas relay data to the satellites.

USER EQUIPMENT (USER SEGMENT)

User equipment is installed in ships, aircraft, and motorized vehicles. The latter version can be carried by personnel as a manpack. SEAL teams and other special forces units use the manpack version. Also, GPS can be used as high up as 500 miles above the Earth's surface for space shuttle navigation. The most common shipboard receiver, AN/WRN-6, will be described later in this chapter.

When the GPS receiver has acquired the satellite signals from four GPS satellites, has achieved carrier and code tracking, and has read the NAV-msg, it is ready to start navigating. The GPS receiver normally updates its pseudorange and relative velocities once every second. The next step is to calculate the GPS receiver position, receiver velocity, and GPS system time. The GPS receiver must know GPS system time very accurately because the satellite signals indicate to the GPS receiver the time of the transmission from the satellite.

The GPS receiver uses system time as the reference time for when it receives the satellite signals. The difference in time between when the signal leaves the satellite and when it arrives at the GPS receiver antenna is directly proportional to the distance between the satellite and the receiver. Therefore, the same time reference must be used by both the GPS satellites and the GPS receiver. The clock in the GPS receiver is not nearly as expensive as the atomic clock used in the satellites, because such a clock would make the receiver too expensive. Instead, a less expensive crystal oscillator is used and the receiver corrects its offset from GPS system time in the following way:

The GPS receiver makes four pseudorange measurements. The measurements are pseudoranges because the receiver's own clock offset introduces a bias to the true range to the satellites. The receiver needs four pseudoranges to solve four simultaneous equations with four unknowns. When the four equations are solved, the GPS receiver has estimates of its position and GPS system time. The GPS receiver velocity is calculated using the same types of equations as those used for position and time calculation, using relative velocities instead of pseudoranges.

SATELLITE RANGING

GPS ranging is based on triangulation using known positions of satellites as reference points. However, knowing the exact position of the satellite is a difficult task, so GPS relies heavily on transmission time. Position with reference to a satellite is based on the length of time the transmitted signal takes to get from the satellite to the receiver. We know the velocity of RF energy and the frequency of the transmission. Therefore we must only solve a simple equation to find our position relative the satellite. The basic concept of satellite ranging is shown in figure 13-16 and described as follows:

1. Determine the distance to one satellite (figure 13-16, view A). This places you in a sphere that is centered on the satellite and has a radius equal to the distance to the satellite.
2. Determine the distance to another satellite (figure 13-16, view B). This second measurement places you in another sphere; however, your location is now narrowed down to a circle. This circle is created by the intersecting of the first and second spheres.
3. Determine the distance to a third satellite (figure 13-16, view C). There are only two points on the earth where all three spheres intersect. Our position is easily determined because one of those two points is obviously not correct due to its altitude or distance from our estimated position.
4. Determine the distance to a fourth satellite (figure 13-16, view D). Since there is only one point on earth where all four spheres could possibly converge, we have a precise fix.

The GPS can determine position fixes within 50 feet or less and is accurate to within a tenth of a meter per

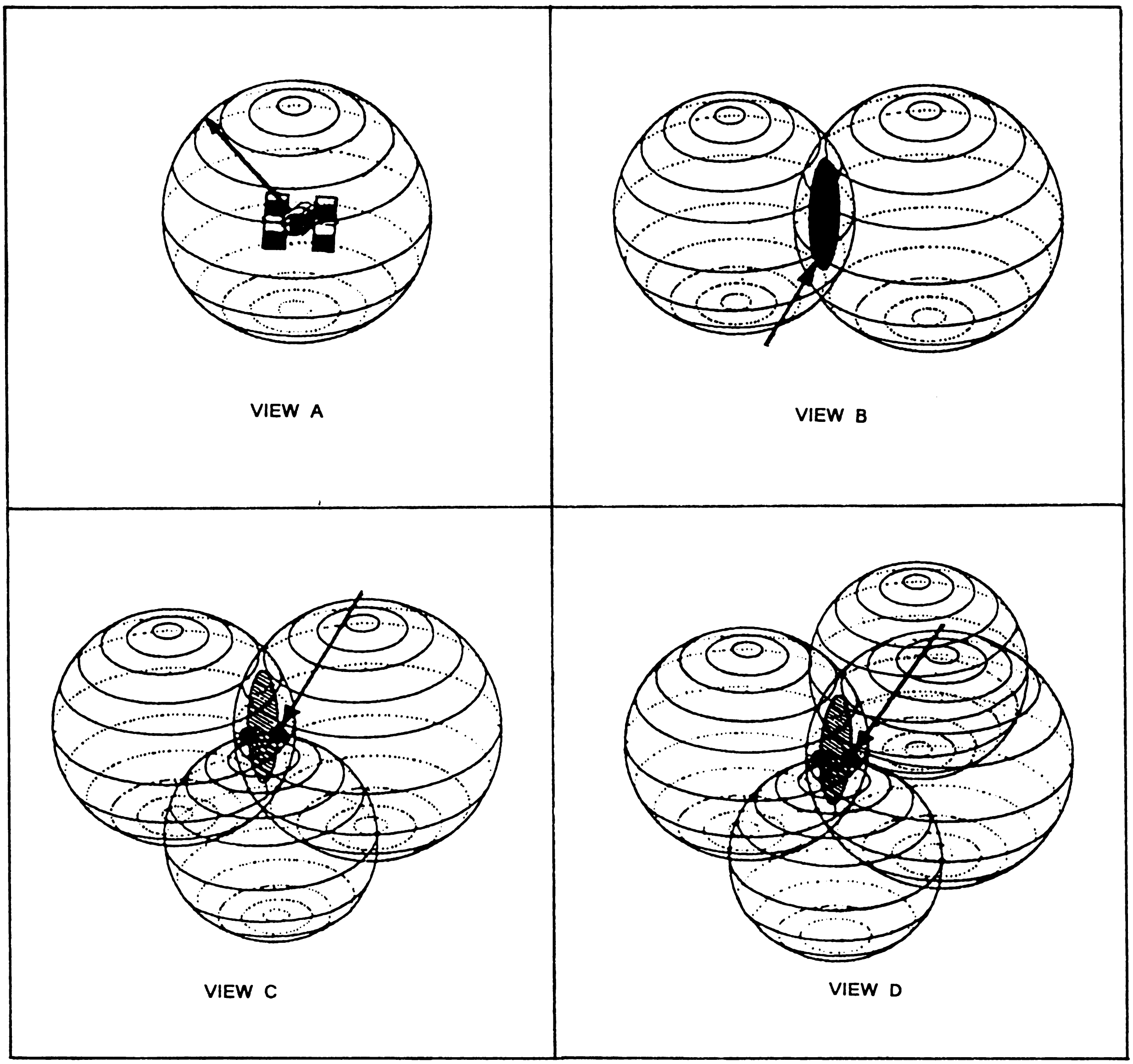
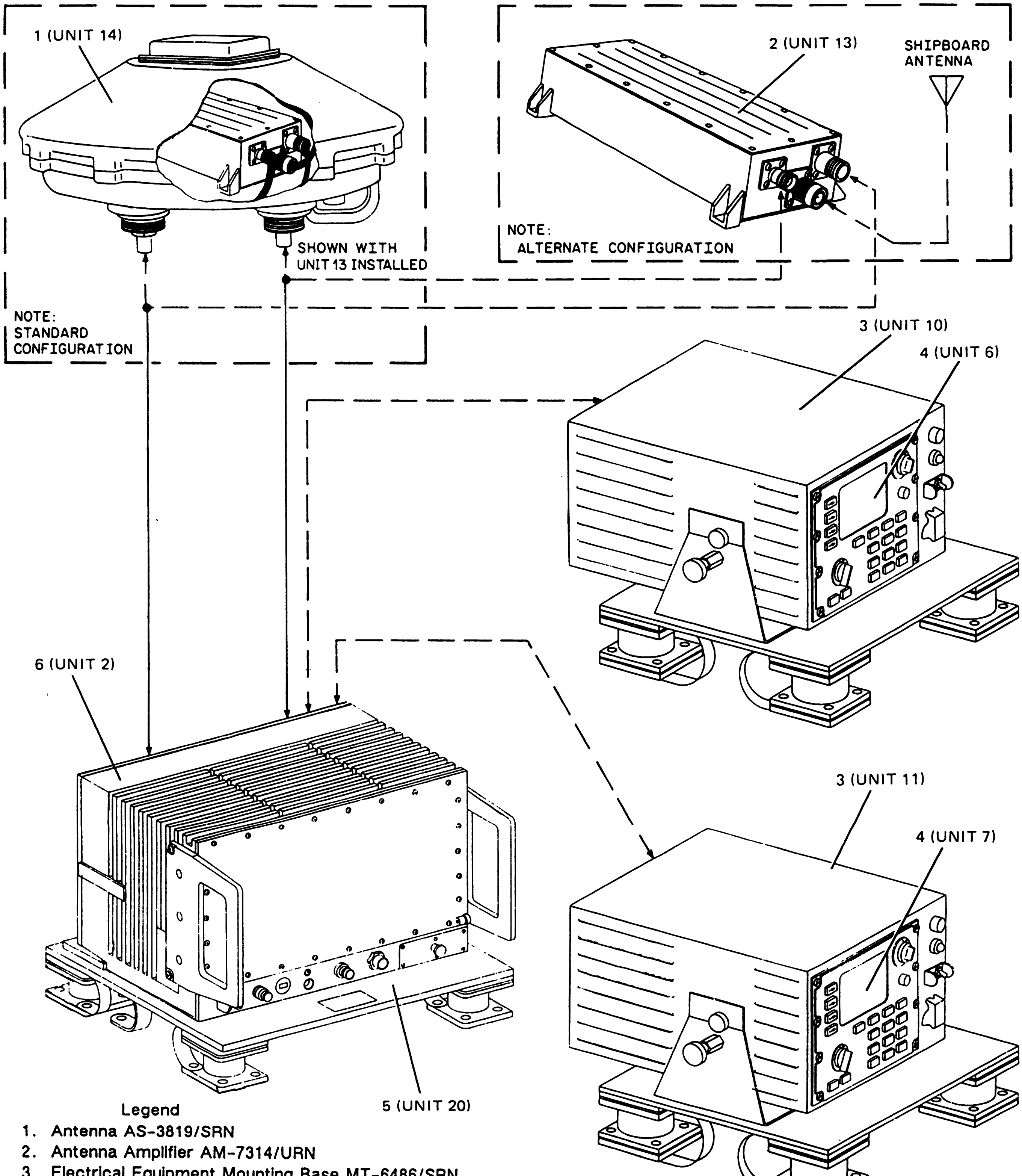


Figure 13-16.–Determining GPS location.



Legend
1. Antenna AS-3819/SRN
2. Antenna Amplifier AM-7314/URN
3. Electrical Equipment Mounting Base MT-6486/SRN
4. Indicator Control C-11702/UR
5. Electrical Equipment Mounting Base MT-6586/S
6. Radio Receiver R-2331/URN

Figure 13-17.–AN/WRN-6(V).

Table 13-1–AN/WRN-6(V) Variants

	Surface-Ships/Submarines							
AN/WRN-6(V) LRUs	(V)1	(V)2	(V)3	(V)4	(V)5	(V)6	(V)7	(V)8
RECEIVER, R-2331/URN	1	1	1	1	1	1	1	1
ELEC EQUIP MOUNTING BASE, MT-6586/S	1	1	R*	R*	R*	R*	1	1
INDICATOR CONTROL, C-11702/UR	2	1	1	2	2	1	1	2
ELEC EQUIP MOUNTING BASE, MT-6486/SRN	2	1	1	2	R*	R*	1	2
ANTENNA, AS-3819/SRN	1	1	1	1	1	1		
ANT AMP, AM-7314/URN	1	1	1	1	1	1	1	1

"R*" indicates the equipment is rack mounted and does not use an electrical equipment mounting base.

second for velocity and 100 nanoseconds for time. Other characteristics of the GPS are as follows:

- Continuous availability of fix information in all kinds of weather
- User-passive; for example, signals are received from the satellites without risk of giving away the location of the receiver
- Resistant to imitation and jamming of signals
- Use can be denied to the enemy

The GPS receivers are able to automatically convert from one grid system to another at the user's choice. Although this system will make some other navigation systems obsolete, inertial navigation will remain because it is self-contained and cannot be jammed. Additionally, the inertial navigation and global positioning systems complement each other. The GPS can be used to align the inertial navigation system, and in turn, the inertial navigation system can assist the GPS in its satellite acquisition and tracking.

Although each satellite continuously transmits time, position, and velocity information, a receiver must process signals from four satellites to get full use from the GPS.

AN/WRN-6(V) SATELLITE SIGNALS NAVIGATION SET

A shipboard navigation system that uses GPS is the AN/WRN-6(V) shown in figure 13-17. This system computes accurate position coordinates, elevation, speed, and time information from signals transmitted by GPS satellites. In the P mode, it has an accuracy of 16 meters and in the C/A mode it has an accuracy of 100 meters, although better results have been reported by individual users. Table 13-1 shows the various configurations of the AN/WRN-6(V). The two major components of the set, the receiver and the indicator control are described below. The other units depicted in figure 13-17 perform functions similar to those same units in other systems. For more detailed information, refer to the appropriate equipment technical manual.

Radio Receiver R-2331/URN

The R-2331/URN (fig. 13-17) is the receiver/processor for the AN/WRN-6(V). The electronic assemblies are housed in a shock- and damage-resistant chassis and accessed via a cover assembly. Input/output connections are provided on both the front and rear of the chassis. Three C-cell alkaline batteries are used to save critical memory contents when primary power is

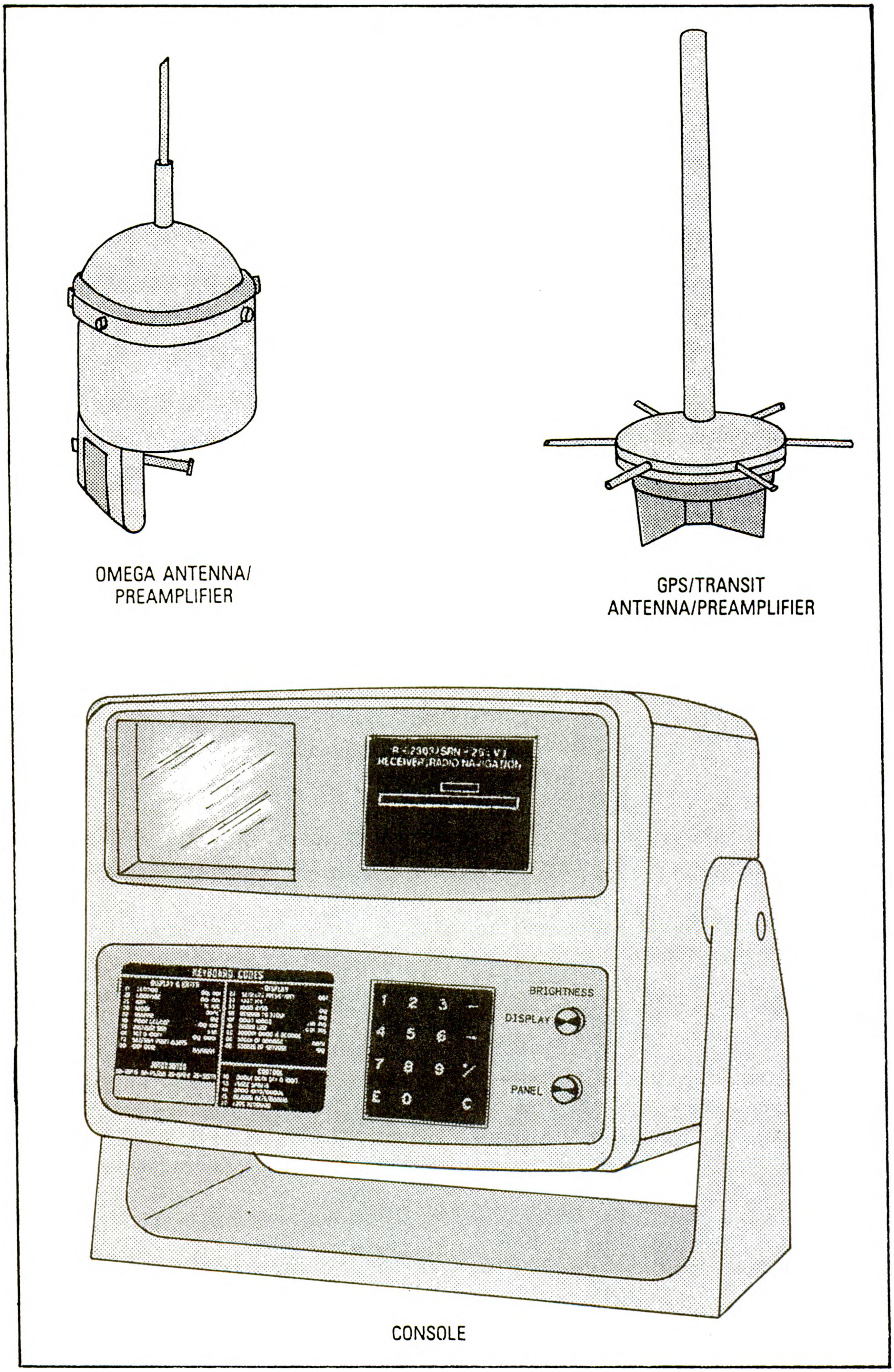


Figure 13-18.–AN/SRN-25(V)1 Radio Navigation Set.

lost. The R-2331/URN also contains operator controls and indicators.

Indicator Control C-11702/UR

The C-11702 indicator control is used as an operator input/output interface for the system.

RADIO NAVIGATION SET AN/SRN-25(V)1

The AN/SRN-25(V)1 (fig.13-18) is a highly integrated navigation system that uses data from GPS and Transit satellites and Omega ground stations in computing position. The AN/SRN-25 contains a single-channel Transit receiver, a two-channel GPS receiver, a three-channel Omega receiver, a data entry keyboard, a display unit, a digital processor, a power supply, and a battery back-up system for use in case of temporary loss of external power. The navigation program for the digital processor is permanently stored in a read-only memory. There are separate reference oscillators for the Transit and GPS systems. An RF frequency converter module allows interfacing to an external frequency standard in the AN/SRN-25. All components except the antennas are located within the console chassis. No external units are required; however, interface connections are provided on the back panel so that external equipment may be connected if desired. With the proposed shutdown of the Transit and Omega systems, this equipment may not be widely dispersed in the fleet.

TACTICAL AIR NAVIGATION (TACAN)

TACAN is a polar-coordinate type radio air-navigation system that provides an aircraft with distance measuring equipment (DME) and bearing information. Usually, a meter in the aircraft indicates, in nautical miles, the distance of the aircraft from the surface beacon. Another meter indicates the direction of flight, in degrees-of-bearing, to the geographic location of the surface beacon (fig. 13-19). The pilot can use the bearing and distance from a specific beacon, identified by its identification signal to fix his geographic position.

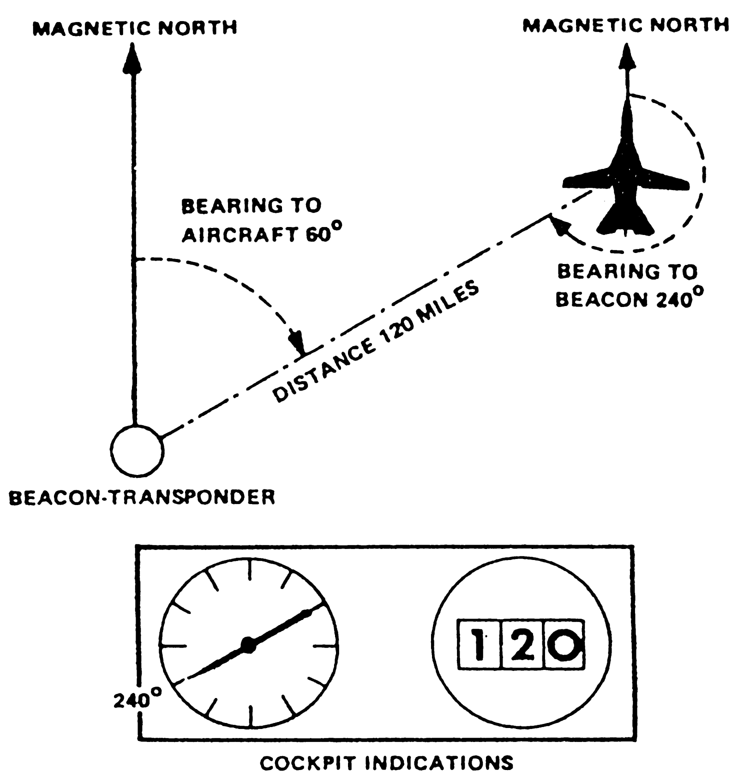


Figure 13-19.–TACAN aircraft indications.

TACAN PRINCIPLES

The distance measuring concept used in TACAN equipment is an outgrowth of radar-ranging techniques; i.e., determining distance by measuring the round-trip travel time of pulsed rf energy. The return signal (echo) of the radiated energy depends on the natural reflection of the radio waves. However, TACAN beacon-transponder facilities, located at specific geographic positions, generate artificial replies rather than depending upon natural reflection. The airborne equipment generates timed interrogation pulse pairs that are received by the surface TACAN system and decoded. After a 50 µsec delay, the transponder responds with a reply (fig. 13-20). The round trip time is then converted to distance from the TACAN facility by the airborne DME. The frequency and identification code provides the geographic location of the transmitting beacon.

TACAN Pulse Pairs

All TACAN pulse signals, generated by either the airborne or ground equipment, are pulse pairs spaced 12 sec apart (for all "X" channels). The transponder uses a twin-pulse decoder to pass only pulse pairs with the proper spacing. The purpose of the twin-pulse technique is to increase average power radiated, and to make the TACAN system less susceptible to false signal interference. Once the interrogation is decoded by the receiver, an encoder will generate the necessary pulse pair required for the transponder's reply.

Constant Transponder Duty-Cycle

In principle, the TACAN transponder need only reply to aircraft interrogations to supply the necessary distance data. However, the total pulse output of the transmitter would constantly vary according to the number of interrogating aircraft. For azimuth information to be supplied, the average power supplied to the antenna must be relatively uniform over time. To accomplish this, the transponder is operated on the constant-duty-cycle principle.

In this method of operation, the receiver has automatic gain and squitter (noise-generated output) controls that maintain the receiver at a constant pulse output (fig. 13-21). If few interrogations are being received, the squitter and gain of the receiver will increase and add noise-generated pulses until the constant pulse output is obtained. If more interrogating aircraft come into range, the gain and squitter will decrease to maintain constant pulse output. If more than 100 aircraft interrogate, typically only the strongest 100 will generate replies from the transponder.

Beacon-Transponder Identification Code

To provide aircraft with positive identification of the replying transponder, an identification feature is

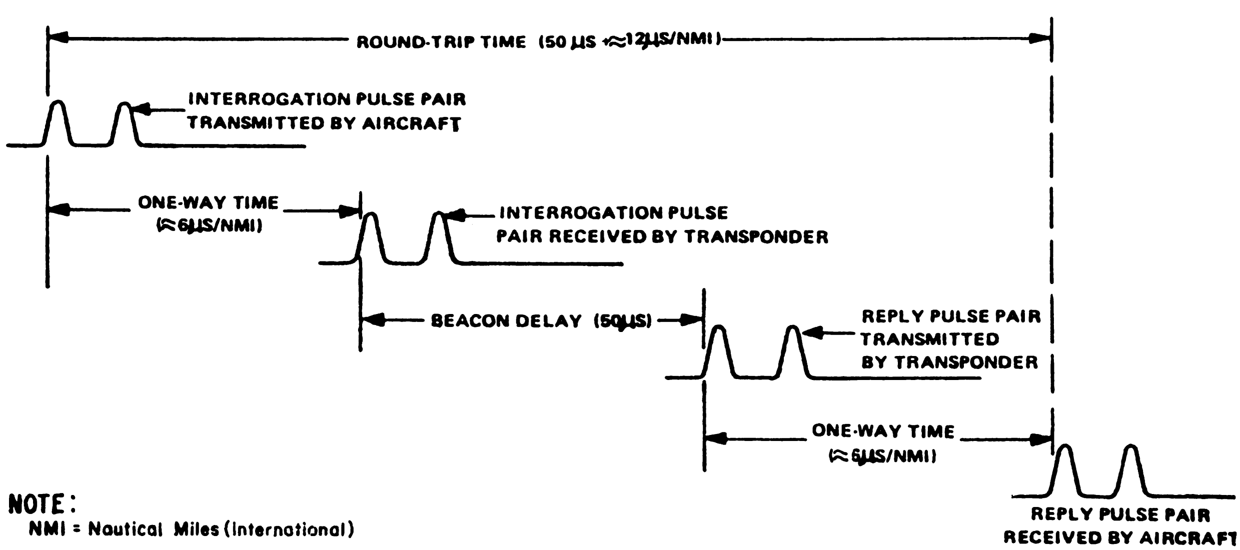


Figure 13-20.–Distance measurement round-trip travel time.

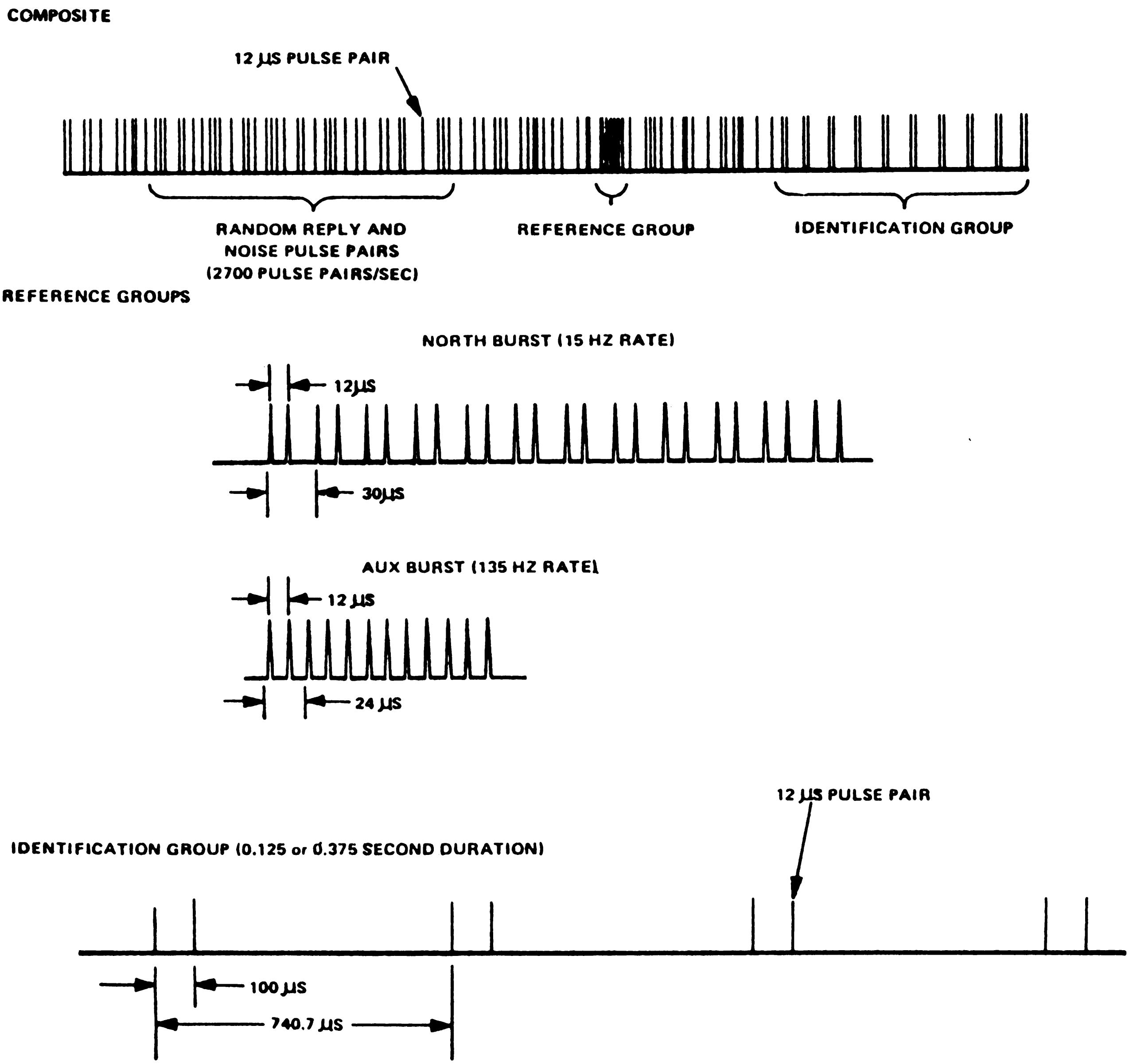


Figure 13-21.–Transponder output pulse train.

necessary. To meet this need, an identification code is transmitted at approximately one-half minute intervals. This is done by momentarily interrupting the transponder distance data and squitter-generated output and substituting pulse groups spaced at a 1350-pps rate. Each pulse group contains two sets of 12 µsec pulse pairs spaced 100 µsec apart. The duration of the identification pulse groups varies to represent Morse-coded characters. The duration for a dot is 0.125 second, and for a dash 0.375 second. (See fig. 13-21.)

15-Hz Bearing Information

The timing of the transmitted pulses is used to supply distance information to the aircraft. This leaves amplitude modulation as another medium for the transponder to convey information to aircraft. The TACAN beacon-transponder modulates the strength of the pulse to convey bearing information by producing a specified directional-radiation pattern rotated around a vertical axis. This signal, when properly referenced, identifies the aircraft direction from the TACAN facility. This, and distance data, give a two-point fix for specific aircraft location.

The rf energy from the transmitter is fed to a stationary central element in the antenna that has no directivity in the horizontal plane. A vertical, parasitic element is rotated around the central element at 15 revolutions per second. The distance between the central element and the parasitic element is established to obtain a cardioid radiation pattern (fig. 13-22). To an aircraft at a specific location, the distance-data pulses would contain a 15-Hz amplitude-modulated signal due to the rotation of the cardioid radiation pattern.

Bearing information can now be obtained by comparing the 15-Hz modulated signal with a 15-Hz reference burst signal received from the ground facility. The phase relationship between the 15-Hz modulated signal and the 15-Hz reference burst signal will depend on the location of the aircraft in the cardioid pattern. The 15-Hz reference burst signals are transmitted when the maximum signal of the rotating cardioid pattern aims due east (fig. 13-22). The reference signals are

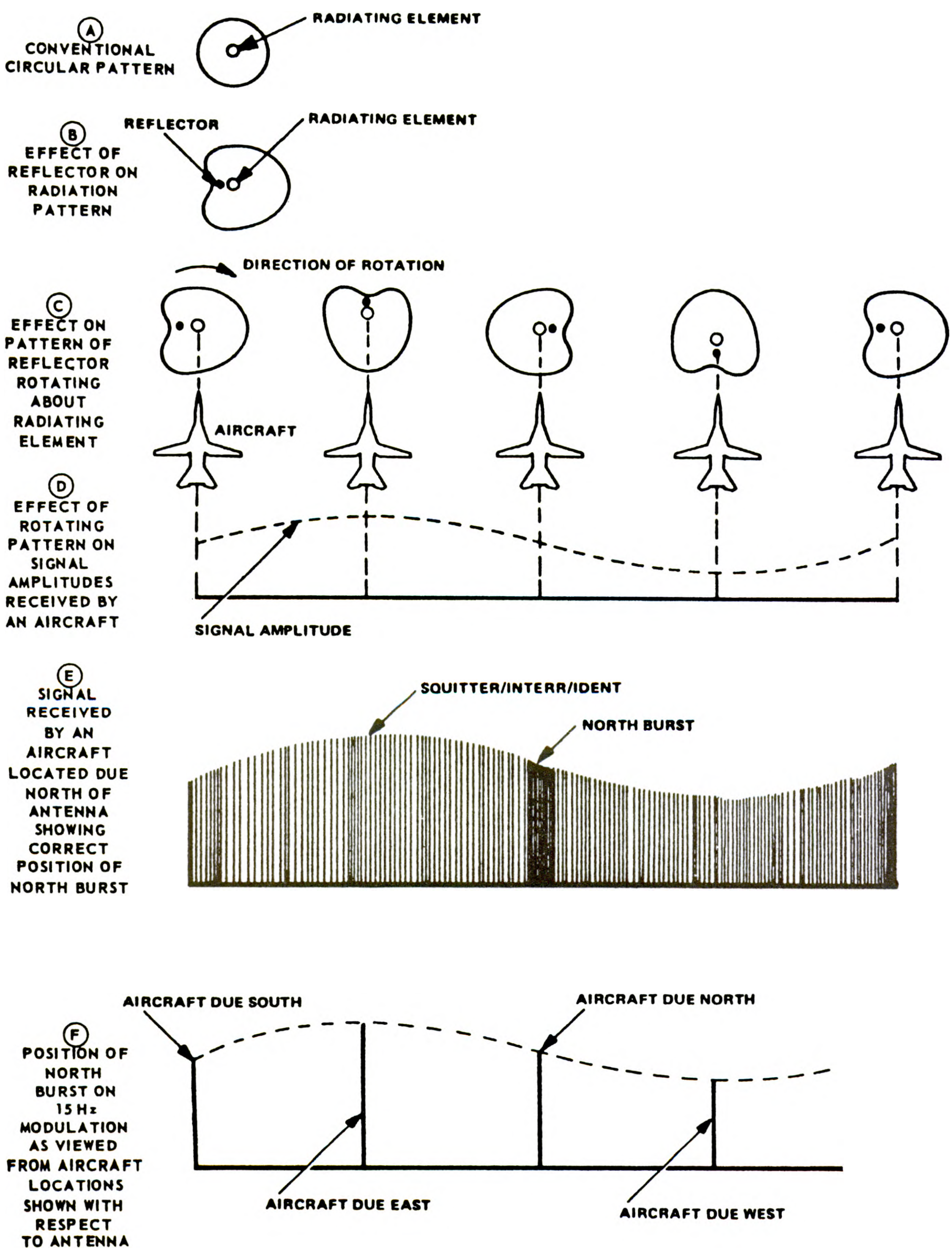


Figure 13-22.–Development of radio beacon radiation (15 Hz only).

distinguished from the distance data by transmitting a burst of 12 pulse-pairs (12 μsec apart) spaced exactly 30 μsec apart. This group of 12 pulse pairs is commonly referred to as the North or main reference burst.

135-Hz Bearing Information

Errors in the single parasitic element system arise from imperfection of the phase-measuring circuits and radio propagation effect known as *site error*. The errors are significantly reduced by adding to the antenna a group of nine parasitic elements mounted 40 degrees apart (fig. 13-23). These nine parasitic elements rotate around the central elements with the single element and modify the antenna cardioid radiation pattern. Although the cardioid pattern is still predominant, it is altered by superimposed ripples. The maxima of these ripples, or minor lobes, are spaced 40 degrees apart. The aircraft now receives the 15 Hz with a 135-Hz ripple amplitude modulated on the distance data pulses (fig. 13-24).

To furnish a suitable reference for measuring the phase of the 135-Hz component of the envelope wave, the transponder is designed to transmit a coded 135-Hz reference burst similar to that explained for the 15-Hz reference. The 135-Hz reference burst is a precisely timed group of six pulse pairs (12 μsec apart) spaced exactly 24 μsec apart (fig. 13-21). In one rotation of the parasitic elements, eight 135-Hz reference bursts are

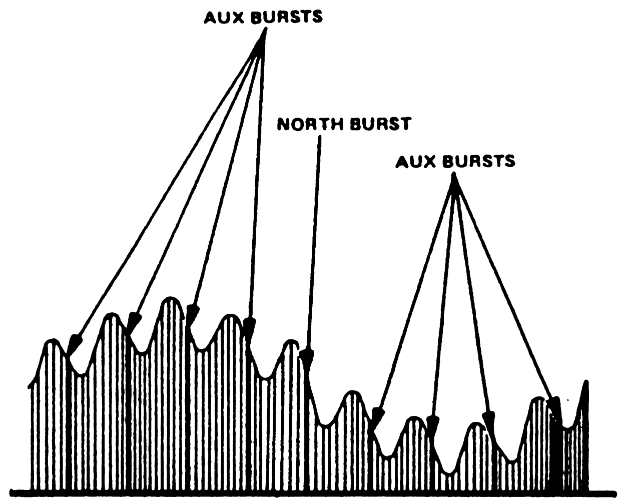


Figure 13-24.–Radio beacon radiated 15 Hz and 135 Hz pattern showing auxiliary and North reference burst as viewed from an aircraft located due north of beacon.

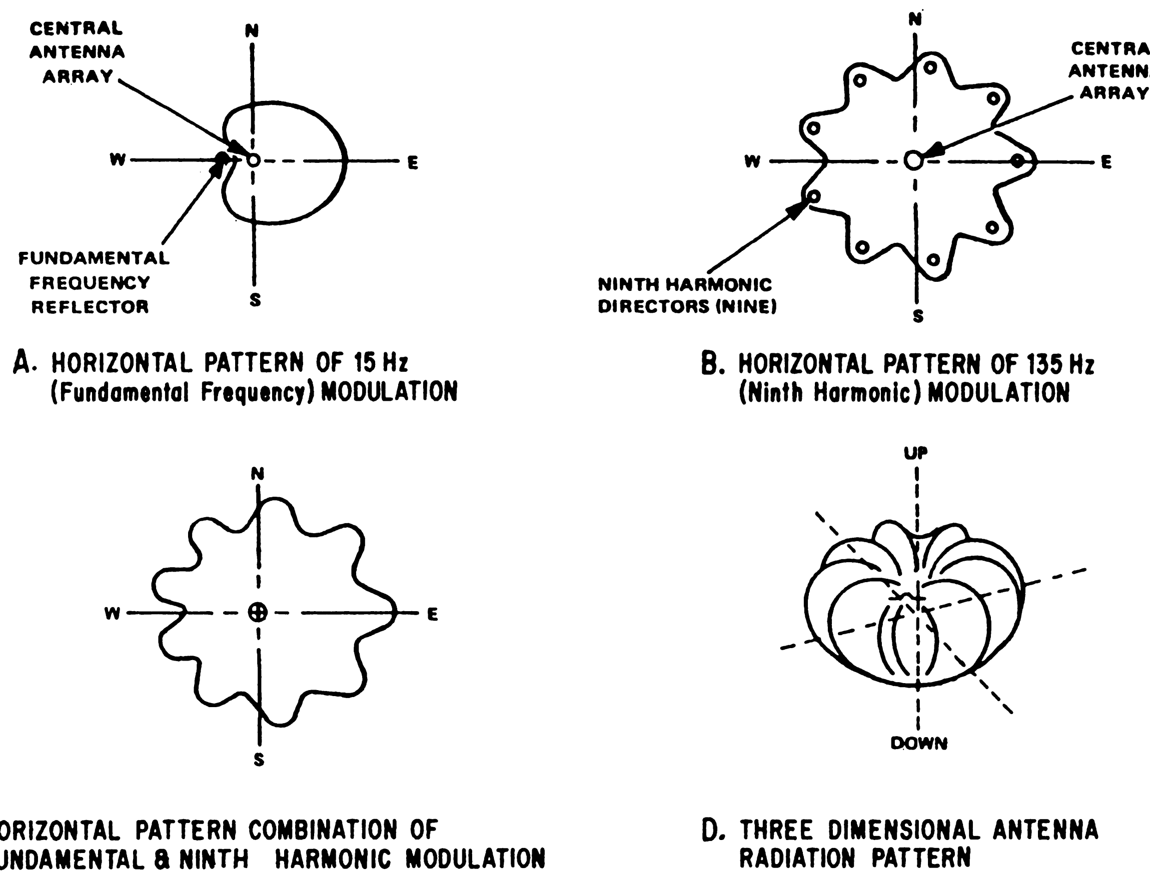


Figure 13-23.–Development of composite radiation pattern.

transmitted. The ninth group transmitted is the 15-Hz reference group. Each group is separated by 40 degrees of rotation. The 135-Hz reference group is commonly referred to as the auxiliary or aux reference burst.

The composite TACAN signal is composed of 2700 interrogation replies and noise pulse pairs per second, plus 180 north burst pulse pairs per second, plus 720 auxiliary burst pulse pairs per second for a total of 3600 pulse pairs per second, or 7200 pulses per second.

TACAN Signal Priorities

Priorities have been established for transmission of the various types of TACAN signals. These priorities are as follows:

1. Reference bursts (North and auxiliary)
2. Identification group
3. Replies to interrogations
4. Squitter

Therefore, the identification group, replies, or squitter will be momentarily interrupted for the transmission of either the main or auxiliary reference group. The transmission of replies or squitter will be interrupted every 37.5 seconds during the transmission of an identification code dot or dash.

Characteristics of Radio Beacon Signals

All signals transmitted by the radio beacon consist of pulse pairs with 12 µsec spacing between the two pulses of the pair. The number of pulse pairs per second and the spacings between pulse pairs (i.e., the spacing between the leading edge of the first pulse of the first pulse pair, and the leading edge of the first pulse of the next pair) depend upon, and are a characteristic of, that particular signal element. However, it is the spacing of 12 µsec between the pulses of a pair that provides the aircraft with a means of distinguishing between the signal pulses from the radio beacon and any other pulses that may be present at the received radio frequency. The characteristics of the signal elements transmitted by the radio beacon are given below:

1. North Reference Burst–consists of 12 pulse pairs with 12 µsec spacing between pulses of a pair, and 30 µsec spacing between pulse pairs occurring 15 times per second.
2. Auxiliary Reference Burst–consists of six pulse pairs with 12 µsec spacing between pulses of a pair, and 24 µsec between pulse pairs occurring 120 times per second at the rate of 135 Hz.
3. Identification Code–consists of a train of 2,700 pulse pairs per second with 12 µsec spacing between pulses of a pair occurring at a 1,350-Hz double-pulsed rate (100 µsec between double-pulsed pairs). The tone pulses are phase-locked to the reference bursts.
4. Distance Measuring Interrogations–consist of pulse pairs with 12 µsec spacing between pulses of a pair. The spacing between pulse pairs depends upon the pulse repetition rate peculiar to the interrogating aircraft.
5. Squitter Pulses–consist of pulse pairs with 12 µsec spacing between pulses of a pair. The number of pulse pairs per second depends upon the number of interrogations being received by the beacon, but with a minimum spacing of 40 µsec (60 µsec for some equipment) between pulse pairs.

TACAN EQUIPMENT

There are a number of different types of TACAN equipment aboard ship that perform the same function, although they are physically different in appearance. The newer AN/URN-25, TACAN radio set is installed in new construction shps and is replacing the older AN/SRN-15A and AN/URN-20B(V)1 sets as ships are overhauled.

Radio Set AN/URN-20C(V)1

The single Radio Set AN/URN-20C(V)1, (fig. 13-25) and dual Radio Set AN/URN-20C(V)2 are TACAN radio sets intended for ship or shore installation. The functions performed by the single and dual sets are identical. The dual set, however, includes two transponder groups, one additional monitor, and three additional line voltage regulators. Also, the local control units, interconnecting wiring, and the test monitor control (TMC) rf components are different from those of the single set. The additional equipment in the dual set makes it possible to continue operating the TACAN set if one transponder group should fail.

The radio set can operate in either the "X" or "Y" mode. In the X mode, the set transmits both distance measuring and bearing information. In the Y mode, only distance measuring information can be transmitted, although an equipment field change being tested may make transmission of all information feasible.

Capabilities and Limitations

In the X mode, the radio set transmits on one of 126 discrete channel frequencies (1 MHz apart) within the ranges of 962 MHz to 1024 MHz and 1151 MHz to 1213 MHz. In the Y mode, the set transmits on one of 126 discrete channel frequencies (1 MHz apart) within the 1025-MHz to 1150-MHz range. The radio set receiver, operating in the 1025-MHz to 1150-MHz range for both the X and Y modes, is always 63 MHz displaced from the transmitter frequency.

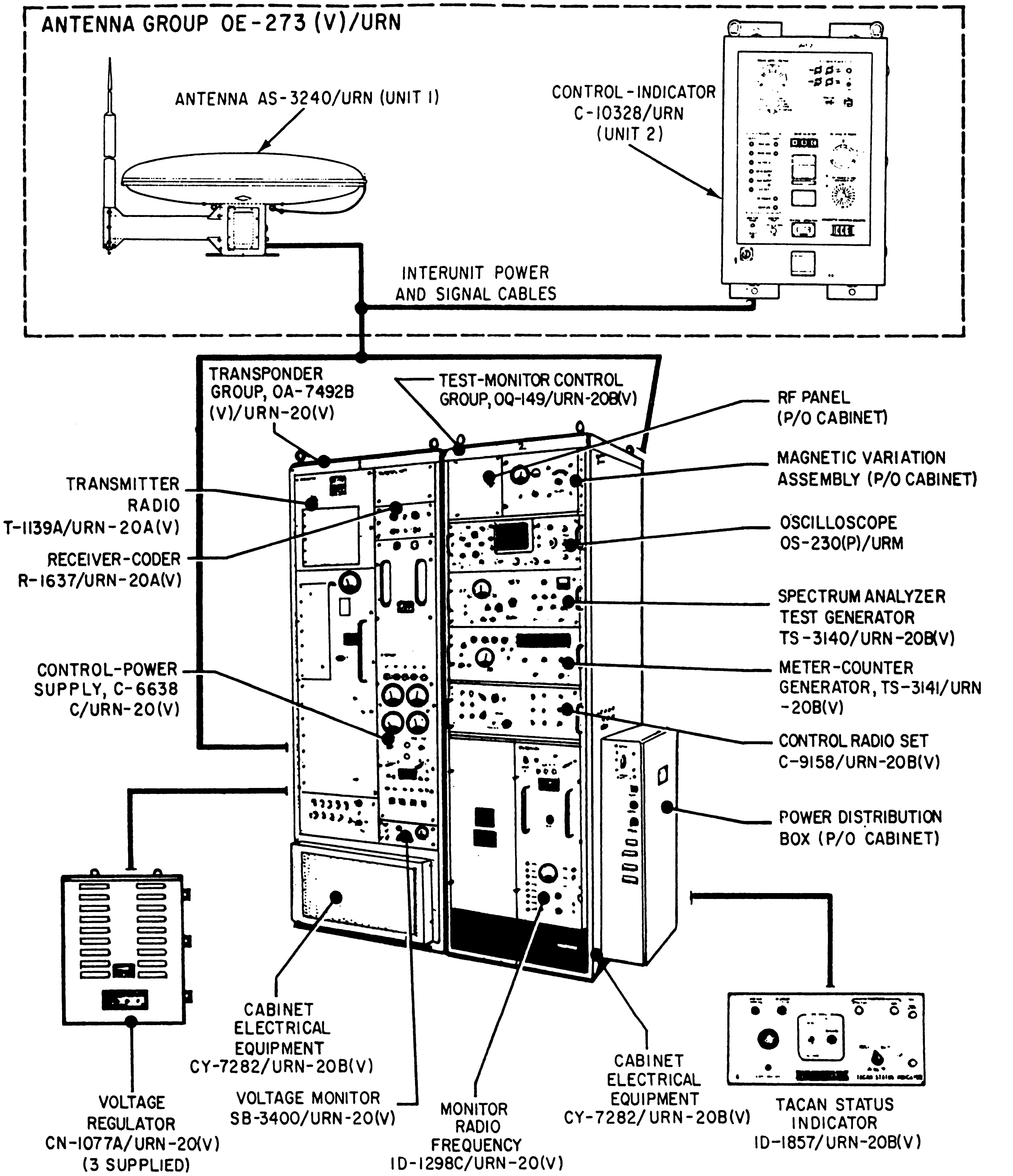
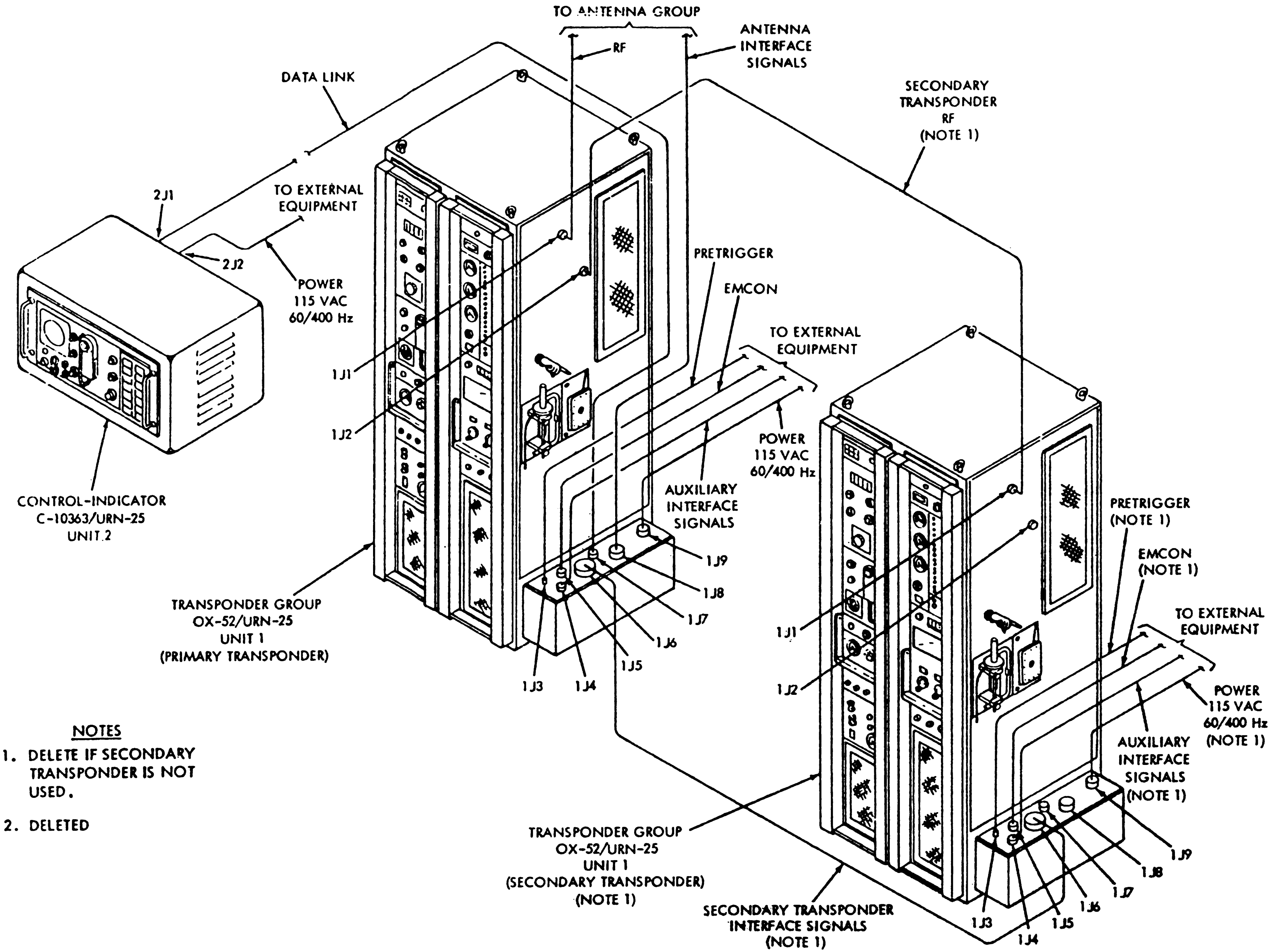


Figure 13-25.–Radio Set AN/URN-20C(V)1 (single radio set).



NOTES

1. DELETE IF SECONDARY TRANSPONDER IS NOT USED.
2. DELETED

Figure 13-26.–Radio Set AN/URN-25.

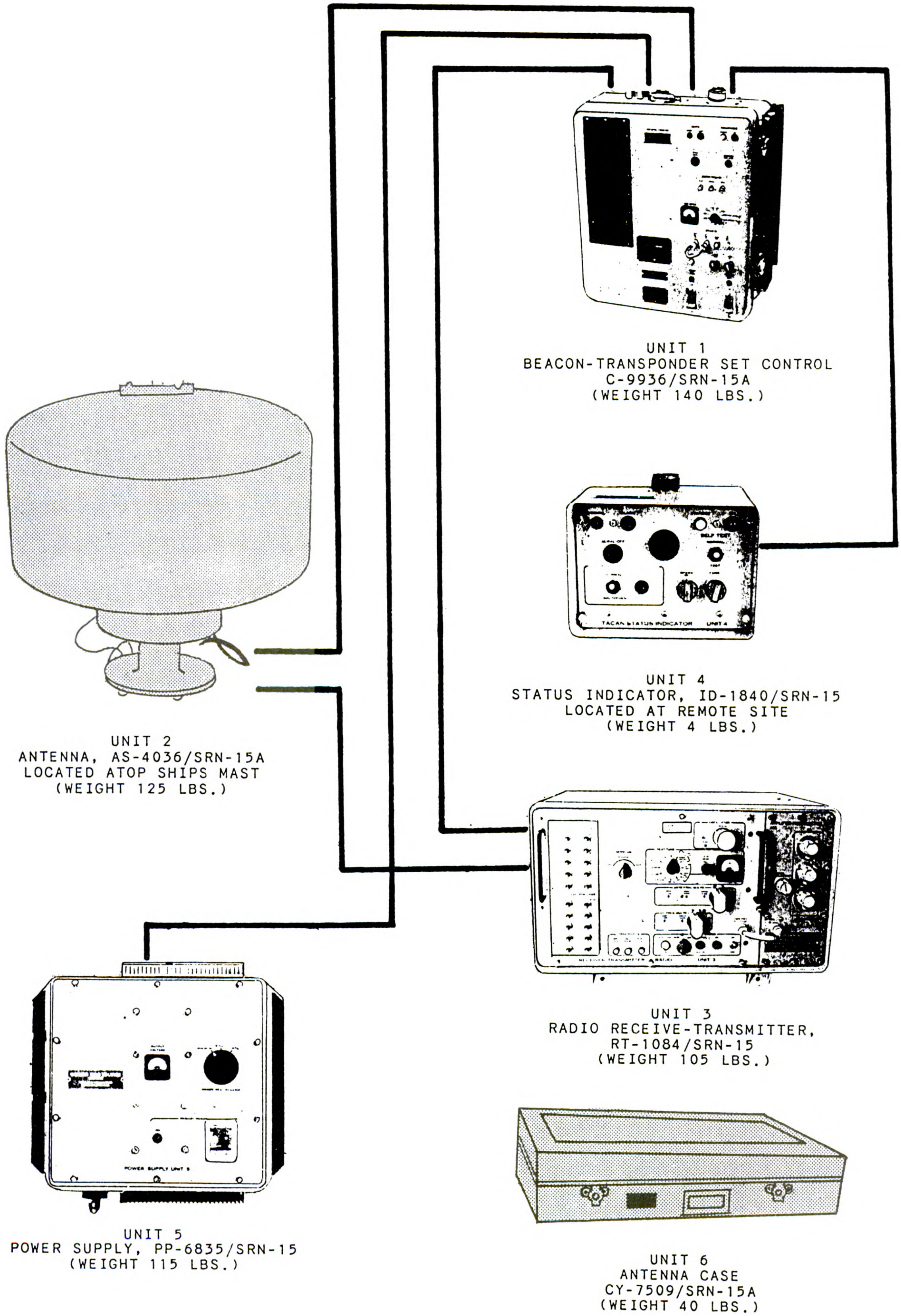


Figure 13-27.–AN/SRN-15 System Configuration.

The radio set can provide individual distance measuring service for up to 100 interrogating aircraft simultaneously. Of the 3600 pulse pairs per second transmitted by the radio set, 900 pulse pairs contain the bearing information; the remaining 2700 pulse pairs are either random noise pulses, identity pulses, or replies to interrogations from the aircraft. Once every 37.5 seconds, the interrogation replies and random noise pulses are interrupted for the transmission of identity pulses.

The radio set has a receiver sensitivity of -92 dBm or better and a nominal peak power output of 10 kilowatts at the transponder cabinet output. (Power output may be limited to less than peak by directives). Since the bearing and identification signals are delivered spontaneously and not in response to interrogations, an unlimited number of properly equipped aircraft can derive this information from the radio set over a line-of-sight range up to 300 nautical miles.

Radio Set AN/URN-25

The AN/URN-25 is a newer TACAN beacon set that replaces the AN/URN-20B(V)1 sets on many ships. It is smaller and has been improved for modern shipboard use. It consists of two major units, the Transponder Group OX-52/URN-25 and the Control-Indicator C-10363/URN-25, as illustrated in figure 13-26. Each transponder is housed in a cabinet with two vertical drawers, one containing the coder-keyer and the other the receiver-transmitter. The control-indicator displays the status of the transponder and failure alarms, and allows limited control of the transponder from a remote location. It may be mounted in its own cabinet or in a standard 19-inch rack. The AN/URN-25 operates similarly to the AN/URN-20 described earlier. For more specific details on the AN/URN-25, refer to the appropriate technical manual.

Beacon-Transponder Set AN/SRN-15A

The AN/SRN-15A Beacon-Transponder Set (fig. 13-27) is a lightweight, low cube, highly reliable system specifically designed for use as a shipboard air (helicopter) navigation system. This system is being phased out and replaced by newer models.

TACAN Radio Set Antennas

All shipboard TACAN radio sets use the same type of antenna. The most common model is the OE-258/URN which, unlike a radar antenna, does not physically rotate. The older mechanical TACAN antennas have all been replaced with the newer solid-state version.

REFERENCES

GPS A Guide to the Next Utility, by Jeff Hurn. Published by Trimble Navigation Ltd. 645 N. Mary Avenue, P.O. Box 3642,. Sunnyvale, Calif., 1989.

Satellite Signals Navigation Set AN/WRN-6(V), EE170-AA-OMI-010/WRN6, Navy Space and Warfare Systems Command, Washington, D.C., 1990.

CHAPTER 14

NAVY TACTICAL DATA SYSTEM

OVERVIEW

This chapter will help you better understand NTDS. NTDS is a vital and important part of Battle Group operations. You should be well versed in NTDS, as you may not have a strong NTDS technician to assist you. Also, you should know all facets of NTDS, especially if you have a staff on board.

OUTLINE

NTDS overview

Link 11

Configuration

Transmission

Reception

Operator entries

Encryption devices

Radio requirements

Audio signal description

Problem solving

NAVAL TACTICAL DATA SYSTEM (NTDS)

In recent years the nature of naval warfare has been radically altered with the introduction of new, ultracomplex, and tremendously effective combat systems. The sophisticated systems that have evolved have not solved or eased the basic command problems that confront the U.S. Navy. During combat, the shipboard combat information center (CIC) must deal with extremely complex tactical situations. These situations require that a multitude of intelligent and highly significant decisions be made in a very short period of time.

The Naval Tactical Data System (NTDS) is the first practical approach to ensuring the most effective use of both decision time and full fleet capabilities. Integrated design and major components of the NTDS provide the fleet with automated data handling capabilities.

Operationally, this computer-centered control system coordinates the collection of data from a ship's sensors (radar, sonar, navigation systems, electronic warfare, and fire control) and from external sources via communications links. It also allows commanders in the fleet to rapidly communicate tactical information between ships. Computers transfer, at extremely high speeds via tactical data communications nets, information that was previously handled by voice communication or manual means. This increases tremendously the ability of individual ships to perform their separate tasks. Figure 14-1 shows the typical NTDS input/output configuration.

NTDS uses three separate data transmission links to maintain tactical data communications with other units. Refer to figure 14-2. We will describe each link system briefly in the paragraphs that follow. Each of these links provides a unique capability to transfer data rapidly to other ships, aircraft, and shore facilities without the delay of human intervention. Link 11 and Link 4A are transmit/receive systems. Link 14 is a receive-only system. The data processing subsystem formats the messages for each of the data links based on shipboard inputs from the display subsystem, sensor inputs, and other data link inputs. Because Link 11 has a major impact on the mission of the fleet, we will address it in detail as a major portion of this chapter. As the EMO, you must know and understand Link 11.

LINK 11

The automatic data communication links provide the operational commander with a high-speed, accurate

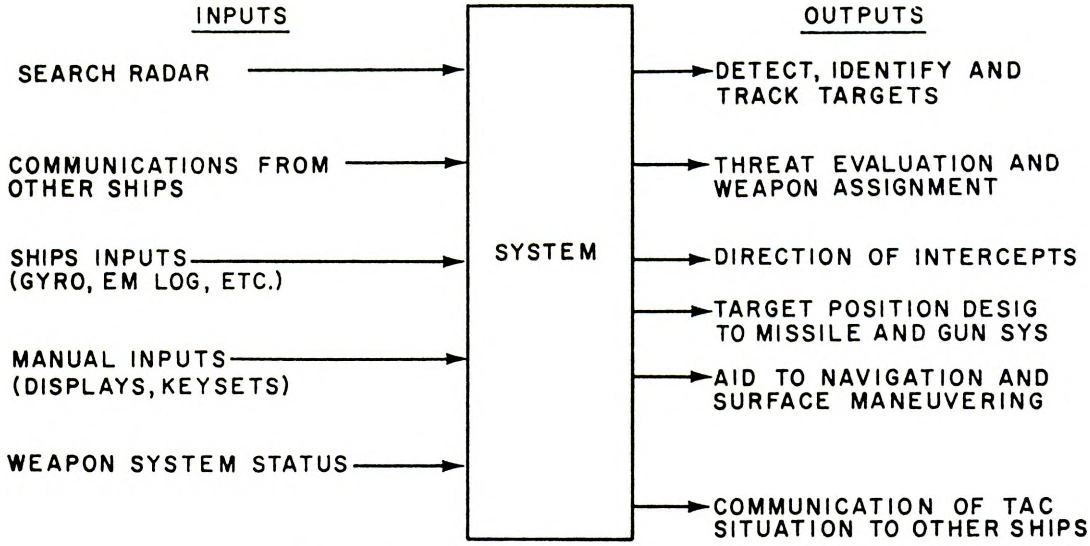


Figure 14-1.–Typical NTDS input/output configuration.

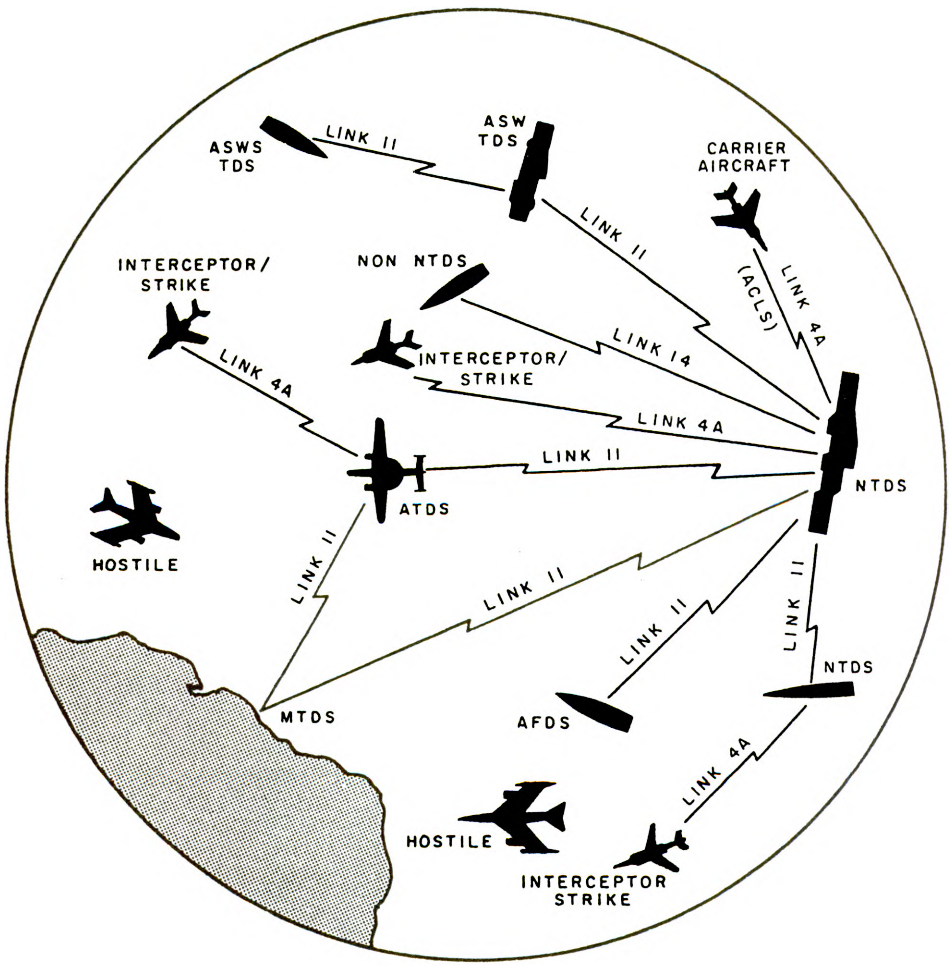


Figure 14-2.–NTDS intersystem communications.

mode of tactical communication. Link 11 provides high-speed computer-to-computer transfer of tactical environment information, command orders, and participating unit status to all other tactical data systems with a nominal range of 300 miles. Tactical information currently transferred consists of surface, subsurface, air, and ECM track information on friendly, hostile, and unknown identity tracks.

LINK 14

Link 14 provides a means of transmitting track information, identity, engagement status, drop track reports, and gridlock information to units not capable of participating in the Link 11 net. This is basically a manual link relying on voice and manual TTY communications.

LINK 4A

Link 4A enables the operational program to take control of the autopilot in a suitably equipped aircraft to control landing and takeoff, to pursue, or to follow collision intercept geometry. It can control a flight to a strike area and return it to the base without requiring pilot action. The pilot has the option of (1) going fully automatic, (2) using the visual display to aid in interpreting the intercept controller's dialogue, or (3) totally ignoring the Link 4A transmission.

LINK 16

Link 16 is essentially the same as Link 11. It is an automatic, high-speed data communications link that provides the same information as Link 11. However, Link 16 uses a merged message format, allowing interservice and NATO link operations, thus expanding our overall link capabilities. Link 16 can have either of the following two titles, depending on its use:

TADIL J (Tactical Data Information Link J)–This is the NATO term for Link 16

JTIDS (Joint Tactical Information Distribution System)–This is the interservice term for Link 16

JTIDS is a high capacity, digital system that combines integrated communications and relative navigation and identification capabilities. The system permits secure, jam resistant data, and voice transfer in real time among the dispersed elements of the military services. The JTIDS architecture provides broadcast and point-to-point data communications for weapons systems, sensors, and command centers.

NTDS SYSTEM OVERVIEW

NTDS accomplishes its objectives in real time. It receives data from various sensing devices that are in continuous contact with the outside environment. It then uses the data to evaluate each event as it happens. The rate of sampling of each sensing device is determined by how frequently data is needed to update the system.

The design philosophy of NTDS is built around the unit computer concept. The unit computer concept is based on having standard computers operate together to obtain greater computer capacity and functional capacity. Refer to figure 14-3 for a simplified diagram of an NTDS system.

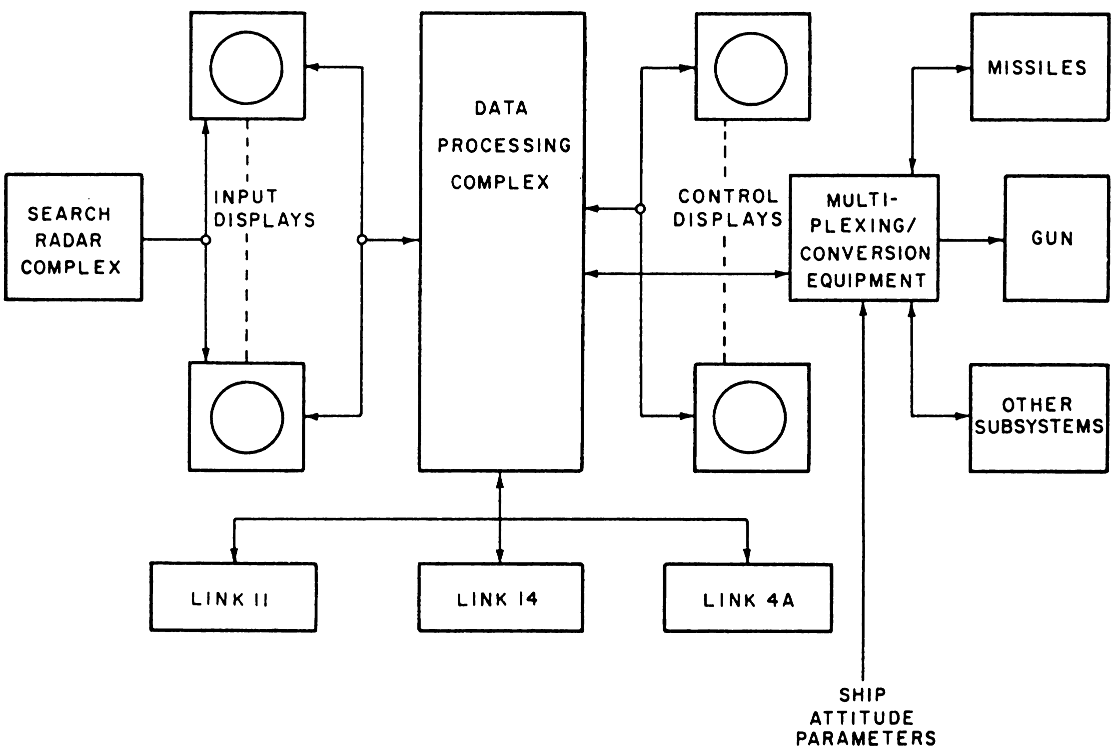


Figure 14-3.–Simplified NTDS diagram.

Processing and correlating this data is another function of NTDS. Figure 14-4 shows a typical NTDS equipment grouping.

NTDS SYSTEM CONFIGURATION

To accomplish the varied tasks required of NTDS, the system is divided into three major subsystems:

- Data processing subsystem
- Data display subsystem
- Data transmission subsystem

Each of these subsystems is an integral part of the NTDS system configuration. The data these subsystems generate and feed back to the central data processing subsystem are stored, processed, and distributed by the operational program to provide usable output data for the other subsystems.

The remainder of this chapter will cover the data transmission subsystem, specifically Link 11.

LINK 11

To understand how the Link 11 system operates, you must be able to identify its hardware components (equipments) and the functions they perform. Being able to trace the path of data is important to overall understanding. Link 11, or Tactical Digital Information Link (TADIL) A, uses netted communication techniques (group of participating units) and a standard message format for exchanging digital information among airborne, land-based, and shipboard tactical data systems. Link 11 communications are conducted in either the high frequency (HF) or ultrahigh frequency (UHF) bands, or through limited range intercept satellite communications (LRI SATCOM). When operating in the HF band, Link 11 provides omnidirectional coverage of up to 300 nautical miles (NM) from the transmitting site. When operating in the UHF band, the link provides omnidirectional coverage to approximately 25 NM ship-to-ship, or 150 NM ship-to-air. Link 11 uses various symbols to represent hostile and friendly operational units in a particular area. These symbols are displayed on a crt for tracking and battle group strategy.

LRI SATCOM

LRI SATCOM is used to effectively extend the UHF line of sight range for battle group tactical link operations. This link is known as the Tactical Relay Information Link (TACRIL). TACRIL uses an AN-ARQ-49 pod attachment to an aircraft operating with the task force and provides one channel for Link 11 operation and two channels for voice communications. Using UHF provides better communications security and using TACRIL reduces satellite channel congestion.

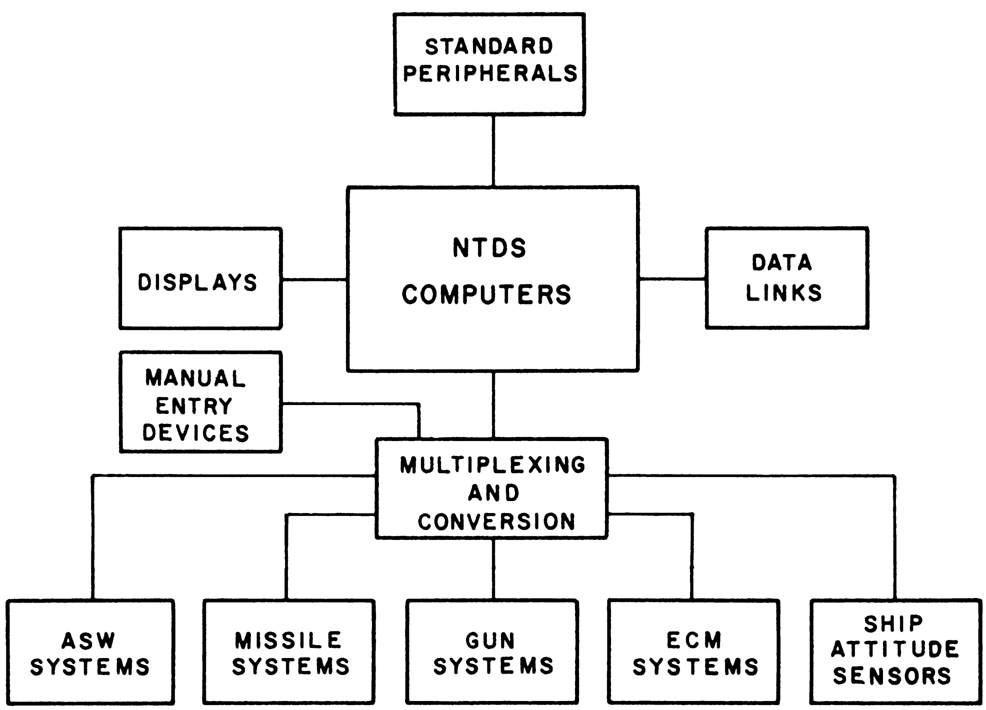


Figure 14-4.–NTDS equipment grouping.

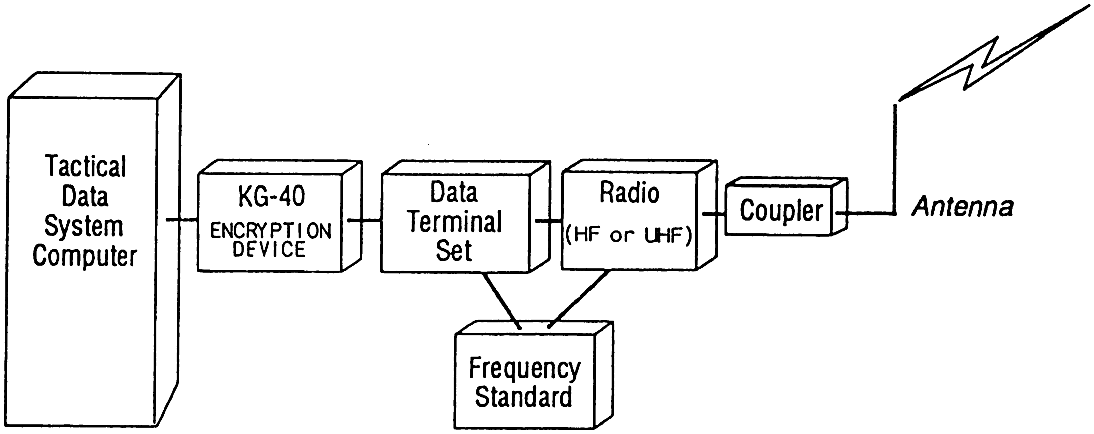


Figure 14-5.–Link 11 equipment configuration.

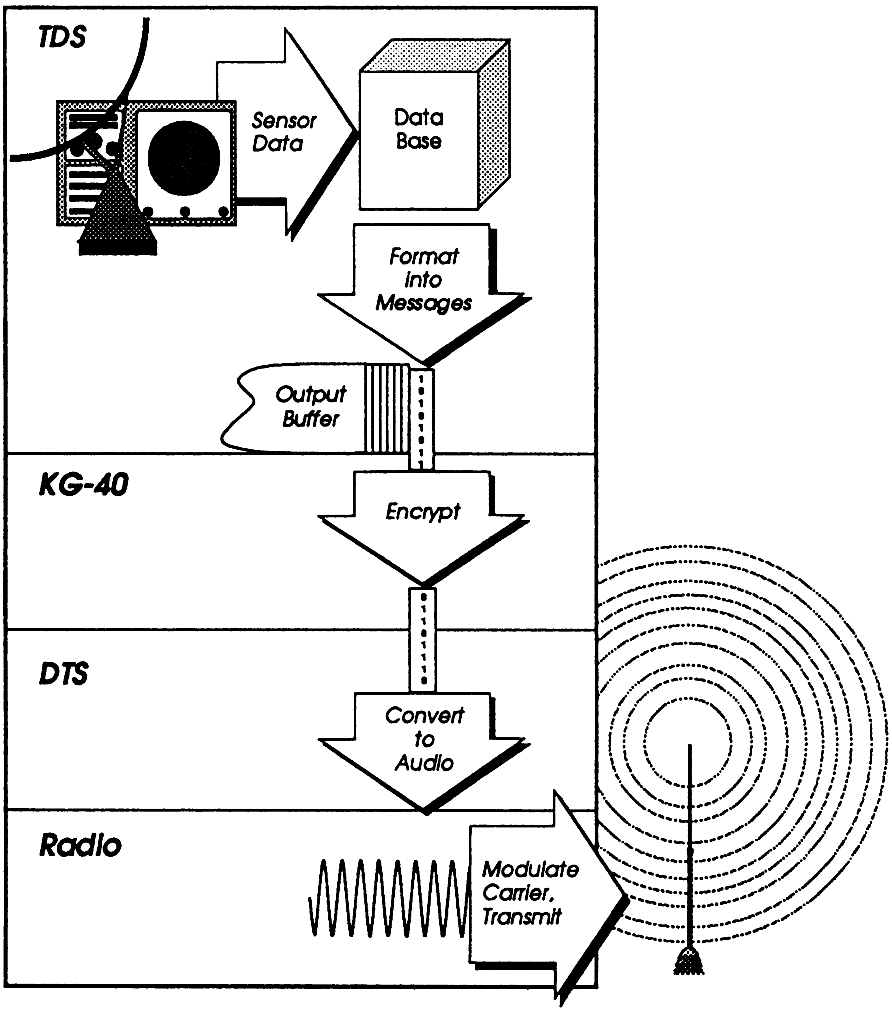


Figure 14-6.–TDS data transmission.

EQUIPMENT CONFIGURATION

There are many different Link 11 configurations. The representative Link 11 configuration shown in figure 14-5 consists of a computer system, an encryption device, a data terminal set (DTS), an HF or UHF radio, a coupler, and an antenna. By referring back to figure 14-3, you can see that we are only addressing a portion of the overall NTDS system.

DATA FLOW ON TRANSMISSION

Data flow on transmission is depicted in figure 14-6. The TDS receives data from sensors, such as radar, navigation systems, and operators, and collects this information into a database. Before this database can be shared with other TDS computers, the information must be formatted into messages that have a specific, well-defined structure. Commands and other administrative information are also formatted into messages for distribution to other units. Data is modulated by the transmitter in either HF or UHF and broadcast to other units participating in the link.

DATA FLOW ON RECEPTION

When a transmitted signal is received, it is demodulated by the receiver. The resulting audio signal is sent to the DTS, where it is converted back into digital data. It is then passed on to the KG-40, where the information is decrypted. Finally, this decrypted data, once again in the form of the message that originated at the transmitting unit, is sent on to the TDS computer where it is collected in an input buffer for processing. See figure 14-7.

THE TACTICAL DATA SYSTEM (TDS) COMPUTER

Tactical Data System computers in use in the U.S. Navy include the CP-642A/B, the AN/UYK-7, and the AN/UYK-43. Figure 14-8 shows typical TDS computer installation by ship class.

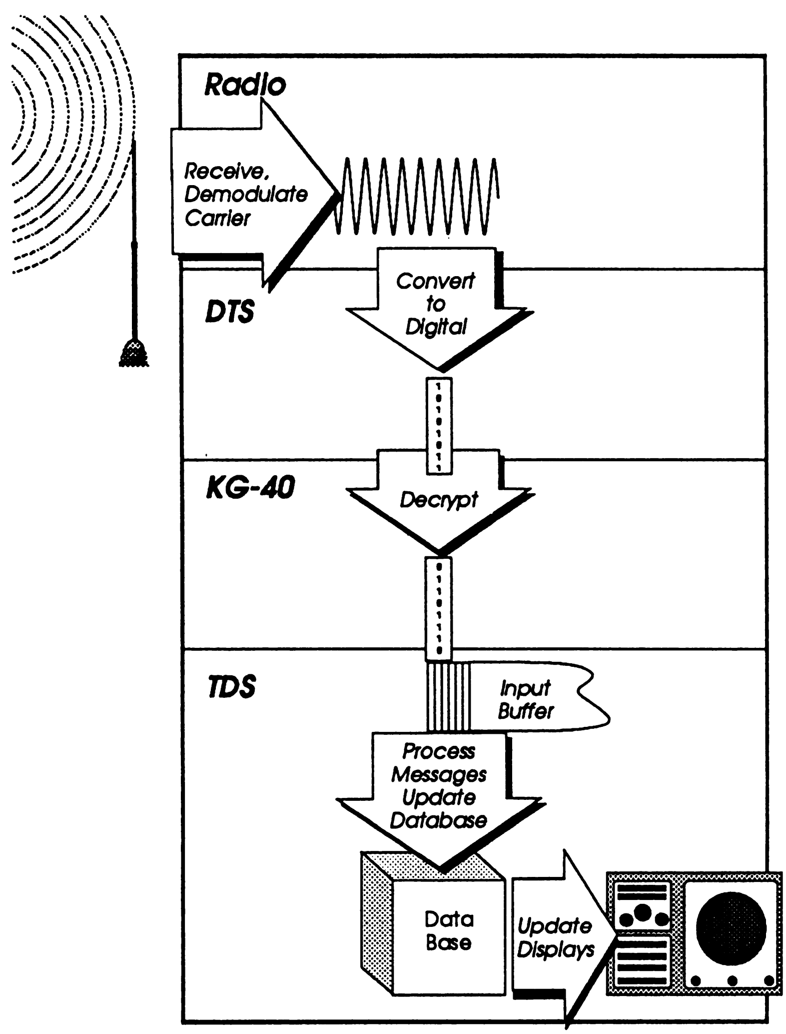


Figure 14-7.–TDS data reception.

Model	Active	Class
CP642A	6	CG, CV, CVN
CP642B	18	CG, CGN, DDG, FF, CV, CVN
UYK-7	100	CG, CGN, DD, DDG, LHA, FFG, AEGIS, CVN
UYK-43	13	CG, CGN, DDG, LHD, CV, CVN

Figure 14-8.–Typical tactical data system computers.

Physically, these NTDS computers may appear quite different, but their Link 11 functions remain identical:

- Supplying tactical digital information to net participants
- Retrieving and processing incoming tactical digital information received from net participants

The software in the NTDS computer performs many other functions in addition to maintaining the tactical database. It manages the displays, performs interim updates of track locations, responds to operator entries and inquires, and controls all peripheral input and output (I/O). All NTDS software must pass rigorous testing to be certified. This certification testing is performed by the Navy Center for Tactical System Interoperability (NCTSI).

OPERATOR ENTRIES

The NTDS computer accepts operator entries, such as the Data Link Reference Point (DLRP), participating unit (PU) identification, track block data, and various filter select modes. These entries must be made correctly. **Improperly entering any one of these values will cause the link to either degrade or break down completely.**

Suppose, for example, that a PU is transmitting good data with a strong signal. All of that data is input to the NTDS computer system for processing. If the NTDS operator enters an incorrect identification number for the PU, none of the tracks originating from that PU will show on the NTDS display.

After information is received, it must be **correlated** or matched, with information that already exists in the database. Of particular importance is the matching of object positions. Any incorrect operator entry could prevent proper correlation and might confuse the tactical picture with numerous uncorrelated tracks.

Correctly matching the positions held by your own ship with those of other units is known as **gridlock**. Failure to maintain gridlock might be caused by inaccurate positioning data from one of the ship's sensor or from its navigation system, or by an inaccurate data entry of an operator. Fortunately, external audio or visual alarms will usually alert the operator when navigation input failures occur. There are no such alerts, however, for inaccurate operator entries.

THE ENCRYPTION DEVICE

The most commonly used encryption device is the KG-40 depicted in figure 14-9. It provides communications security (ComSec) for the 24 channels of tactical data that flow through the system. Each channel is encrypted to prevent interception.

When the KG-40 is properly loaded, ComSec operation is fully automatic and requires no further operator intervention. Be especially sure to load the correct keylist for the day and the operations area (OpArea). Having the correct keylist properly loaded is so vital to data exchanges that the verification and loading must be cross-checked by two people.

Occasionally the KG-40 will go into an alarmed condition, usually when it receives signals that do not meet Link 11 protocol requirements. The alarm condition is indicated by a red light. When an alarm condition exists, no data will pass into or out of the KG-40. Reset the KG-40 to restart the flow of data between the NTDS and the DTS.

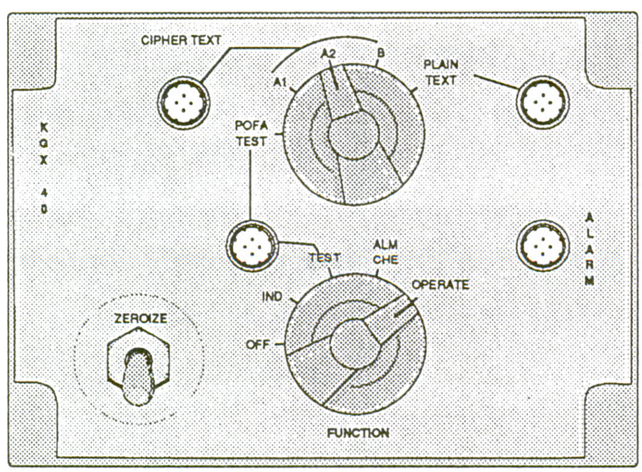


Figure 14-9.–KG-40 control panel.

DATA TERMINAL SET (DTS)

The DTS is the heart of the Link 11 system (see figure 14-10.) In addition to encoding NTDS data into audio tones, it generates and recognizes protocol signals that control the operation of the net.

Several models of the DTS are currently in use in the fleet. Figure 14-11 summarizes the different DTS models, the years during which they were first introduced, numbers of sets in the fleet, and the types of platforms on which they are located. Seven of these models are currently installed or about to be installed on surface and subsurface USN platforms. AEW and ASW aircraft use variations of the AN/USQ-76.

The DTS is designed as a modulator/demodulator (MODEM). Normally it operates in a **half duplex** mode, during which it can either send or receive data, but cannot do both simultaneously. The single exception is during system test, when it operates in a **full duplex** mode and can send and receive data at the same time.

Additional functions performed by the DTS include the following:

- Error detection and correction
- Audio signal generation
- Link protocol control
- NTDS interface control
- Error Detection and Correction (EDAC)

The DTS requests and accepts tactical data in the form of a 24-bit data word from the NTDS computer. To these 24 bits, it adds a 6-bit error detection and correction (EDAC) code. These 6 bits are also referred to as **Hamming** bits. The value of these bits is based on a parity check of specific combinations of the original 24 bits. The EDAC, or Hamming, bits allow error checking to be performed on received data words. If a single bit error occurs, it can be located and corrected. A selection on the DTS determines whether a detected error is to be labeled or corrected.

Audio Signal Generation

The newly formed 30-bit word is used to phase-modulate 15 internally generated audio tones. The phase-modulated audio tones, together with a Doppler correction tone, are then combined into a composite audio signal that is applied to either the HF or the UHF radio equipment for transmission.

Link Protocol Control

In addition to encoding data from the NTDS, the DTS both generates and recognizes protocol data that controls the type and number of link transmissions. These protocol words include codes indicating the start of a transmission, the end of a transmission, and the number of the next unit to transmit.

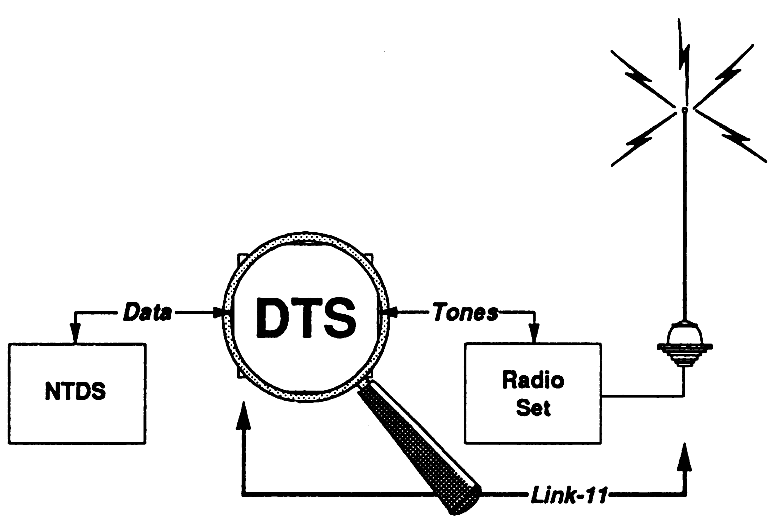


Figure 14-10.–Data terminal set.

System	Introduced	Active	Class
AN/USQ-36	1964-66	49	CG, CGN, CV, CVN, DDG, FF, LCC
AN/USQ-59	1971-72	9	DDG, LHA
AN/USQ-63	1973-74	35	DD, DDG, LHA
AN/USQ-74	1981-1987	86	*BB, CG, CGN, CV, DDG, FFG, LHD, CVN, *AGF, *AVM
AN/USQ-76	1983	31	SSN, ASWOC
AN/USQ-79	1979	17	NTISA, TACC, TAOC
AN/USQ-83 (APE)	1986-1989	2	Tech Eval FF AGF, AEGIS
AN/USQ-92	1984	2	MULTOTS Detachments 1, 2
MX512-P	1990	-	PHM, MULTS, USCG
			*Receive-Only Link Eleven (ROLE)

Figure 14-11.–Active data terminal sets.

NTDS Interface Control

The interface with the NTDS is under the control of the DTS. The DTS signals when it has input data and when it wants output data. The operation of this interface is controlled by an external interrupt from the DTS, with a code designating the purpose of the interrupt. The DTS-to-NTDS interrupt codes are summarized in figure 14-12.

Essentially, the NTDS is slaved to the DTS. When the DTS recognizes an output requirement, such as when it receives its own PU number, it generates a

Interrupt Code	Function
2	Reset
3	End of Receive
4	Prepare to Transmit, roll call with PU addresses supplied by the computer
5	Prepare to Transmit, roll call with PU addresses supplied by the controller
6	Prepare to Receive
7	Prepare to Broadcast

Figure 14-12.–DTS-to-NTDS interrupt codes.

CHARACTERISTIC	DESCRIPTION
NTDS Interface	In accordance with MIL-STD-1397 Type A (NTDS Slow)
Communications Interface	All DTSs can interface with the AN/SRC-16, AN/SRC-23, AN/URC-75, AN/WSC-3, AN/URC-93, AN/GRC-171, URC-81/83, R-1903, T-1322/SRC, AN/URT-23C/D, R-1051F/G/H link-capable radios.
Operator Interface	AN/USQ-74/83: RT display/keyboard AN/USQ-36/59/79/76/92: Thumbwheel or manual switches/keypad
Tone Library	605-Hz Doppler tone and 15 phase-modulated tones: 935, 1045, 1155, 1265, 1375, 1485, 1595, 1705, 1815, 1925, 2035, 2145, 2255, 2365, and 2915 Hertz.
Doppler Correction	Varies by DTS model.
Data Rates	1364 bits per second (slow) 2250 bits per second (fast)
Controls	**Operate**: Transmit/receive or receive only (RadSil) **Net Modes**: Roll Call, Broadcast*, Short Broadcast*, Net Sync, Net Test **Sideband Select**: Automatic, Lower Sideband, Upper Sideband, Diversity **Timing**: Corrected or Stored **Error Correction**: Label or Correct **Station Mode**: Net Control Station or Picket **Doppler Correction**: On or Off **Data Rate**: Fast or Slow **Range:** Range to Net Control Station in nautical miles **NTDS Communications**: On or Off **C&D Control**: On or Off* **XMT Chan**: Primary or Secondary**
Status Indicators	**Normal Operation**: Communication Indicator, Receive Mode, Net Busy, Transmit Mode and Synchronization. **Error Indication**: Receive Code Error, Transmit Data Error, Receive Data Error and Signal Quality*.

* Not applicable to AN/USQ-36
**Applicable to AN/USQ-74 only

Figure 14-13.–DTS system capabilities.

Prepare to Transmit interrupt. The NTDS then provides the requested channel activity. When the DTS recognizes an input requirement, such as a start code, it generates a *Prepare to Receive* interrupt.

The NTDS computer supplies and receives digital information only after being notified to do so by the DTS. The path from the DTS to the NTDS computer runs through the KG-40, which is required to be transparent to the flow of information between the DTS and the NTDS.

Modes of DTS Operation

The DTS can be set to any one of the following modes:

- Net Synchronization
- Net Test
- Roll Call
- Short Broadcast
- Broadcast
- Radio Silence

Net Synchronization (NS), also called "Net Sync," is used to establish communications initially. Net Test (NT) is used for connectivity checks and for checking or setting line levels. Roll Call (RC) is the normal mode of operating the Link 11 net. Short Broadcast (SBC) and Broadcast (BC) are used in certain tactical situations. Not all data terminal sets support the Broadcast and Short Broadcast modes. Radio Silence disables all DTS output transmissions. Figure 14-13 summarizes the DTS system capabilities. These modes will be described in more detail later in this section.

Operator Entries and Selections

Many parameters affecting the operation of the DTS are under the operator's control, whether his ship is a picket (PKT)/participating unit (PU), or the net control station (NCS) (in charge of net operations). Some of those parameters are as follows:

1. Net mode of operation
2. Which sideband is to be processed
3. What type of timing is to be used
4. Whether errors are to be labeled or corrected
5. Whether or not frequency correction is enabled
6. Which data rate to use, and so on

The operator must always enter his ship's own PU number. If the operator's ship is the NCS, he must also enter the numbers of the PUs he plans to poll. A glossary of DTS control settings is presented in figure 14-14.

Unfortunately, not all DTSs have default settings for these entries and selections. On DTSs without default settings, the operator must explicitly check all settings on every occasion. The usual mode of operation is fast data rate, automatic sideband selection, roll call net mode, and fast and continuous synchronization.

Status and Error Indicators

The DTS reports current status and error conditions using indicator lights. While the specific set of indicators and their names may vary with the model of DTS, the following basic conditions are usually monitored and indicated:

- Transmit
- Receive
- Net Busy
- Transmit Data Error
- Receive Data Error
- Code Error
- Sync Complete

These indicators provide the operator with useful information about the condition of the Link 11 signal input to, and output from, his DTS.

RADIOS FOR LINK 11 DATA COMMUNICATIONS

The Link 11 transmitters and receivers provide point-to-point connectivity between widely separated units in the net. Both HF and UHF radios are used in Link 11. HF is used to establish a net when the range between units in the net is from 25 to 300 NM. For ranges of less than 25 nautical miles, HF Limited Range Intercept (LRI) can be used. UHF is used when the range between units is less than 25 NM. Current

CONTROL NAME	MEANING
Net Mode	Selects the Net Mode in which to operate.
Roll Call (RC)	The NCS will automatically interrogate each picket in turn as determined by operator's PU number setting in the Address Array. NOTE: **Ownship's PU number (Own Address) has to be entered in NCS terminals; otherwise no own ship track data will be transmitted by NCS.**
Broadcast (BC)	Station will broadcast a continuous series of messages to all net participants. NOTE: **Broadcast initialization has to be coordinated with acting NCS to prevent net jamming (except AN/USQ-79 users).**
Short Broadcast (SBC)	Station will send a single data transmission to all net participants.
Net Sync (NS)	Enables the NCS to transmit a continuous net synchronization transmission (preambles). Enables the picket to receive a net synchronization transmission.
Net Test (NT)	Enables the NCS to transmit a known data pattern. At the picket station, the received pattern is compared with the known (stored) test pattern. Used for connectivity checks.
Radio Silence	Disables all DTS output transmissions.
Sideband Select	Selects which sideband (channel) or sideband combination will be used for transmit/receive signal processing.
Auto	The DTS will select the first error-free data from Upper Sideband, Lower Sideband or Diversity channel.
Lower Sideband (LSB)	The frequency band 3000 Hz below the assigned carrier frequency. The DTS is restricted to transmitting/receiving on LSB only.
Upper Sideband (USB)	The frequency band 3000 Hz above the assigned carrier frequency. The DTS is restricted to transmitting/receiving on USB only. **NOTE: The UHF band is restricted to a single audio channel only (USB).**
Diversity (DIV)	A combination formed from USB and LSB.

Figure 14-14.–DTS control settings.

CONTROL NAME		MEANING
Timing		Used to select the transmit time base mode.
Corrected (COR)		Enables correction of the time base each time own station address is recognized by a picket in the Roll Call mode.
Stored (STR)		Enables use of the stored time base obtained during Net Sync mode. **NOTE: Can be used only by a picket station that has established sync during Net Sync operation.**
Error Correction	L C	Selects whether an error in data reception is to be **Labeled** only or **Corrected** and **Labeled.**
NTDS Comm.	On Off	Inhibits or connects communications between DTS and NTDS computer. All other DTS functions remain unaffected.
Station Mode	NCS PKT	Indicates Net Control Station operation. Indicates picket station operation.
Sync	F/C	Fast and continuous frame sync is enabled.
	F	Only fast sync is enabled. Sync only on five-frame preamble period.
	C	Only continuous sync is enabled. Sync occurs only during reception of Net Sync signal in the Net Sync mode.
Doppler Correction	On Off	Doppler correction logic enabled. Doppler correction logic disabled.
Data Rate	Fast Slow	Fast data rate of 2250 bps. Slow data rate of 1364 bps.
Range	XXX	Picket enters 25-NM range increment to NCS to compensate for signal propagation delay.
C&D Control*	On/off	TDS computer-generated addressing is enabled/disabled.
XMT Chan*	Pri/Sec	Selects UYK-20 transmit data channel to Communications Interface Unit. **PRI = USB, SEC = LSB.**
* USQ-74 only		

Figure 14-14.–DTS control settings–Continued.

deployment of communications systems is summarized in figure 14-15.

General Link 11 Radio Requirements

Link 11 radios must meet requirements that are different from radios designed for voice-only operation. The primary differences include the transmit-to-receive switching time, the keyline interface, the audio band-pass characteristics, the fast automatic gain control, the attack and release timing, and the audio input and output level conditioning at 0DBM. Because of the speed at which the link operates, all link communication equipment must be able to keep up with the repetitive cycles of transmission and reception.

On most ships, the only communications equipment that can be used for link operations is the link-capable equipment included in the NTDS patch panels. Do not try to use other equipment for link operations. Also, do not use transceivers dedicated for link operations for other purposes.

HF Radios

HF radios used for link operations use the link audio signal to modulate, or vary, the amplitude of their carrier. These radios, usually AN/SRC-23s, have several modes of operation, including Single Sideband Suppressed Carrier (SSBSC), Double Sideband Suppressed Carrier (DSBSC), Independent Sideband Suppressed Carrier (ISBSC), Amplitude Modulation (AM), and Continuous Wave (CW).

In SSBSC, either the upper sideband (USB) or the lower sideband (LSB) is output, depending on the operator's selection. In DSBSC, both USB and LSB are output. In ISBSC, both the USB and the LSB are output, but they are generated independently from separate LSB and USB audio input signals. The AM mode consists of the carrier and the USB. In the CW mode, the carrier can be turned on and off, like Morse code.

In actuality, the signal could be transmitted in any one of the modes, depending on the circumstances and equipment available to all users. However, for Link 11 operations, the Independent Sideband Suppressed Carrier mode is used. In this mode, the Link 11 audio signals generated by the DTS are applied to both the upper and lower sidebands for transmission.

A **sideband** can be thought of as a channel. In HF Link 11 transmissions, both channels carry the same audio signal. The RF carrier frequency is not transmitted because it conveys no intelligence. To extend the effective signal range, all signal power goes into the intelligence-carrying sidebands. One advantage of

	System	Active	Class
HF	AN/SRC-16	26	CG, CGN, CV, CVN, DDG, LCC
HF	AN/SRC-23	30	CG, CGN, CV, CVN, DDG, LCC, FF
HF	T1322/R1903	42	DDG, DD, CG
HF	AN/URC-75	5	LHA
HF	AN/URC-81	4	DDG
HF	AN/URC-109	1	LHD
HF	AN/URT-23C/R1051G	73	DDG, FFG, SSN
HF	AN/URT-23D/R1051H	10	CG
UHF	AN/URC-93	61	CGN, CG, CVN, CV, DG, LCC, LHD
UHF	AN/WSC-3	119	FF, DD, DDG, FFG, BB, AGF, SSN, CG
UHF	AN/URC-85	18	CGN, DDG, DD
UHF	AN/URC-83	5	LHA

Figure 14-15.–Communications systems currently in operation.

using both sidebands with the same audio signal is that it affords a degree of diversity, so that signal fading and ambient noise can be overcome at the receiver. Whenever one sideband degrades, the other sideband does not degrade at the same time. The receiving unit can automatically select the best data from the upper sideband, the lower sideband, or the diversity.

A SSB transmitter that transmits the carrier frequency is in need of alignment. A good rule of thumb to remember is that a SSB transmitter with no modulation applied to its input should produce output at the antenna of no more than 0.8 volts, measured as the root mean square (RMS). This would be the reading a voltmeter would give when set on the ac scale. If the RMS output is greater than this, RF power is being wasted in the non-intelligence portion of the spectrum, and the intelligence portion may possibly be distorted as well.

UHF Radios

UHF radios use a modulation technique called **frequency modulation** (FM). In UHF radios, the Link 11 audio signal is used to modulate or shift the radio frequency about a center frequency. This technique of modulation is more resistant to interference than amplitude modulation. During the demodulation process, FM receivers limit the number of amplitude deviations. Only frequency deviation is used to extract the intelligence. UHF is always limited in range to line-of-sight (LOS).

HF Antenna Couplers

Since link is a radio system, it must be able to tune the transmission line (cable) and the antenna to match the radio's output impedance to the antenna. This produces maximum output from the transmitter. Remember that some couplers provide the added advantage of allowing many transmitters to be fed into a single antenna. The resulting configuration is called a **multicoupler** group. See figure 14-16. Multicouplers require frequency management to prevent influence across adjacent channels. Typically, a 15-percent frequency separation between adjacent channels should

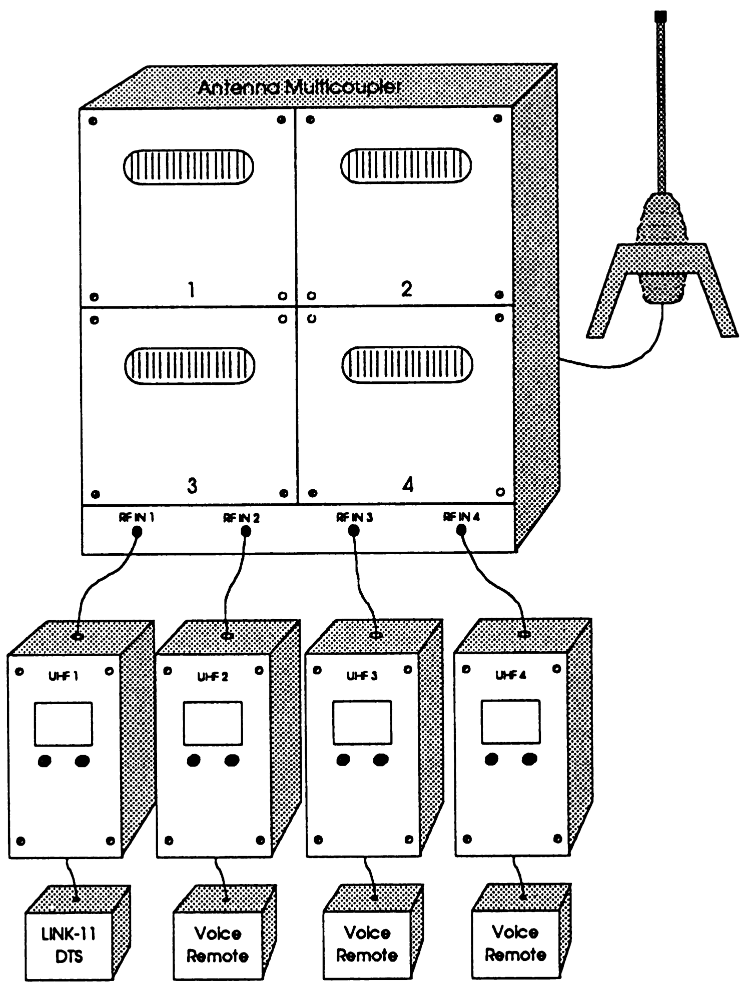


Figure 14-16.–Antenna multicoupler setup.

be maintained. Failure to maintain sufficient frequency separation between adjacent channels will allow adjacent couplers to leak energy between units. Serious signal distortion, as well as costly equipment failure, could then occur.

UHF Couplers

In general, UHF antenna couplers are combined within the system group or are part of the UHF transceiver. Because they have smaller components and lower power requirements, UHF couplers typically perform quite well.

Most UHF antenna couplers contain preset channels, a feature that permits faster tuning and remote selection of predesignated channels. On the surface, remote selection may appear to be a tactical advantage. The problem with having the user remotely select tactical channels is that he may create a frequency management nightmare. The user cannot effectively maintain a 15-percent frequency separation between adjacent predesignated channels; the result may be Pri Tac voice on the Link 4 (nicknamed Dolly) circuit, or vice versa.

To prevent this problem from occurring, most installations provide designated radios, frequencies, and multicouplers. The user then selects the audio path connection to the desired channel. In this way, potential frequency management problems and hardware configuration problems can be circumvented in advance.

Antennas

Antennas used for link communications are standard HF (AM spectrum) and UHF (FM spectrum) antennas, identical to those used for voice communications.

Frequency Standards

Link 11 DTSs, transmitters, and receivers are capable of operating with either an internally generated frequency standard or an external frequency standard. Using this standard in operating these components can help alleviate the problem of component frequency error. Some typical frequency standards that are used are the URQ-9, URQ-10, and URQ-23.

Patch Panels and Switchboards

Patch panels and switchboards are used in the Link 11 system to accomplish the following:

1. Interconnect system equipment and components
2. Allow technicians to isolate and test simple components

Patch panels and switchboards also allow redundancy to be designed into the system. Redundancy helps to ensure link capability even when a particular component (e.g., a radio) has failed or is undergoing preventive maintenance. Flexibility in the way components are connected is essential. By using patch panels and switchboards, we can both meet the connection requirements and provide maximum component flexibility.

The four major equipment areas (NTDS computers, encryption units, DTSs, and RF systems) are connected to one another through various types of patches. This allows the operator to detour around inoperative equipment. Patching configurations are unique to each class of ship. One configuration may use both patch cables and manual switches, while another configuration may contain only manual switches, or even a mix of computer-controlled input/output selectors.

A typical patching system is basic and uncomplicated but, nonetheless, failure prone. The 26 or 28 data channels require 52 to 56 individual wire conductors to connect the NTDS computer to the encryption unit and the encryption unit to the DTS. Double this number to satisfy both transmit and receive connection requirements. To accomplish the necessary switching between units, mechanical switches must have a section or wafer dedicated to each pair of conductors.

Switches that have an open-faced construction have the greatest number of problems. Dust and dirt can damage the multiple-switch contact surfaces. The loss of a single bit of data along this pathway is very difficult to detect.

LINK 11 DATA PATH

The successful exchange of Link 11 tactical information requires that the data pathway extend completely from the transmitting NTDS computer to the receiving NTDS computer.

The flow of data during transmission is illustrated in figure 14-17. The 24 bits of message data are

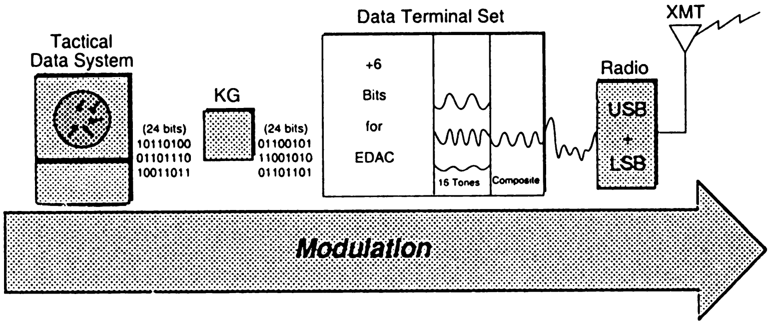


Figure 14-17.–Data flow during transmission.

encrypted in the KG and the encrypted bits are passed to the DTS. In the DTS, 6 bits of Hamming code are added for EDAC purposes. The resulting 30 bits are encoded into the phase shifts of the 15 Link 11 audio tones. These are then summed with the unshifted 605-HZ Doppler tone to form a composite signal. USB and LSB signals are both generated from this process. In HF communications, both are input to the radio for transmission as independent sidebands of an amplitude-modulated carrier. In UHF communications, the USB signal is input to the radio for transmission on a frequency-modulated carrier.

For this data transfer to occur, several operator entries and switch positions must be correct. The TDS, KG, and DTS must be properly cabled, and the KG cannot be in an alarmed condition. Your own ship's address must be entered correctly into the DTS. The audio signal must be correctly cabled to the radio. The radio must be set both for data and to the correct frequency. Proper frequency separation must be maintained between coupler channels.

Once the signal has been transmitted, it can be received by another unit. The flow of data during reception is illustrated in figure 14-18. The transmitted signal is received by the antenna and passed to the radio receiver. On HF, the upper and lower sidebands are demodulated from the carrier. On UHF, a single signal is demodulated from the carrier and appears on the USB channel. The demodulated audio signals, input to the DTS, are decoded into 30 bits of digital data based on the phase of each of the 15 data tones. The 30-bit value from the specified sideband (USB, LSB, DIV, AUTO) is selected for further processing. The 6 EDAC bits are examined to determine whether there are any errors in the 24 data bits. Finally, the 24 bits are unscrambled within the KG and passed, with their two error status bits, to the NTDS computer.

For this *reception* data transfer to occur, several operator entries and switch positions must be correct. Proper frequency separation must be maintained between coupler channels, and the radio must be set for data and on the correct frequency. The transmitting ship must be within range and the signal not blocked, jammed, or otherwise degraded. The audio signal(s) must be correctly cabled to the DTS, and input at 0 dBm. Doppler correction should be enabled at the DTS, and the correct sideband selected. The DTS, KG, and NTDS, must be properly cabled, and the KG cannot be in an alarmed condition. The PU number must be entered correctly in the PU list at the NTDS.

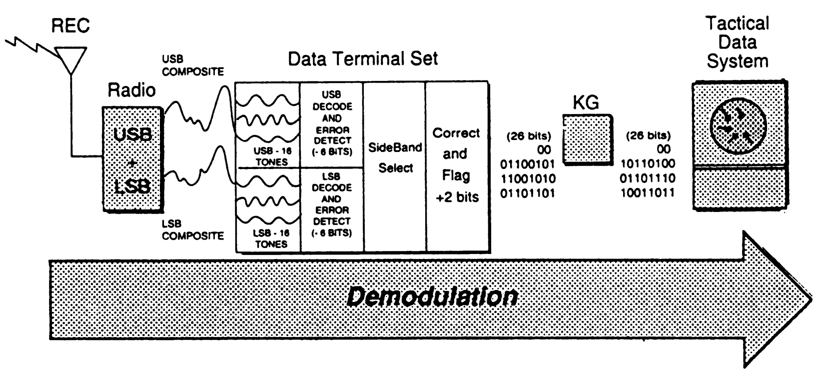


Figure 14-18.–Data flow during reception.

LINK 11 AUDIO SIGNAL

The Link 11 audio signal is produced by the DTS. This signal contains both protocol information, which controls the net, and the actual digital data being shared among the tactical computers. Anomalies, either in the protocol or in the signal structure, can affect the operation of the net and the validity of the received data. Understanding the Link 11 audio signal will help you to recognize anomalies when they occur and to anticipate their effects on the net.

Frame Structure

Link 11 audio signals are pulse trains that can be divided into general types of signals: the preamble signal and the data signal. Each of these signals is divided into **frames**. The length of time for each frame depends on the data rate–that is, on how fast the data is being transmitted. Preamble signal frames contain information necessary for the receiving equipment to process the data signal; i.e., unit identification, error check, number of data signal frames, and so on. Data signal frames contain the actual tactical information: target location, speed, heading, and so on.

Two *frame times* are supported in Link 11. These times are established by the available data rates. Typically, these are referred to as the fast data rate and the slow data rate. Fast data rate operates at 75 frames/second, with a frame time of 13.33 milliseconds, resulting in 2250 bits per second (bps). Slow data rate operates at 45.45 frames/second, with a frame time of 22.0 milliseconds, resulting in 1364 bps.

The time within the center of the frame during which the data is stable is known as the *integration interval*. This is the time during which data is taken for processing. The integration interval for the fast data rate is 9.09 msec. The integration interval for the slow data rate, however, can be either 9.09 milliseconds or 18.18 milliseconds.

The long integration interval available at the slow data rate allows twice as much signal to be processed, thereby providing an increase of 3 dB in the signal-to-noise ratio. Figure 14-19 shows the comparison of fast and slow data rates.

THE PREAMBLE SIGNAL.–The preamble is a two-tone audio signal. This signal is composed of a 605-Hz tone and a 2915-Hz tone. The 2915 Hz tone is periodically shifted in phase by 180 degrees. The preamble frame is located in the time between these shifts, during which the phase is constant.

The phase-shift on the 2915-HZ tone is used by many Data Terminal Sets to "frame up"–that is, to determine precisely where the frame boundaries occur. For this reason, the 2915-Hz tone is sometimes called the "framing tone." The 605-Hz tone is used to determine whether there is a frequency error or Doppler shift in the transmitted signal. The 605-Hz tone is sometimes called the Doppler tone. For a signal to be recognized, both tones are required.

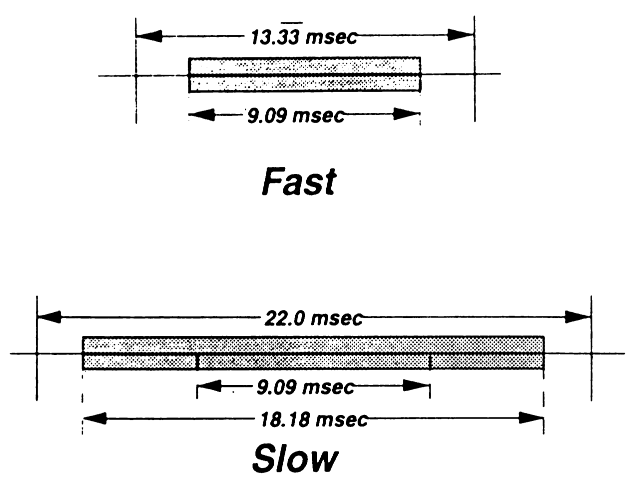


Figure 14-19.–Integration interval.

The power in the 605-Hz tone must be 6 decibels (dB) greater than that of the 2915-Hz tone. During preamble frames, both the 605-Hz tone and the 2915-Hz tone are each given twice their normal amplitude, or four times their normal power. This accomplishes two things:

1. If more power is contained in the preamble tones, the signal is easier to recognize above the background noise.
2. The power in the two tones of the preamble signal is approximately the same as the total power in the combined 16 tones of the data signal.

THE DATA SIGNAL.–The data signal consists of several *data frames*, each of which is a 16-tone audio signal. The tone frequencies of this signal are odd harmonics of 55 Hertz. The specific tones, or frequencies, are illustrated in figure 14-20.

Fifteen of these tones are used to encode binary data. The phase of each tone represents two bits of data. The phase is shifted at the end of each frame and is then held constant for the duration of the next frame. The 16th tone is the 605-Hz tone. As in preamble frames, the power of the 605-Hz tone must be 6 dB above the power in each of the data tones. The 605-Hz tone remains phase continuous; that is it is not phase shifted during the entire transmission.

Data Encoding

Information is encoded in the Link 11 signal by a method called *differential quadrature phase-shift keying modulation*. During a frame, each frequency has a particular phase. The amount of change, or phase difference, determines the value of a 2-bit number. There are four possible combinations: 00, 01, 10, and 11. Each combination is associated with a phase

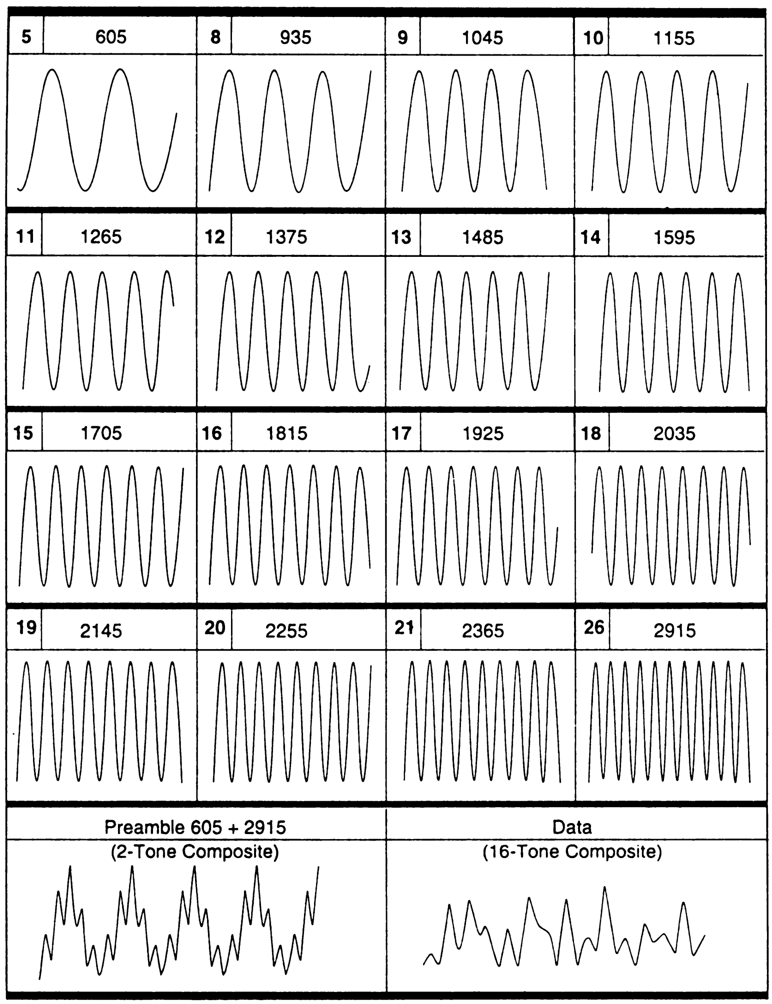


Figure 14-20.–Link 11 audio signal.

difference of one of four values: 45°, 135°, 225°, or 315°. Each of these angles marks the center of a quadrant, or quarter section of a circle, as illustrated in figure 14-21. Each quadrant is assigned a binary (2 bit) value. Any phase difference falling within that quadrant represents that binary value. The 2-bit value 11, for example, would be encoded by a phase change of -45° (or, equivalently, 315°).

Notice that this system of encoding can tolerate an error in the prescribed phase shift of up to 44° before a single bit error will occur. An error in phase shift that is greater than 45°, but less than 135°, will cause the phase angle to fall into an adjacent quadrant. The values are assigned to quadrants in such a way, however, that only one bit error will be introduced as long as the quadrant into which it falls is adjacent to the target quadrant.

Phase Shift	*Value (Even, Odd)*
-45°	*1,1*
-135°	*0,1*
-225°	*0,0*
-315°	*1,0*

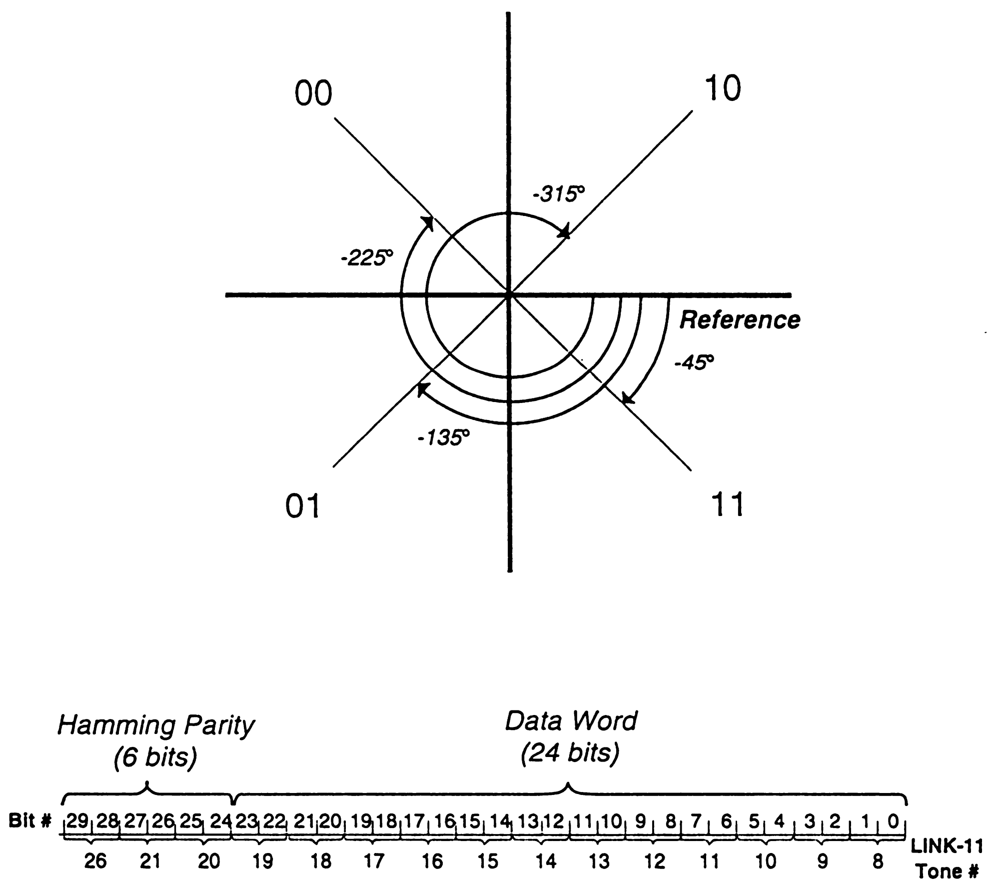


Figure 14-21.–Quadrant method for determining the 2-bit value for each tone.

TRANSMISSION BUILDING BLOCKS

Transmissions are composed of preambles, a phase reference, control codes, a crypto frame, and message data.

THE PREAMBLE

The preamble, as previously discussed, consists of a two-tone signal composed of the 605-Hz tone and the 2915-Hz tone. The 2915-Hz tone is shifted in phase by 180° at the end of each frame. A transmission always begins with five frames of preamble.

THE PHASE REFERENCE FRAME

The data frame that immediately follows the preamble is called the **phase reference** frame. It provides a reference phase for each of the data tones of the following frame. The difference between the phase angle of a given tone in the reference frame and that of the same tone in the subsequent frame defines the phase shift for that tone.

There is only one phase reference frame in a transmission. Each subsequent data frame acts as the phase reference for the frame that immediately follows it.

CONTROL CODES

The operation of the link is controlled by **control codes**. The 15 data tones allow the encoding of 30 bits of information, 2 bits per tone, in each frame. The control code is a special two- frame sequence. There are no Hamming bits associated with control codes. These codes can be recognized with up to 4 bits in error on each frame.

The Link 11 control codes are the *start code*, the *picket stop code*, the *control stop code*, and the *PU address codes*. There are 62 possible PU address codes, one for each octal PU number between 01 and 76. Expressing these bits in octal requires 3 bits per octal digit, or 10 places.

THE ADDRESS CODE

An **address code** immediately follows either the phase reference frame, in the case of an NCS call-up, or the control stop code, in the case of an NCS report. The **address code** specifies which PU is to transmit next. Recognition of an address code identical to a ship's own address causes the DTS to issue a Prepare-to-Transmit interrupt to the NTDS computer.

THE START CODE

The **start code** immediately follows the phase reference frame. It specifies that a data report is about to begin. Recognizing the start code causes the DTS to issue a Prepare-to-Receive interrupt to the NTDS computer.

If a start code is not received at the NCS's DTS within 15 frames of the call-up, the NCS will poll the unit a second time. Since there are five preambles, a phase reference, and two frames of start code, eight of the 15 frames are taken up with the initial building blocks of the transmission. To avoid having this response jammed by a second call-up, a picket DTS must begin its response within seven frames of receiving and recognizing its own address. In the real world, a picket DTS will usually respond within three frames of recognizing its own address.

THE PICKET STOP CODE

The **picket stop code** marks the end of a PU's data report. Recognizing a picket stop causes a DTS to issue an End-of-Receive interrupt to the NTDS computer. It takes both frames for the stop code to be recognized. The first frame of the stop code will be passed to the NTDS computer as data before the End-of-Receive interrupt is issued.

THE CONTROL STOP CODE

The **control stop code**, which is transmitted only by the NCS, marks the end of the NCS's own report. It is followed immediately by the address code of the next unit to transmit. Recognition of a control stop also causes a DTS to issue an End-of-Receive interrupt. Again, both frames of the control stop are required for the stop code to be recognized and the first frame of the control stop is passed to the NTDS computer as data.

MESSAGE DATA FRAMES

Between the start code and the stop code is the **message data** that originates from an NTDS computer. For each message data frame, the computer supplies 24 bits of information plus two bits representing the error code.

The relationship of the various parts of three Link 11 signals are shown in figure 14-22.

CRYPTO FRAME

The first frame following the start code is actually generated within the KG-40. It is passed to the DTS while the first frame of message data is being encrypted. The first frame of message data is then passed to the DTS while the second frame is encrypted. In this way, the data is "pipelined" from the NTDS through the KG to the DTS.

MODES OF OPERATION

The five modes of operation are *Net Synchronization, Net Test, Roll Call, Short Broadcast,* and *Broadcast* (or Long Broadcast). The mode of operation is selected at the DTS.

NET SYNCHRONIZATION

The **Net Sync** transmission is a continuous series of preambles. Net Sync is initiated manually by the operator and continues until stopped manually by the operator. Operationally, it is often used as a first step in verifying RF connectivity between units.

NET TEST

The **Net Test** transmission consists of a 21-frame repeating test pattern. This test pattern is a subset of the address codes. The transmission begins with preamble frames and a phase reference frame, and is then followed by the test pattern.

Net Test mode is a test of connectivity between units. It is also a useful signal for setting the DTS audio input and output levels. The Net Test signal should be input to the DTS at 0 dBm. Net Test also checks the DTS's PU address receive circuits.

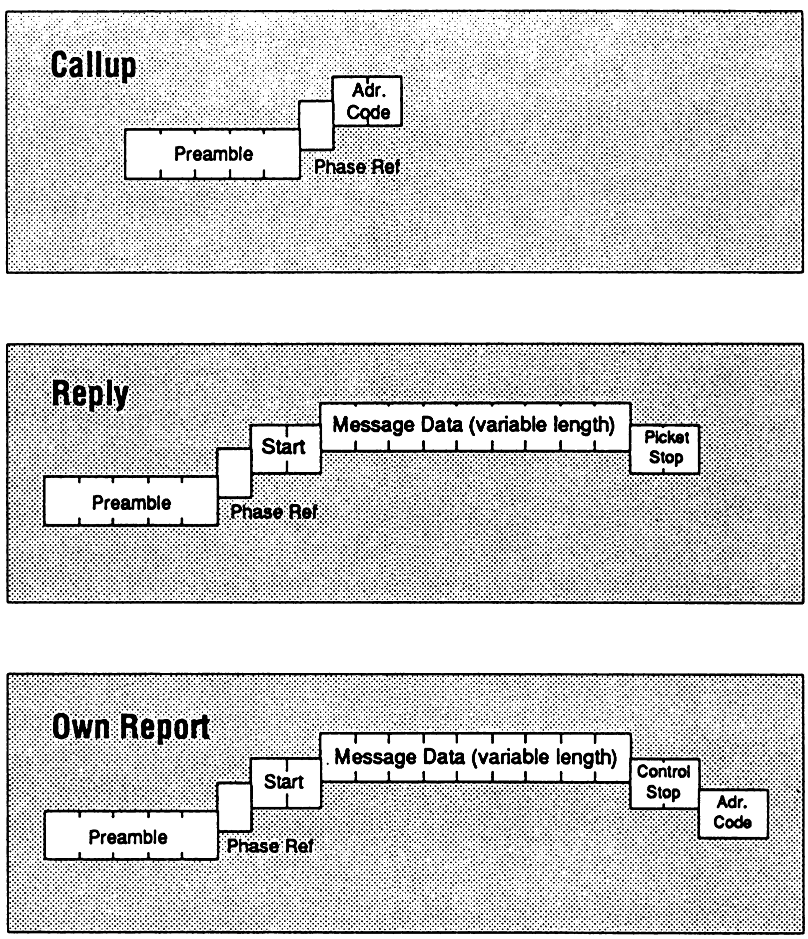


Figure 14-22.–Link 11 signals.

ROLL CALL

Roll Call is the normal mode of operation for Link 11. In roll call, one unit is designated as the Net Control Station (NCS). The remaining units serve as picket stations, or participating units (PUs). The NCS's DTS controls the sequence in which the other PUs are polled. Each PU transmits its data when it is called. During the remainder of the time, a PU is receiving reports from the other members of the net.

If a PU does not answer its call, the NCS will automatically poll him a second time. If he still does not respond, the NCS polls the next unit in the sequence. When each polling sequence, or net cycle, is complete, the NCS reports its own information. In this way, tactical data is exchanged among the net members. The operation of the DTS, once initiated, is automatic.

The types of transmissions that occur during roll call are the NCS call-up (interrogation), the picket reply, and the NCS report (interrogation with message).

SHORT BROADCAST

Short Broadcast is a single data transmission to all members of the net by a station that may be acting as either picket or NCS. It is initiated manually by the operator at the DTS.

BROADCAST

The **Broadcast**, or Long Broadcast, net mode consists of a continuous series of short broadcasts, separated by two frames of dead time. It is initiated manually by the operator at a station acting as either picket or NCS. It continues until the operator stops it manually.

RADIO SILENCE

Radio Silence is the absence of any transmission. A PU in radio silence will receive data from other members of the net, but will not respond even if it is polled.

TRANSMISSION ANOMALIES

Transmission anomalies are defined as transmissions which, although occurring during operational conditions, do not match any of the Link 11 transmission structures that we briefly described earlier in the Modes of Operation Section. These anomalies are often, but not necessarily, symptomatic of equipment problems.

THE EMPTY REPORT

Sometimes a report contains no data; the start code is immediately followed by the stop code. This can occur both in picket replies and in NCS reports.

THE CRYPTO SPIKE

Sometimes a report contains only one frame of data. The transmission consists of a start code, a single frame of data, called a *crypto frame*, and a stop code. This can occur both in picket replies and in NCS reports.

THE NCS-REPORT CALL-UP

DTS units that use computer-enabled addressing must obtain the address of the next unit to poll from the NTDS computer. These units have a nonstandard call-up structure for the first time a PU is polled. Their first call-up resembles an NCS report that has only one frame. The address for the second call, however, is not an anomaly. It is automatically supplied from within the DTS and looks like a normal call-up. Operationally, this idiosyncrasy has no effect except to increase the time it takes to complete one net cycle.

THE TOO-SHORT REPORT

A minimum number of administrative messages are required in every transmission. If the frame count of a report, including the phase reference frame and control codes, is fewer than 14, the NTDS software is not operating according to these requirements.

SELF-JAMMING

Sometimes a PU answers its call-up, but the NCS either does not hear or does not recognize the response. This situation can occur when the NCS has a poor receive capability. It may also occur when the unit is very distant or has a weak signal. Sometimes it occurs when the NCS is trying to process a signal in the Diversity mode and the unit is transmitting only on upper sideband. It may also occur for reasons that are still undetermined.

If the NCS does not receive a PU's response within 15 frames, it will automatically poll the PU a second time. This second call-up will jam any picket reply in progress. Hypothetically, this period of dual transmission will last for eight frames. But because the frame boundaries of the two transmitters may not be aligned, up to 10 frames of the picket reply may actually be affected. Depending on the length of the picket's transmission, it could also be jammed again 15 frames later, when the NCS polls the next unit.

Units that were successfully receiving the PU's transmission will report a poor signal-to-noise ratio and bit errors for that unit. Because identification information may be located in the area affected, the situation is often worse: the entire transmission may be lost. This naturally affects the receive quality for that unit. The picket may be unjustly accused of having equipment in need of repair, when the problem has actually been caused by the NCS.

ATMOSPHERIC INTERFERENCE

After the signal has been transmitted, it is subject to distorting effects such as skywaves, multipath interference, co-channel interference, and carrier frequency instability or drift. You can prevent some of these problems; others are beyond your control. Understanding how the environment affects the transmitted signal will help you to recognize the problems you can do something about. Refer to chapter 10 for more detailed information on atmospheric interference of radio communications.

AUDIO INPUT LEVELS

The audio impedance for both input and output for Link 11 radios is 600 ohms, balanced. **Balanced** means that neither conductor on the input or output is at ground potential. All link audio levels should be set at 0 dBm. That is, the HF and UHF transmitters should have a 0-dBm audio input applied from the data terminal set. The HF and UHF receivers should have their outputs set for 0 dBm. This value, of course, may later have to be adjusted upward, to compensate for patch panel or line losses. While performing preventive maintenance on the system, technicians must take measurements at both the transmitter input and at the DTS receive input. The goal is to provide 0 dBm to the transmitter and 0 dBm to the DTS.

RADIO KEYLINE

The radio **keyline** originates at the DTS and controls the transmit and receive states of the radio equipment. Three methods of keying the radio are available:

- A "phantom" key carried on the same line as the DTS transmit audio at +6 volts dc for transmit and 0 volts dc for receive.
- A separate unbalanced-to-ground keyline at +6 volts dc for transmit and 0 volts dc for receive.
- A separate unbalanced-to-ground keyline with ground switching the radio to the transmit state and an open circuit switching it to the receive state.
- The DTS will pre-key the transmitter before it applies the audio signal. This pre-keying allows the transmitter to come up to 90% of full power before the audio modulation arrives. No radio keyline adjustment is required.

SIDETONE

The **sidetone** is actually an echo of what is being transmitted. The audio signal from the DTS's input to the transmitter or the resultant modulated RF is coupled directly into the radio receiver. The radio receiver output returns to the DTS receive input and is used by the DTS to verify its own transmit quality. Based on this sidetone information, the DTS Transmit Data Error indicator may then be set.

TRANSMISSION PROBLEMS

You have likely heard the phrase, "There's link all over the place, it's on every circuit!" Usually this situation occurs when the RF output power of a Link 11 transmitter reaches a point at which cross-coupling of energy to other circuits occurs. The unique "ping-pong" sound of Link 11 on the 1MC, Site TV channels, and other shipboard circuits is rarely forgotten, and unfortunately causes many headaches among NTDS personnel. Other types of Link 11 interference that can affect the transmitted signal, however, are more subtle than too much output power.

INTERMODULATION DISTORTION

The mixing of signals and their harmonics to produce new output frequencies in called **intermodulation distortion**. Link 11 uses 16 audio tones to modulate RF transmitters. This is a relatively broadband signal that covers a wide area of the spectrum when transmitted. These audio tones can mix with other modulation byproducts to produce an even wider occupation of the spectrum. Avoid this condition at all costs. Adhering to PMS and other Link 11 maintenance publications (such as newsletters and bulletins) are in the best interest of the communications technician.

To avoid problems arising from intermodulation distortion and energy cross coupling, always keep the transmitter output power at the minimum required for connectivity. Never allow the transmitter audio input level to exceed 0 dBm (.774 V RMS). Keep the grid and plate currents of the transmitter power within their rated tolerances.

ELECTROMAGNETIC INTERFERENCE AND RADIO FREQUENCY INTERFERENCE

Electromagnetic interference and radio frequency interference (EMI/RFI) can have devastating effects on all shipboard communication circuits. We discussed this in chapter 10. Sometimes HF Link 11 signals can completely obliterate circuits operating in the UHF band. In such extreme cases, isolating the problem may be more difficult because the normal Link 11 "ping-pong" may not be heard in the upper frequency bands.

The preferred way to isolate an EMI/RFI problem is usually by selectively quieting the active data and voice circuits. After the problem emitter has been located, an operator should adjust its frequency, power output, or assigned antenna. Simply selecting another antenna for transmission may be a solution; changing frequencies may also be a solution. In either case, many hours of frustrating work may be required to isolate the problem emitter. We recommend that you review the EMI section of chapter 10 to become more familiar with these problems.

Keep the power levels of Link 11 emitters to a minimum. Do not be fooled by transmitter RF output meters! A transmitter RF output meter indication of 200 watts on a link circuit means average power. Applying a single-tone input to the transmitter, rather than the 16-tone Link 11 signal, will provide a true indication of maximum output power.

CO-CHANNEL INTERFERENCE

Failure to maintain sufficient frequency separation between adjacent channels will allow adjacent couplers to leak energy between units. This is called **co-channel interference**. For example, the AN/URA-38 antenna coupler, used in automatic mode with the AN/URT-23 transmitter, may actually retune itself to a transmission frequency on an adjacent channel whose separation is less than 15 percent. Serious signal distortion, as well as costly equipment failure, may then occur.

CARRIER FREQUENCY ERROR

Link 11 digital data is modulated onto individual audio tones using the quadrature phase-shift keying technique of encoding as described earlier.

Carrier frequency error occurs when the transmitter's internal or external frequency standard is inaccurate. This causes the sidebands to be displaced by the amount of error.

On demodulation, this frequency error will be perceived as a phase shift of the Link 11 tones. A good rule of thumb for estimating the amount of phase error is to assume that a 5-degree phase shift of the audio tones will result for every 1 Hertz of carrier frequency error.

For example, suppose a tone is intended to be shifted in phase by 45° to produce a certain data bit value. If the transmitter has only 1 Hertz of frequency error, then all data tones will have a 5-degree phase shift bias factor. At the distant station the 45-degree phase-shifted data tone will actually be shifted 50°, or the intended 45° plus the 5° introduced by the carrier frequency error. As a greater and greater error in the carrier frequency is introduced, the phase shift of the data tones also increases. Eventually the phase difference angle is in the wrong quadrant, and the receiving station will decode an incorrect value for the data bits.

The DTS's Doppler correction function compensates for the differences in relative velocity between platforms. It can compensate for frequency errors of up to +75 Hertz. If the Doppler correction function has been disabled, however, good data cannot be decoded from a frequency-shifted signal.

Carrier frequency error causes more degradation of the Link 11 signal than Doppler shift. A relative platform velocity of 58 knots will result in a Doppler shift error of only 100 parts per billion. This amounts to only a 1° phase error at 2 MHz and a 3° phase error at 6 MHz.

To combat frequency errors, each ship is equipped with an extremely accurate frequency standard. Using this external, central frequency standard for all Link 11 systems will alleviate the problem of component frequency error. Link 11 transmitters, receivers, and DTSs should be connected to a calibrated frequency standard, such as the AN/URQ-10/23.

CORRECTING LINK 11 PROBLEMS

In the past, Link 11 was repaired by the trial and error approach. This approach has several difficulties, particularly in regard to a system as complex as Link 11. First, the reasons why an action corrects a problem are not always understood. Second, an action that coincides with another action may appear to be corrective, when in fact it has no impact (for example, changing net control station may coincide with the correction of a switch position). Third, a corrective action in one situation may not apply to other situations, and in fact may have negative effects in another situation (for example, entering dummy PUs). This trial and error approach evolves into a list of myths, or potentially corrective actions, that operators try repeatedly when problems arise, without knowledge of the real problem.

The purpose of this section is to replace the trial-and-error approach with a systematic troubleshooting method. The rationale for this method is that complex Link 11 problems can be correctly diagnosed by isolating them to a particular PU (or PUs) in the net, and then to a location or subsystem on the PU. OPNAVINST C3120.39(B) supports this method of troubleshooting and should be consulted for more detailed information.

For any net, the number of potential sources of problems increases as the number of units increases. This means that for a net with a large number of PUs, you should assume there may be more than one problem. Each problem, however, needs to be addressed independently, and only one corrective action should be taken at a given time. To do otherwise may prevent you from identifying the actual cause of a problem.

Certain human errors that result in loss of data are generally the easiest to correct. PU address entry errors, for example, are prevalent, have a profound effect on net performance, and are simple to correct. These are easily identified on the Link 11 Monitor System (LMS-11) displays (see figure 14-23), but can be checked manually without an LMS-11. Similarly, a radio switched to voice instead of data can cause tone attenuation and loss of data. Once the problem has been identified, the switch position is easily corrected.

SOURCES OF PROBLEMS

Problems arise from different sources. The four major sources of problems are as follows:

- Inadequate planning
- Incorrect initialization
- Equipment malfunctions
- Environmental factors

INADEQUATE PLANNING

Link operations are preceded by a planning phase during which participants are identified, PU numbers and track blocks are assigned, frequencies are designated, and the capabilities and limitations of the participants are considered. When you plan link operations, follow procedures in the Link 11 SOP as well as those specified in battle group directives. Ensure that there will be adequate frequency separation, that the proper crypto is designated, and that all specifiable parameters are communicated to all units.

Ensure that trained personnel are on each unit to support that unit's assignments. These are only a few of all the items that you must take into consideration. If planning is inadequate, at best, the link will be more difficult to manage; and, and at worst, it will not function at all.

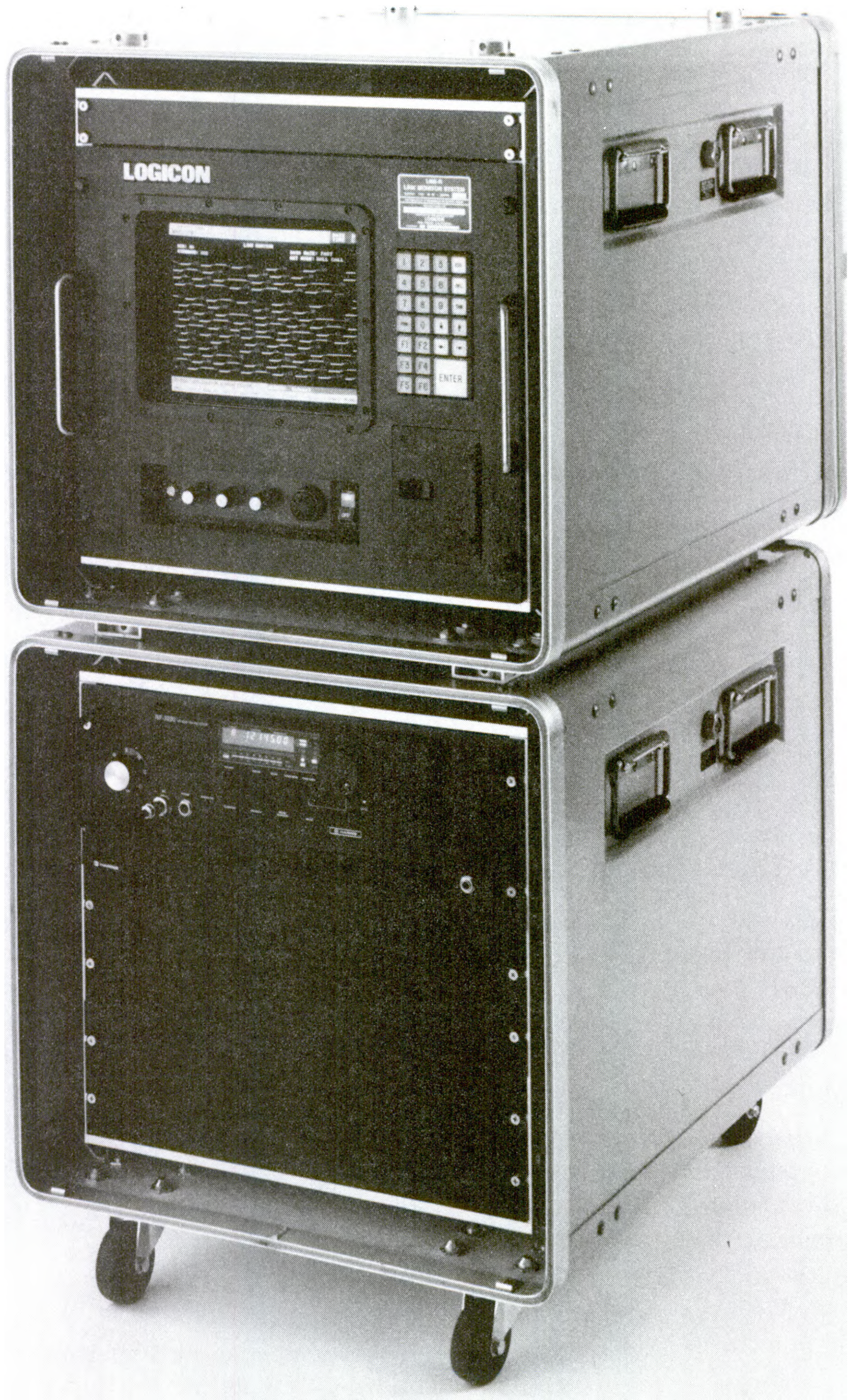
INCORRECT INITIALIZATION

Initialization procedures are very important. The opportunities for human error abound. Ensure that all pre-checks are performed and the initial setup is correct. This includes operator entries such as DLRP, ownship position, PU number, and track block, as well as checking switch positions and settings for the crypto, DTS, and radio. No amount of preplanning can compensate for sloppy initialization procedures. If the DTS data rate switch is set for slow, for example, while the net is operating at the fast data rate, you will receive no data. All initialization procedures should be reviewed by appropriate personnel before link operations begin. An independent second review of the initialization procedures will help to prevent the errors that often occur at this time.

EQUIPMENT MALFUNCTIONS

The most important step in troubleshooting after recognizing that there is a problem is to isolate the problem to a specific unit and then to the malfunctioning component. In most cases, the malfunctioning unit will be out of the net temporarily while fixing or reconfiguring its equipment.

Be aware that initialization errors can sometimes masquerade as equipment malfunctions. For example,



Courtesy of Logicon, Inc., Tactical and Training Systems Division

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Figure 14-23.–LMS-11 (top unit).

failure to enter ownship address correctly at the DTS may appear to be a transmit problem.

ENVIRONMENTAL FACTORS

Do not rule out environmental factors. They fall into two groups, problems that are self-induced (EMI/RFI interference) and natural phenomena (thunderstorms, diurnal effect, and solar cycle). You should consider environmental problems as the source of a problem if, after you are sure that link operations have been well planned, initialization procedures have been properly followed, and no malfunctioning equipment can be found, the problem still persists. See chapter 10 for a detailed description of these factors.

RECOGNIZING PROBLEMS

In determining the severity of a problem, consider the effect on other net participants as well as the effect on an individual unit. It is important to note that Link 11 troubleshooting requires at least a semi-operational net. Otherwise, you are simply troubleshooting your own system for problems.

A unit answering every other call-up with an empty data report may, for example, be an acceptable problem in the given situation. A unit whose NTDS computer is down can still act effectively as NCS.

In some cases, one unit's problem can disrupt the entire net. An example of this is the NCS with poor receive capability who calls over a PU's response. Another example is the unit with no stop code on the end of the transmission which causes the entire net to hang up while the NCS times out.

A successful link depends on proper planning, proper initialization, proper equipment function, and favorable environmental conditions. The goal of Link 11 troubleshooting is to ensure that as many as possible of these conditions are met.

STRATEGY

If all PUs are not receiving all of the desired data, there is a problem. If this problem can be isolated to a particular portion of the net and then to an individual PU, it can be further traced to a particular location, piece of equipment or component on that unit. Figure 14-24 shows how link problems can be isolated.

The following steps summarize a strategy you can use to recognize and isolate Link 11 problems to the PU level:

1. Are all PU addresses entered correctly?

At each platform, check ownship PU address entries at the DTS and in the NTDS computer. At the NCS check transmit address entries in the DTS and PU address entries in the NTDS computer.

2. Are all PUs responding?

Observe the receive indicators of the DTS acting as NCS. If you do not detect a response, determine whether the geographical range of that unit can account for its lack of response. Request that the battle group's LMS-11 operator verify that each unit is responding.

3. Does every PU's response contain data?

Request that the LMS-11 operator verify that message data is contained in all responses. Check for track numbers in the required range. Check the reception quality (RQ) value for each PU. For every PU that responds without data, check for an alarmed crypto, NTDS keyset errors or malfunction, and patching problems, in this order.

4. Are all units receiving data?

Verify reception of data at the NTDS. Check the values of RQ and Track Quality (TQ). If data is not being received from a particular unit, check whether other units are receiving that unit. This will help determine where the problem is located.

The process of answering these four questions will enable you to recognize, and correct, many Link 11 errors before they become serious problems. The successful operation of Link 11 is not automatic. It is not sufficient to verify link connectivity and data quality only once. The net can degrade, and new problems can arise at any time. Monitoring the net is a continuous process, and is essential to ensure continued connectivity and data throughout.

MONITORING THE NET

The quickest way to recognize that a problem exists is by observing the operation of the net. Several monitoring techniques are available. You can listen to the audio signal, (an experienced operator can detect a problem just by listening). You can examine the link monitor parameters calculated by the NTDS computer, and you can request information from the operator of the Battle Group Link 11 Monitor System (AN/TSQ-162(V).

Audio Signal

Most DTSs have a head phone jack that allows you to listen to the audio signal received at the DTS. You can also route it to a speaker. With experience, you will begin to recognize the ping-pong sound of the Link 11 call-up and response sequence. Static or a rough hissing sound identifies a timeout period. Two such timeouts in quick succession indicate that a PU has failed to respond to the double poll. A transmitter off-frequency is indicated by a squeak or squeal occurring every time that unit transmits, at an interval approximately equal to the net cycle time. Lack of the ping-pong sound is a clear indication that the NCS transmissions are not being received. The sound of Net Test or Net Sync can quickly be identified, as well as the rapid-fire sound of two units acting as NCS simultaneously. The sound of voices or Morse code superimposed upon the Link 11 ping-pong quickly suggests that frequency separation may be a problem.

DTS Indicators

Data Terminal Sets are equipped with indicators that provide information useful in determining the quality of Link 11 signal flow through the system. The specific indicators and their names may be different from one model of DTS to another. The MX-512P, for example, provides signal quality and interrogation/response information for each PU. At a minimum, each DTS monitors the following functions and indicates their condition:

- Transmit
- Receive
- Net Busy
- Transmit Data Error
- Receive Data Error
- Code Error
- Sync Complete

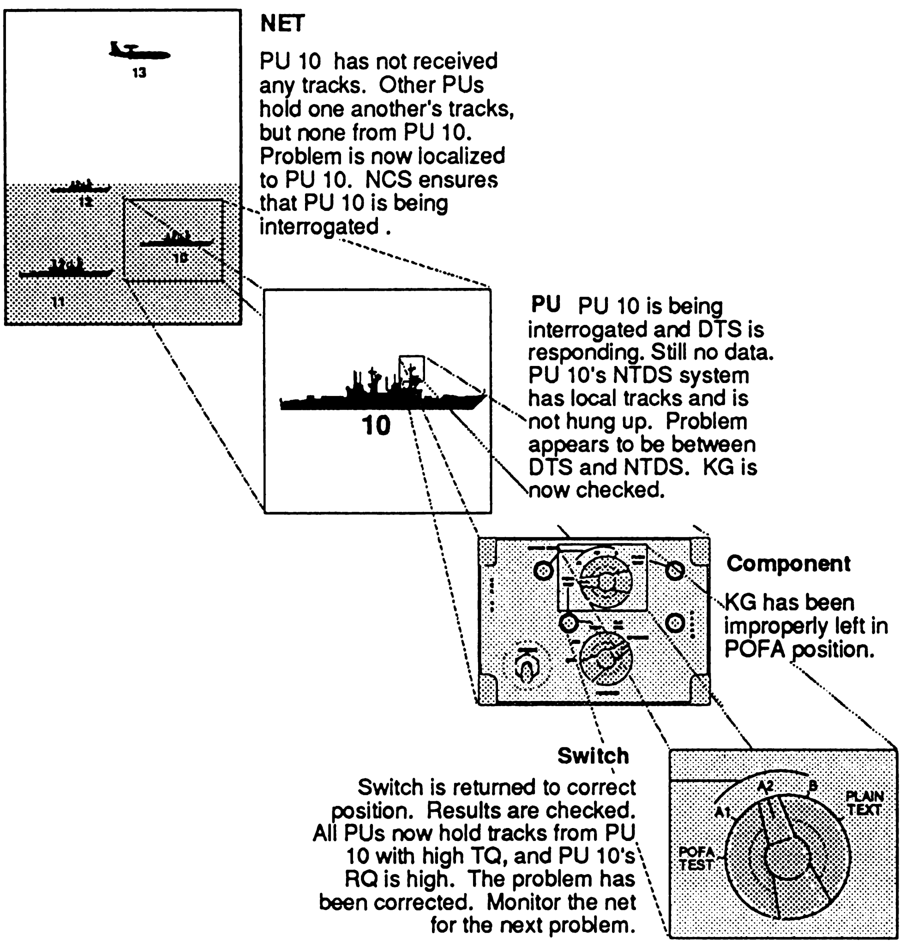


Figure 14-24.–Isolating net problems.

Interpreting these indicators properly can provide you with information about the data flow in your system.

TRANSMIT.–The *Transmit* indicator lights up every time the DTS transmits. The interpretation of the Transmit indicator depends on whether the unit is operating as a picket or as NCS. In the NCS mode, the Transmit indicator lights up every time a PU is polled. The only action required to start this indicator blinking is pressing the Transmit Initiate switch.

In the picket mode, on the other hand, the Transmit indicator can provide quite a lot of information. The DTS transmission in picket mode occurs only after the successful reception of ownship's PU address. This indicates several things: that the radio receiver is properly patched and is providing at least a minimum quality signal to the DTS (recall that address codes will be recognized with up to four bits in error in each frame), that the NCS is polling ownship's address, and that the DTS is processing and recognizing this address.

This indicator does not provide any information about data flow between the DTS and the NTDS computer, nor does it provide any information about signal flow between the DTS and the radio, nor about the quality of the transmitted signal.

RECEIVE.–The *Receive* indicator lights up every time the DTS recognizes a start code. Successful reception of a start code requires the same level of signal quality that recognition of an address code requires. The code will be recognized with up to four bits in error on each frame. The Receive indicator applies to signals received from any station in the net, not just to those received from the NCS.

The Receive indicator light turns off when the subsequent stop code is recognized. The same level of signal quality is required for recognizing this stop code (up to four bit errors per frame can be tolerated) as for recognizing the address code and start code. The fact that the stop code was processed demonstrates that the radio and DTS can provide this minimum quality of signal for the duration of an entire message.

If the Receive light comes on and stays on while the net "hangs up" for a brief period, the stop code was not recognized. Either it was not transmitted; or some time after the start code was received, the signal weakened or became garbled by interference, or the DTS lost frame synchronization.

NET BUSY.–The *Net Busy* indicator lights up whenever the DTS receives audio input from the radio. Because this includes noise or static as well as the Link 11 signal, the only thing you can infer from this indicator is that the DTS is patched to a radio receiver.

TRANSMIT DATA ERROR.–The *Transmit Data Error* indicator lights up whenever a bit error is detected by the EDAC function of the DTS on the message data portion of the transmitted signal. This signal is monitored as a sidetone on the receive line. If no sidetone is returned to the DTS, for example, this indicator will light up every time the unit transmits.

A Transmit Data Error indicates a problem with ownship's signal pathway or equipment. The source of the problem may be on either the transmit side or the receive side of the system. In isolating the cause of the problem, you need to consider how the sidetone is generated in your particular equipment configuration.

RECEIVE DATA ERROR.–The *Receive Data Error* indicator lights up when a bit error is detected by the EDAC function of the DTS on the message data portion of the signal received from another unit. This indicates a problem somewhere in the communications pathway between the transmitting unit's DTS and the receiving unit's DTS. Assuming that the audio signal generated by the transmitting unit was initially error free, the problem could be in the cabling to the transmitter, the transmitter itself, the transmitting antenna, the medium, the receiving antenna, the receiver, the cabling to the receiving DTS, or any combination of these locations.

Note that control codes such as the start code and stop code will be recognized with up to 4 bits in error in each frame, whereas message data with only 1 bit in error will cause this indicator to light up. Receive data errors correspond to information loss in the flow of data between NTDS computers.

In isolating the source of the problem, it is helpful to note whether it appears to be associated with the reception of data from a single unit or from all units, and whether the Transmit Data Error indicator is lighting up as well. A problem with the receive side of the DTS would, for example, cause the DTS to have difficulty receiving all signals, including the side tone of its own transmissions.

CODE ERROR.–The *Code Error* indicator lights up when bit errors are detected in the control codes of either a transmitted signal or a received signal. These two-frame codes include the start code, stop code, and address code. They will be recognized with up to 4 bits in error per frame. A lighted indicator means that a code was successfully processed even though it contained bit errors. There is no indicator light, however, for the more serious problem of a signal so poor that a code could not be recognized at all.

SYNC COMPLETE.–The operation of the *Sync Complete* indicator is not as uniform as the other indicators. In general, if a DTS is set for Net Sync and is successfully receiving, recognizing, and synchronizing on the Net Sync signal, this indicator will light up. Its operation during roll call, however, varies according to the particular model of DTS and can be determined from the applicable terminal's documentation.

NET CYCLE TIME

Net Cycle Time (NCT) is a parameter calculated by the NTDS computer program of each unit as part of the link monitoring capability. It measures the average time between reporting opportunities, as measured by that unit. By comparing the NCTs measured by each PU, you can determine if one unit is being polled more often than other units, or if one unit is consistently missing call-ups.

RECEPTION QUALITY

Reception Quality, or RQ, is a numeric value measuring the ability of every ship to receive every other ship. It is calculated by the NTDS system aboard every ship during normal roll call operations. It provides a means of diagnosing transmission and reception problems during the operation of the link.

Let's examine how RQ is determined. Every unit's data report contains a sequence number. Every NTDS follows this sequence for each PU and then assigns a grade. This grade depends on two factors:

- Have any transmissions been missed?
- Did any data contain bit errors?

If all PU transmissions have been received, and if the percentage of frames with bit errors is low, the highest grade, an RQ of seven, is assigned to that PU. An RQ value less than seven indicates that responses from a PU are missing, and/or his message data contains bit errors. Figure 14-25 illustrates the approximate correspondence between RQ and percentage of error-free message frames. This illustration assumes that every transmission is received. It does not take into account that an error in one frame causes two frames of information to be lost.

RQ	# Transmissions Missed	Good Data
7	None	93 - 100%
6	None	79 - 92%
5	None	65 - 78%
4	None	50 - 64%
3	None	36 - 49%
2	None	22 - 35%
1	None	7 - 21%

Figure 14-25.–Reception quality (RQ) value.

Limitations Of RQ

The RQ value for a PU is updated each time a transmission is received. If no transmission is received (for example, if the PU suddenly goes radio silent or his crypto becomes alarmed), the previously held value of RQ will remain in effect. Because the old RQ value is held through the period of unreceived transmissions, an RQ value does not necessarily, by itself, provide an accurate indication of the quality of the link. RQ values must be carefully interpreted.

The RQ Matrix

A useful tool for using RQ to evaluate a link is the RQ matrix, figure 14-26. The numbers of the PUs in the net are written as the rows and column headings of a table or matrix. An "x" is placed where each number intersects itself (along the diagonal if the numbers are in the same sequence). Starting with the first row, enter the RQ values for every other PU held by the unit first listed. Repeat for all rows. In figure 14-26, PU 06 holds PU 13 with an RQ of 2; PU 17 with a RQ of 7; PU 43 with on RQ of 7; and PU 61 with an RQ of 7.

Using the RQ Matrix

Let us examine the RQ matrix illustrated in figure 14-26 in greater detail. PU 06 is receiving PU 13 with a RQ of 2. In fact, all units are receiving PU 13 poorly.

PU \ PU	06	13	17	43	61
06	X	2	7	7	7
13	7	X	7	7	7
17	7	2	X	7	7
43	7	2	7	X	7
61	5	2	3	5	X

Figure 14-26.–RQ matrix.

But PU 13 is receiving all stations well. This may indicate that PU 13 has a poor transmitting system. Any equipment along the transmission data path is suspect: antenna, antenna coupler, radio, or DTS. On the other hand, PU 13's low RQ may indicate that the NCS is not receiving him and is polling on top of his responses, clobbering his data for all units.

PU 61 is receiving all units poorly. All units are receiving his data well. This could indicate that PU 61 has a poor receiver.

Figure 14-27 illustrates how RQ values can be used to troubleshoot and manage the net. In this example, the pathway between PUs 30 and 43 is bad in both directions, which may indicate a problem with the RF medium–perhaps extreme range. A change of frequency may help in this case. Shifting NCS to a geographically more central unit may also be a solution. Note that PU 56 appears to have difficulty in receiving all units, indicating a poor receiver.

PU \ PU	30	43	56	62
30	X	2	6	7
43	3	X	7	7
56	2	4	X	3
62	6	7	7	X

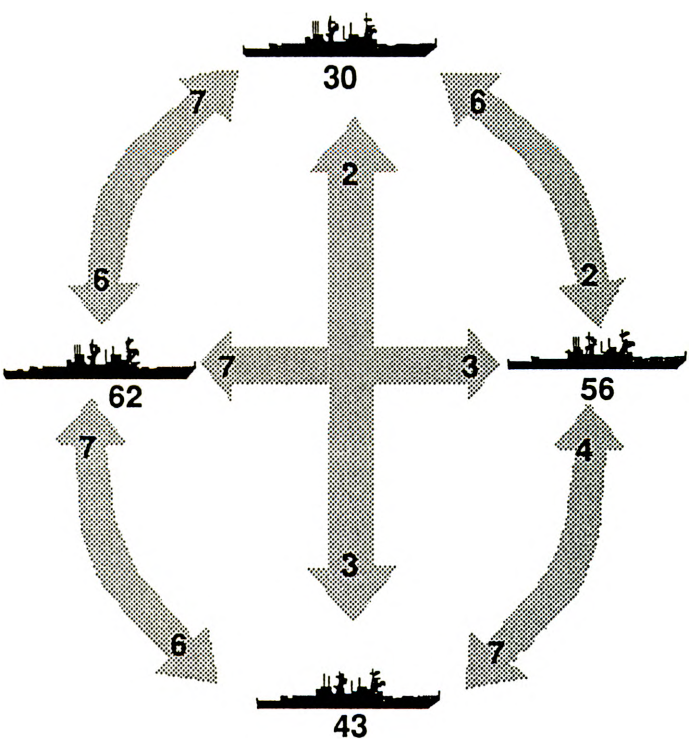


Figure 14-27.–Using the RQ matrix to evaluate communication pathways.

AN/TSQ-162(V)

The AN/TSQ-162(V), or Link 11 Monitor System (LMS-11), is a diagnostic tool designed to troubleshoot the analog portion of the Link 11 system. There is at least one LMS-11 in every battle group. The LMS-11 provides Link 11 system operators with the ability to measure and analyze the quality of link communications in real time.

By decoding a received Link 11 signal in much the same way a DTS does, the LMS-11 analyzes individual characteristics of the composite audio signal with respect to the power and phase of the frequency spectrum. It then calculates measurements of the overall signal power, signal-to-noise ratio (SNR), and Doppler shift. In addition, the LMS-11 measures mean and standard deviation of detected phase errors, counts the total number of frames transmitted and the number with bit errors, and calculates the bit error rate (BER).

Bit errors can be caused by noise, simultaneous transmissions, uncorrected frequency errors, or tone attenuation. The theoretical correlation of signal-to-noise ratio and bit error rate is summarized in figure 14-28.

By viewing real-time displays and summaries of numerical data, the operator can use results from analysis and measurements performed by the LMS-11 to quickly detect and diagnose problems affecting the quality of communication in the overall net.

At the net level, the operator can view the polling sequence as it occurs and observe which PUs are being polled and which PUs are responding. He can determine immediately whether a response contains message data or is empty. He can observe the net cycle time and the

SNR	BER
>14.5	0
14.0	1
13.5	3
13.0	5
12.5	8
12.0	20
<12.0	30

Figure 14-28.–Comparison of bit error rate to signal-to-noise ratio.

percentage of data being exchanged. With a single keystroke, he can change the focal point of the data displayed from the net level to the PU level.

At the PU level, he can identify individual units experiencing problems and can often isolate the cause(s) to one or more pieces of equipment. If necessary, he can also step through a PU's transmission and view the power and phase difference angles for each tone, on each sideband, one frame at a time.

At the frame level, he can look at the decoded value, the number of bit errors, and the SNR, as well as evaluating the individual tones. He can identify the effects of the NCS polling a second time on top of a PU response. He can confirm a missed stop code.

Human error in setting up and operating Link 11 equipment, deviations from standard net protocol, and even some hardware anomalies can be identified quickly and without guesswork with the LMS-11.

DIAGNOSTIC TOOLS

Once a problem has been recognized, an array of test equipment is available for troubleshooting it to the component level. Power meters, spectrum analyzers, and oscilloscopes can be used to check out radios and patch panels. Computers rely on diagnostic programs. Some components of the Link 11 system have a Built-In-Test Evaluation (BITE) function that verifies their performance. Whenever that component is suspected of failing, its BITE can be executed to test it. The AN/USQ-74 DTS, for example, has five levels of maintenance tests that can isolate component failures. The AN/USQ-36 has a self-check function, which does not, however, check the I/O function. The technician must be familiar with these tests so that he knows precisely what is checked and what is not.

In addition to equipment self-tests, several system tests are available. One test is the Programmed Operational and Functional Analysis (POFA), a shipboard program to identify the number of link errors. Others include the Link 11 Audio Signal Simulator (LASS) and the "Quicklook" provided by the Multiple Units Link 11 Test and Operational Training System (MULTOTS) at Navy Center for Tactical System Interoperablity (NCTSI) Detachments.

PROGRAMMED OPERATIONAL AND FUNCTIONAL ANALYSIS (POFA)

The POFA test requires that a special diagnostic program be loaded into the NTDS computer. The test

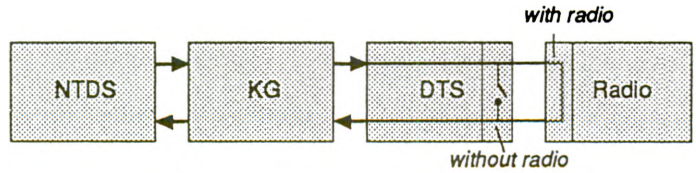


Figure 14-29.–Programmed Operational and Functional Analysis (POFA).

can execute in either the single-station mode or the multistation mode. A special switch setting on the KG-40 is required for performing POFA tests.

The single-station POFA is basically a loop-back test that circulates known data words from the NTDS computer, through the DTS, and back again to the NTDS computer. Single-station POFA can be run with or without the radio. It does not, however, check the operation of the entire system under dynamic conditions. See figure 14-29.

Performing a multistation POFA involves a multiple number of ships. It tests more equipment than the single-station POFA. Known data words are generated from the NTDS computer on one ship, and are sent through the DTS and up and out through the radio to one or more other ships. See figure 14-30 for multistation POFA data flow. Each receiving ship compares this data with a pattern known to its NTDS computer, counts the words in error, and transmits the count back to the original ship. Multistation POFA more closely

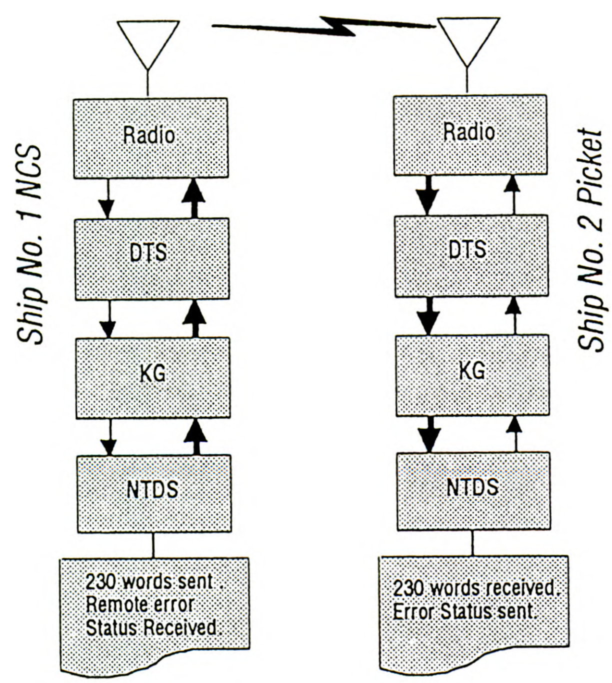


Figure 14-30.–Multistation POFA.

approximates dynamic testing than any other diagnostic. Ideally, the test should be error free. Because the signal is transmitted on the air, however, several attempts may be required before an error free multistation POFA is achieved.

LASS

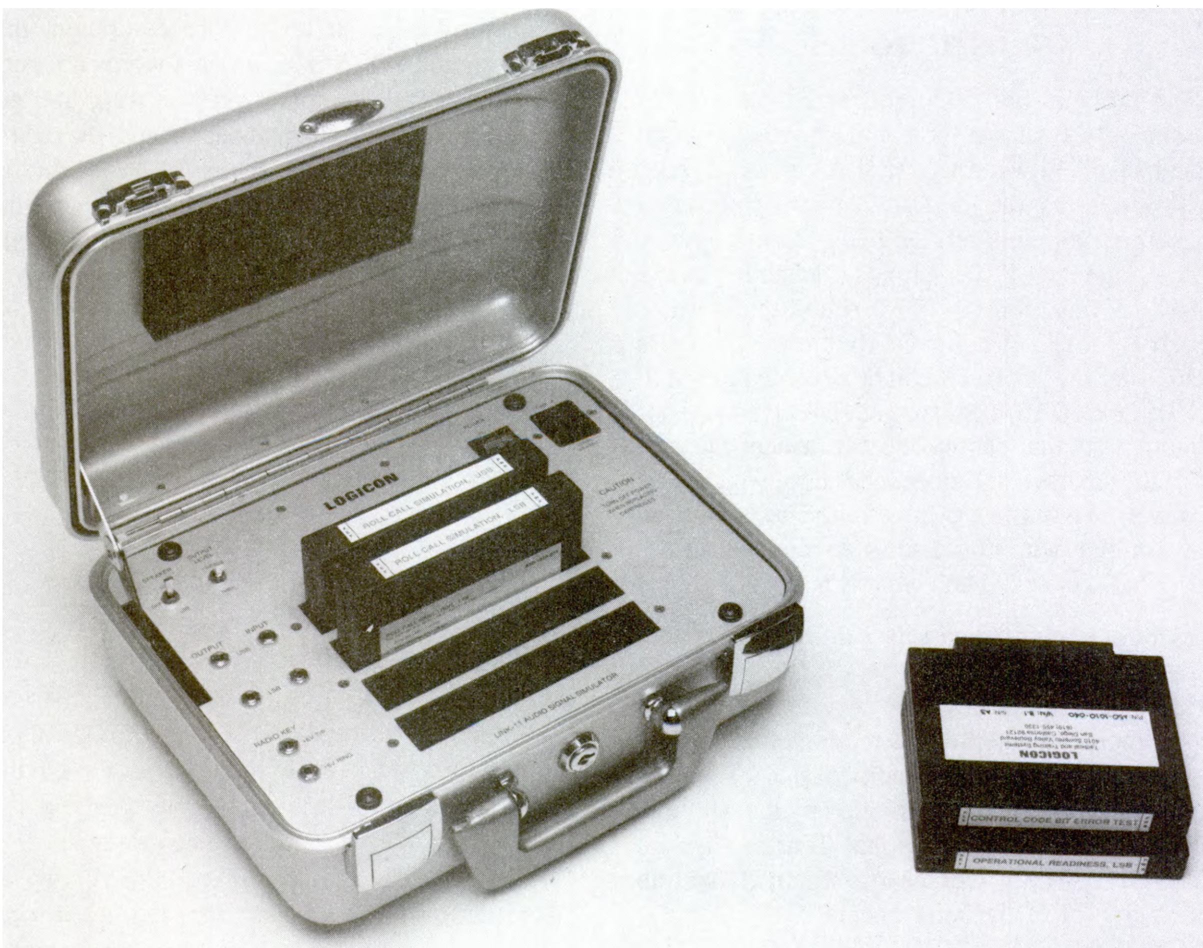
The Link 11 Audio Signal Simulator (LASS), figure 14-31, generates calibrated Link 11 audio signals. The parameters of these signals are specified by programmable cartridges that are inserted into the LASS. The parameters that can be varied include the number of preamble frames, the signal-to-noise ratio, Doppler shift, control code bit errors, tone amplitude errors, and phase errors. Independent signals can be generated for each sideband.

A calibrated signal can be inserted at any point in the audio pathway and the results viewed on the NTDS display, or with the LMS-11. The LASS signal can be used to measure line losses, verify patch signal problems, or test the receive capability of the DTS.

Since LASS also provides a radio keyline, the signal can be transmitted to another unit and used to test that unit's entire receive pathway, from the antenna to the NTDS computer.

MULTOTS QUICKLOOK

The MULTOTS Quicklook is a brief test of a unit's Link 11 system. It includes LMS-11 testing of the unit's hardware functions and selected MULTOTS testing of NTDS software functions as targeted by the unit. After the Quicklook is completed, a debriefing is provided,



Courtesy of Logicon, Inc., Tactical and Training Systems Division

245.8X

Figure 14-31.–Link 11 Audio Signal Simulator (LASS).

usually over the radio coordination circuit. A Services Summary Report is mailed to the unit as a follow-up to this debriefing. Quicklook services are available from NCTSI at the following locations.

San Diego, Calif.	DET 1 Headquarters
Norfolk, Va.	DET 2
Long Beach, Calif.	DET 3
Signonella, Italy	DET 4
Mayport, Fla. Charleston, S.C.	DET 6

Use these facilities to the maximum. They exist to provide you with Link 11 technical assistance and training.

LINK TRAINING

Training in equipment maintenance, repair, and alignment techniques is provided by the Link 11 Technical Enhancement Training (TET) program. This training is performed by the TET team aboard ship, using the ship's equipment. The TET team also evaluates how receptive ship's technical personnel are to the training, and documents the calibration, usability, and availability of shipboard test equipment and technical documentation.

Other resources for training include, but are not limited to, Combat Systems Mobile Training Teams (CSMTT) and Mobile Technical Units (MOTU).

Waterfront seminars are also available. There are two seminars: one for operator/technicians and one for net managers. Each seminar lasts one day.

RECOGNIZING COMMON PROBLEMS

Several recurring Link 11 problems that cause considerable net disruption have been identified. Symptoms on the LMS-11 and NTDS, possible underlying causes, and suggested corrective actions are summarized in the book *Understanding Link 11*, referenced at the end of this chapter.

NET MANAGEMENT

Net management is the activity of planning, monitoring, and adjusting assignments, functions, parameters, and participation within the net. The goal of net management is to provide the connectivity necessary for implementing battle tactics. Net management, therefore, is a coordinated activity that starts before a net is activated and continues until after the net is terminated. This section concentrates on the management of the net, primarily as it relates to establishing and maintaining good link communications. Here you will learn how to select the NCS, select the frequency, minimize net cycle time, maximize data throughout, and evaluate the efficiency of the net as a whole.

A successful team is the product of good management policy, as implemented by a good manager. In Link 11, that manager is called the Net Coordinator. In areas of Link 11 net management, he is responsible to the Force Track Coordinator.

A manager must know both his assets and his liabilities, limiting to the highest possible degree the liabilities while encouraging the full use of assets. In the Link 11 network, he must work on improvements to obtain the realistic goals of minimum net cycle time and maximum data throughout–that is, net efficiency.

In this section we discuss ways to maximize net efficiency. In discussing net management topics such as selecting NCS, selecting frequency, minimizing net cycle time, and maximizing data throughout, you will also learn how these are related to the overall efficiency of the net.

SELECTING THE NET CONTROL

The NCS is the central controller for the Link 11 net. No rank or authority is associated with this function. Communication with the NCS is of primary importance. If a unit fails to recognize its own address, it will never transmit. If the NCS fails to recognize the unit's start code, it will jam the unit's response with a second call-up. The degree of communication among units is called **connectivity**. Perfect connectivity is where all units are exchanging tactical data accurately and completely. Connectivity can degrade as a result of equipment performance, RF propagation characteristics, and range. Selecting the unit to act as NCS is one of the most important decisions to be made in managing the net.

Two principal features should determine the assignment of the NCS: equipment and location. The NCS should have the best operating Link 11 system and should be in the optimum location to remain in communication with all other units.

EQUIPMENT

The manager of the net *must* know the material readiness of all Link 11 equipment units in the net *before* he designates the NCS. If he assigns NCS to a unit with a degraded system, such as a radio receiver with low sensitivity, he could degrade the performance of the entire net.

For example, suppose the net manager designates the "weak unit" as NCS. The "weak" NCS will then immediately begin missing valid PU responses to calls. He will poll a PU a second time, 15 frames later, while it is still on the air with the initial response. By reinterrogating the PU while it is still responding to the initial call, NCS both continues to miss the PU's response and prevents the other PUs in the net from hearing the response. This causes the entire net to be jammed. To a large extent then, NTDS front-end performance (antenna, coupler, transceiver, and DTS) ultimately dictates overall net performance.

The NCTSI detachments can replicate a battle group link scenario in interactive mode. In addition to NTDS program checkout, they can perform special operational readiness tests on the NTDS transmit and receive capabilities. Testing all possible combinations of equipment, not just the transmitter and receiver known to be the best performers, is recommended.

Subsequent test debriefings will give the net manager a feel for his assets and his liabilities. The MOTUs can assist ship's force in resolving problems that are beyond the scope of routine maintenance.

LOCATION

The NCS should be located in a position that allows it to receive each unit in the net by direct RF communication. The HF surface and air ranges are about 300 miles. A surface range for UHF is about 25 miles. For surface-to-air the UHF range can be extended to 150 miles. The use of an AEW platform with a UHF relay capability (Auto Cat) can be used to extend the UHF surface range.

SELECTING THE FREQUENCY

The following factors affect the selection and usability of frequencies for Link 11:

- Limited number of available Link 11 designated frequencies
- 2-6 MHZ band congestion
- Day/night radio propagation characteristics
- Solar flare and sunspot activity
- Self-inflicted radio frequency interference and its effect on other shipboard tactical circuits
- Aircraft limitations at frequencies below 4 MHZ

Frequencies with specific types of emissions characteristics are allocated to specific users. Ideally, no other user would ever use a frequency assigned to your battle group. In reality, radio frequencies are often infringed on by unauthorized users, especially in areas outside of the continental U.S. For that reason, a Net Coordinator may opt to stay on a certain HF frequency for weeks on end to ensure its continued availability.

Because the 2-6 MHz band offers the advantage of maximum groundwave coverage, there is often severe frequency congestion in this band. The best approach when seeking a clear HF frequency is to have the Communications Department personnel monitor available frequencies and make recommendations. These personnel will have the Communications Plan and will know what frequencies are available for Link 11 use. Additionally, the communications personnel will know what frequencies are currently in use and will be able to ensure correct separation of active frequencies. The RMs in communications should periodically scan through the authorized frequencies to determine which one is best, should a change be required suddenly. The procedure for monitoring and changing frequency on Link 11 is contained in OPNAVINST C3120.39(B). Arbitrarily jumping from frequency to frequency without knowing the condition of the destination frequency can lead only to delays in establishing an effective link.

The Net Coordinator should require all track supervisors to monitor the link actively by listening to it. Monotonous as this may be, link performance is directly related to frequency quality. A seasoned operator listening to the audio, can recognize frequency degradation almost immediately.

Frequency selection can also be dictated by the time of day. High frequencies during the day, lower frequencies at night. As we discussed in chapter 10, the ionosphere tends to disperse and move higher at night. A lower frequency will give you a better "bounce" at night due to the diminished ionosphere.

Ship dispersement will also affect your selection of frequency. If all ships are within 25 miles of NCS, a 2-6 MHz frequency at noon may work just fine, or a shift to UHF may even be advisable.

NET CYCLE TIME

One measure of **Net Cycle Time** (NCT) is the time required for NCS to complete a polling sequence of all PUs. This is the NCT of the net. Another measure of NCT is the average time between PU reporting opportunities. This is the PU NCT. It is calculated and reported by each PU in the net. The value measured by one PU may be different from that measured by other PUs, as well as being different from the NCT of the entire net.

A PU's calculation of NCT will agree with that calculated by other units in cases where each unit is addressed only once during the cycle. If a unit is placed in the polling sequence twice per cycle, his calculation of net cycle time will be approximately half that of the value reported by other units, and significantly lower than the actual time required to poll all units.

- Factors affecting NCT include:
- The number of PUs polled
- The number of PUs that replay to the initial call
- The number of PUs that do not reply to either call
- The amount of data that each PU is transmitting

To allow timely responses to orders and keep display information accurate, each PU must transmit as often as possible. The frequency of a PU's transmission is determined by the NCT. Reducing the NCT allows more frequent transmission opportunities for each PU in the net.

Only the portion of NCT affected by the following factors can be reduced:

- The number of PU addresses polled
- The amount of data reported by each unit

The remainder of the NCT is consumed in overhead, such as preambles, phase reference frames, and control codes. Because they administer net functions, these cannot be altered.

You can minimize NCT by ensuring that all PUs respond to their first call-up. You can, if necessary, remove from polling any PUs that do not respond to their first call. Thereafter, you can reduce NCT only by reducing the number of PUs called by NCS, or by limiting the quantity of data exchanged. Remember, a PU need not be called to receive net data.

Also, remember that every dummy PU will add .6 seconds to the link's NCT. If a PU has dropped out of the net to repair or reconfigure equipment, remove his number from the polling sequence until he is ready to rejoin the net. In the case of an aircraft scheduled to participate in a link, wait until the aircraft has been launched or is known to be within the operating area before activating his PU number.

One way to reduce the quantity of transmitted data is by having PUs activate specific track filters in the NTDS. Another way is to ensure that all dual track designations have been resolved.

Identifying and isolating net anomalies can also improve net efficiency. Two typical examples of net anomalies that require attention are net stoppages caused by NCS timeouts and extended PU data transmissions.

NET EFFICIENCY

There is a minimum net cycle time for a net containing a given number of PUs exchanging a fixed volume of data. This minimum NCT assumes that every PU responds to its first call-up, and can be calculated. MIL-STD-188-203-1A specifies that the receive-to-transmit switching time will be between one and three frames at the fast data rate.

For every PU polled, there is an overhead of 23 frames. In addition, once each cycle there are the 15 frames for the NCS's own report (five frames more than the call-up). The total overhead (O) for a net polling (N) PUs can be expressed by the formula:

$$O = (23 \times N) + 5$$

Let D represent the total number, or sum, of data frames transmitted each cycle by all PUs. This is the volume of data exchanged. The total number of frames transmitted is then $(O + D)$. The percentage of data is simply:

$$\%DATA = \frac{D}{O + D} \times 100$$

Note that as the number of PUs increases, the %Data decreases: that is, the data becomes a smaller and smaller percentage of the total frames transmitted. Conversely, as the number of PUs decreases, the %Data increases.

At the fast data rate, there are 75 frames per second. Dividing the total number of frames (data + overhead) by 75 converts this total to the NCT:

$$NCT = \frac{O + D}{75} = \frac{23 \times N + 5 + D}{75}$$

Solving this equation for values of N and D that yield an NCT of 1 second, 2 seconds, and so on, and expressing that D in terms of %Data allows lines of constant NCT to be plotted on a graph.

Knowing the total number of data frames exchanged in a net cycle (or an average number per cycle in a given net), a net manager can use such a graph to determine the effects on NCT of adding or removing PUs from the net. For example, with a total data capacity of 150 frames, a net with six PUs will take a minimum of 4 seconds to complete one cycle. Carrying the same capacity with three PUs in the net would lower the NCT to slightly more than 3 seconds.

This graph also enables the net manager to calculate a quantitative measure of **net efficiency**. The definition of an efficient net is one in which every PU answers every call-up immediately (within two frames). If there are no bit errors on the message data, the efficiency of any net can be determined quickly as the ratio of the minimum NCT to the actual NCT:

$$\%Efficiency = \frac{Minimum\ NCT}{Actual\ NCT} \times 100\ (with\ no\ bit\ errors)$$

For example, the minimum NCT for a net of 10 PUs exchanging 150 frames of data can be determined to be 5 seconds. If the actual NCT is 10 seconds, the net is running at 50% efficiency; if the actual NCT is 8 seconds, the net is running at 62.5% efficiency; if the actual NCT is 5 seconds, the net is running at 100% efficiency. Notice that this does not mean that the %Data is 100%. The %Data corresponding to an efficiency of 100% is approximately 40%. A net of 10 PUs exchanging 150 frames of data spends the remaining 60% of its time on overhead frames.

Notice that this measure of efficiency is independent of the number of PUs in the net. It also independent of the amount of data exchanged. It does assume that none of the data contains bit errors.

To allow for the possibility of bit errors in the message data, the net manager may compare, instead, the ratio of the %Data of the most efficient net with the %Data of the actual net. The LMS-11 measurement of %Data takes bit errors into account.

$$\%Efficiency = \frac{Actual\ \%Data}{Theoretical\ \%Data} \times 100$$

For example, a net polling 5 PUs and exchanging 150 frames of data has a theoretical %Data of 55%. If the actual %Data is 45%, the net efficiency is about 82%.

REPORTING RESERVE

By comparing graphs of different values of D with curves for a fixed number of PUs, the net manager can consider how the NCT will change as the amount of data exchanged increases or decreases. If, for example, his current net is operating with NCS plus three PUs and 100 frames of data at 100% efficiency, his NCT is about 2.5 seconds. If he wishes to maintain a NCT of less than 5 seconds, he has a **reporting reserve** of 150 frames.

TACTICS

The goal of net management is to provide the connectivity necessary for implementing battle tactics. The net manager must translate these tactics into operational requirements for the net.

Under your control are not only which units transmit in a net, but also the frequency of the net access for each unit, the degree of efficiency required, and the amount of reporting reserve that should be maintained. You must weigh for example, the importance of one unit's data against the inefficiency and extended net cycle time caused by its intermittent response pattern. Or you can choose, on the other hand, to poll a unit that is currently in radio silence, knowing that you pay a .6 second price for providing the opportunity for a response. The net manager's job is to perform a quick trade-off analysis of the various actions he can take in a given situation versus their consequences and benefits.

REFERENCES

Understanding Link 11, Logicon, Inc., Tactical and Training Systems, San Diego, Calif., 1990.

CHAPTER 15

SUPPORT SYSTEMS AND MISCELLANEOUS EQUIPMENT

OVERVIEW

As a shipboard EMO, you must be thoroughly familiar with the support systems for your equipment. In this chapter, we will discuss those systems. We will also discuss various other types of equipment for which you may be responsible.

OUTLINE

Support systems

CCTV systems

Electronic warfare systems

Infrared equipment

SUPPORT SYSTEMS

Support systems include electrical power, ventilation, dry air, and liquid cooling systems. Without these support systems, our combat systems could not function. As the SEMO, you definitely need to be aware of these support systems and understand their impact on your combat systems equipment.

COOLING AND DRY AIR SYSTEMS

Cooling and dry air systems safeguard the expensive electronic systems that you are required to maintain. Electronic equipments generate heat and must be cooled. Critical waveguide systems require dry air pressurization to purge them of moisture and to prevent internal corrosion. These systems require you to have a thorough knowledge of cooling and dry air systems, as multimillion dollar electronics cannot continue to exist without them.

AIR COOLING

There are four methods of air cooling:

- Convection
- Forced Air
- Air to Air
- Air to Liquid

Convection

Cooling by the convection principle is shown in figure 15-1. As the heat of an equipment part warms the air in its vicinity, the warm air, being lighter, rises through the outlet openings. The cooler air is drawn in through the inlet openings to replace the warm air. This method is limited in its cooling effect because it relies upon natural airflow and requires that the equipment enclosure be of open construction without air filters. To increase the heat dissipation, a finned heat sink can be added to the heat producing part, as

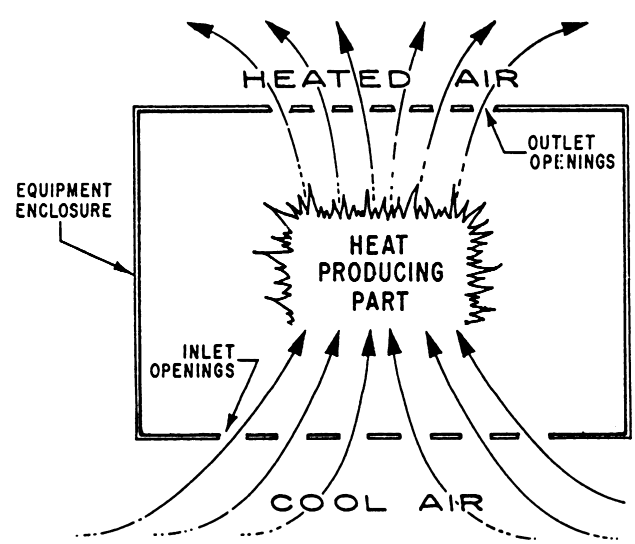


Figure 15-1.–Convection cooling.

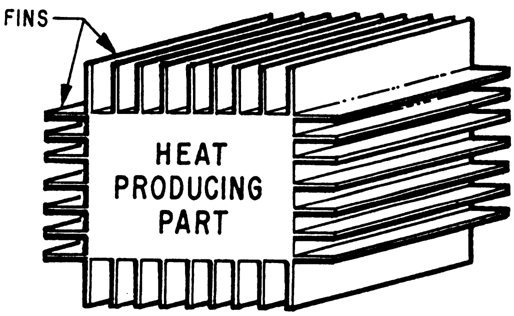


Figure 15-2.–Finned heat sink.

shown in figure 15-2. The fins increase the effective surface area of the part, allowing more heat to be transferred to the air. For the maximum transfer of heat, the part must make contact with the heat sink. Silicone compound is usually applied between the heat source and the heat sink for better thermo transfer. The heat sink must be kept free of any dirt or dust, which would act as an insulator. Remember, in an earlier chapter we stressed ultimate cleanliness of electronic spaces.

Forced Air

To increase the cooling effect over that provided by convection cooling, forced air cooling (fig. 15-3) uses a blower instead of natural convection currents to provide air movement. Cool air is drawn into the equipment enclosure and flows past the heat producing part, picking up the heat. The air is then exhausted from the equipment. An air filter is provided at the air inlet to remove dust and dirt that otherwise would settle on the internal parts of the equipment. The air filter must be kept clean according to the equipment's maintenance requirements to ensure maximum air movement and cooling.

In some equipment, a honeycomb rf interference filter is installed on both the inlet and the outlet to prevent stray rf from entering or leaving the equipment cabinet. These filters can also collect dirt that can reduce the airflow. Have them checked periodically.

Also check the bearings of the blower motor periodically. Because these bearings operate under severe conditions, they have a shorter service life than they might under normal service conditions. A general rule is: if the bearings fail, the entire motor must be replaced. If no replacement is on board, you might have your technicians disassemble the motor and see if they can make temporary repairs. In the meantime, have your supply petty officer order a new motor via CASREP. Do NOT risk damage to the equipment that the blower motor is designed to protect.

Air-to-Air Cooling

Some units of electronic equipment are hermetically sealed to prevent the entrance of moisture. For equipment of this type, an air-to-air heat exchanger (fig. 15-4) is used to prevent the air inside the equipment enclosure from mixing with the outside air and still allow cooling to take place. Air moving past the heat producing part absorbs heat and is forced through a heat exchanger by an internal blower. The heat in the internal air is absorbed by the heat exchanger. The cooled internal air is then returned to the equipment interior to continue the cycle.

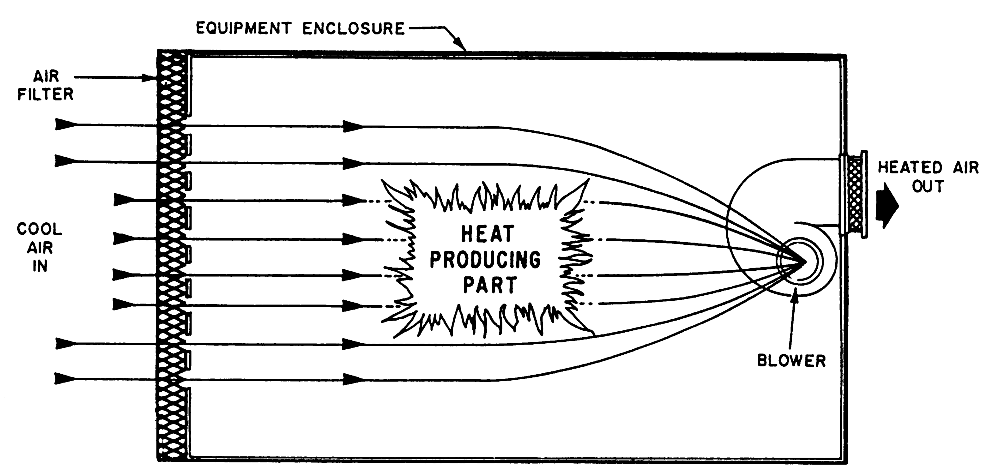


Figure 15-3.–Forced-air cooling.

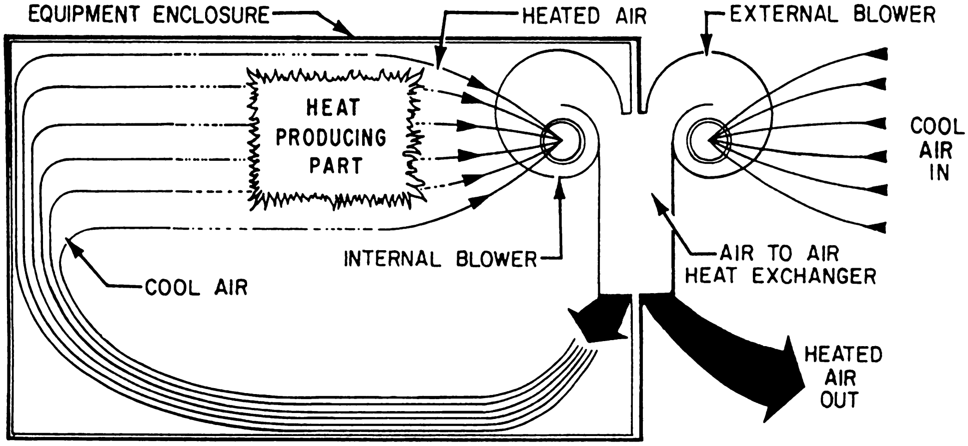


Figure 15-4.–Air-to-air cooling.

Heat is removed from the heat exchanger by forcing cool outside air through the heat exchanger by an external blower. There is no physical contact between the internal air and the external air. In some applications, the internal air is replaced by an inert gas such as nitrogen to prevent oxidation.

Air-to-Liquid Cooling

A more efficient heat transfer is possible by replacing the air-to-air heat exchanger with an air-to-liquid heat exchanger (fig. 15-5). In this method, the internal air is also circulated past the heat producing part and through a heat exchanger, but the heat is removed from the heat exchanger by a liquid coolant circulating through the heat exchanger.

Air-to-liquid cooling systems usually use built-in safety devices to shut down the equipment to prevent overheating. The overheating could be caused by low or no liquid flow, liquid too hot, an inoperative circulating fan, or reduced heat exchanger efficiency because of improper maintenance.

For proper operation, all of the air cooling systems depend on the condition of the ship's ventilation system. Proper maintenance and operation of shipboard ventilation systems is paramount to sufficient cooling of electronic equipment. This includes the cleaning of filters and maintaining of air conditioning boundaries.

Additionally, the "jury rigging" of ventilation systems because of "cooling problems" is unauthorized. Do not allow it.

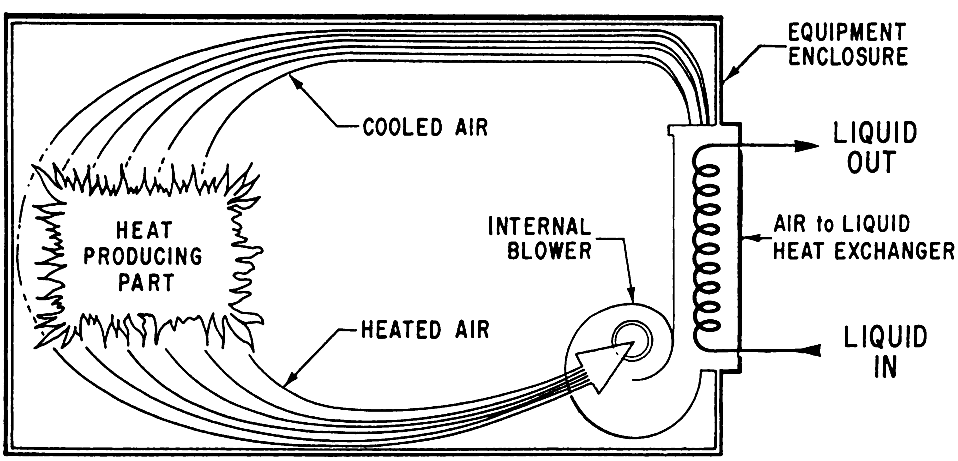


Figure 15-5.–Air-to-liquid cooling.

LIQUID COOLING

Although air-cooling can protect heat-producing devices, liquid cooling, in which the liquid flows directly through the device to be cooled, provides better cooling efficiency. Figure 15-6 shows a basic liquid cooling system. This type of cooling system is normally found on large equipment installations where a large amount of heat is developed. Many radar transmitters, for example, require this type of cooling. The other types that we discussed cannot dissipate the heat that a high powered radar transmitter develops. A disadvantage of this type of cooling system is that it is large and complex.

Because liquid cooling systems are complex and are common aboard ship, we will describe a typical system to give you a better understanding of the how the individual components function within the system and the basic maintenance required to keep the system at a high state of readiness.

For an electronic water cooling system to operate satisfactorily, the temperature, quality, purity, flow, and pressure of the water must be controlled. This control is provided by various valves, regulators, sensors, meters, and instruments that measure the necessary characteristics and either directly or indirectly regulate the system.

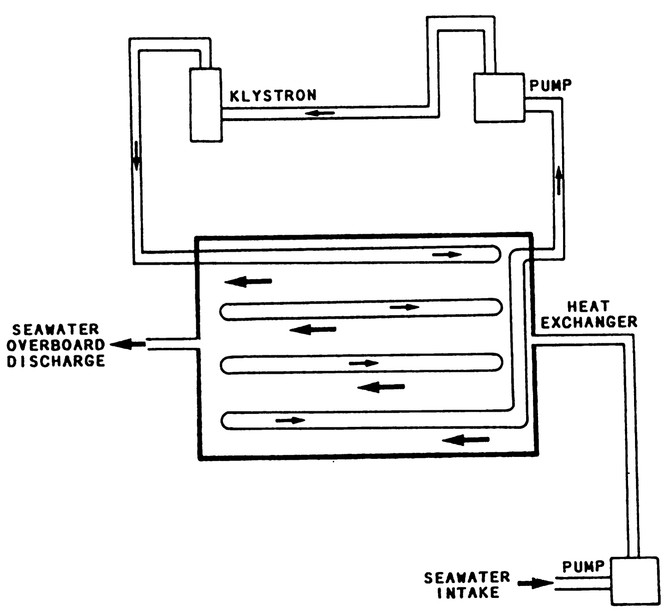


Figure 15-6.–Basic liquid cooling system.

The liquid cooling system consists of a seawater or a chilled (fresh) water section that cools the distilled water circulating through the electronic equipment. The main components of the system are the piping, the valves, the regulators, the heat exchangers, the strainer, the circulating pumps, the expansion tank, the gauges, and the demineralizer. Other specialized components are sometimes necessary to monitor the cooling water to the electronic equipment.

A typical liquid cooling system is composed of a primary loop (system) and a secondary loop (system). The primary loop provides the initial source of cooling water, either seawater or chilled water from the ship's air conditioning plant, or a combination of both. The secondary loop transfers the heat from the electronic equipment to the primary loop. The coolant normally used in the secondary loop is double-distilled water, obtained from the Naval Supply System. This distilled water is **ultrapure** and is maintained in that state by a demineralizer. However, in emergency situations, untreated boiler feed water can be used. **CAUTION**–The use of standard distilled water could cause premature system degradation. In some secondary systems, ethylene glycol is added to the water to prevent freezing when the system is exposed to freezing weather.

Primary Cooling System

The cooling water for the primary cooling system is either seawater or chilled water. The seawater, obviously, is from the sea and the chilled water is from the ship's air conditioning plant.

SEAWATER COOLANT.–Seawater from a sea connection is pumped by a seawater circulating pump in one of the ship's engineering spaces (this pump could just as well be in an electronics space) through a duplex strainer to remove all debris and then through the tubes of a heat exchanger. Finally, it is discharged back into the sea at an overboard discharge. The seawater loop can have either one or several branches. Multiple-branch loops supply primary cooling water to a number of heat exchangers for electronic equipment. To regulate the proper amount of seawater to each cooling branch, an orifice plate is installed in the line between each heat exchanger and the duplex strainer. The heat exchangers are referred to as seawater-to-distilled-water heat exchangers.

Another means of providing seawater is through the ship's firemain. The seawater is taken from the firemain through a duplex strainer and a flow regulator (orifice plate) to and through the heat exchanger. It is then discharged overboard. The connection to the firemain is permanent.

The ship's fire pump is used to pump seawater into the firemain. The fire pump is similar in design to the previously mentioned seawater circulating pump, except that it has a much larger capacity.

Another means of getting seawater as a primary coolant is by an emergency connection. This method is used if the normal seawater supply is lost. The connection is usually by means of a 1 1/2 inch fire hose. The emergency supply comes from an alternate portion of the ship's firemain or a portable pump rigged by the ship's damage control party. The portable emergency hose is normally stored in the liquid coolant machinery room. You, as EMO, should be able to rig the emergency cooling fire hose yourself, if necessary. There may not be time to locate trained individuals to save a multimillion dollar radar. Thoroughly familiarize yourself and all your ETs in emergency procedures.

Seawater systems are referred to as open loop or one pass systems because the seawater flows through the system only once.

CHILLED WATER COOLANT.–Chilled water is taken from the supply main of the air conditioning-chilled water systems. It can be used as either the primary source of coolant or as a backup source for seawater or other primary chilled water. The chilled water flows through the tubes of the heat exchanger (chilled water-to-distilled water), a flow regulator, and back to the chilled water system. A temperature regulating valve at the inlet of the heat exchanger regulates the flow of chilled water through the heat exchanger to maintain the required water temperature in the secondary loop (distilled water). The ship's air conditioning-chilled water circulating pump is used to pump the chilled water through the heat exchanger. The chilled water system is a closed loop water system because the water is recirculated. It must be kept tight and free from leaks to assure satisfactory operation.

Secondary Cooling System

The secondary cooling system is designed to transfer heat from the electronic equipment being cooled to the primary cooling system. This system is usually composed of a distilled-water circulating pump, a compression or gravity-feed expansion tank, the electronic equipment being cooled, a demineralizer, a temperature control valve, monitoring equipment with its associated alarms, and the heat exchanger, which is shared with the primary loop. The secondary system is a closed loop water system, compared to the seawater system, which is a one-pass or open loop system.

TYPES OF LIQUID COOLING SYSTEMS

In the U.S. Navy there are three basic configurations of liquid cooling systems. You could conceivably be involved with all three. The three types of systems are as follows:

- Type I-Seawater/distilled water (SW/DW) heat exchanger with SW/DW heat exchanger standby
- Type II-SW/DW heat exchanger with a chilled water/distilled water (CW/DW) heat exchanger standby
- Type III-CW/DW heat exchanger with a CW/DW heat exchanger standby

The specifications for the type of system (or systems) installed on your equipment will depend upon the operational requirements of the equipment. Some electronic equipments require the temperature of the distilled water to be regulated very closely; others do not.

Type I (SW/DW) systems are used for electronic system installations that can be operated satisfactorily with seawater temperature as high as 95°F. This should result in a distilled water supply temperature to the electronics of approximately 104°F. **Type II** (SW/DW,CW/DW) systems are used in installations that cannot accept a DW temperature higher than 90°F. **Type III** (CW/DW) systems are used in installations where the temperature range is critical. They require close regulation of the DW coolant to maintain temperatures between established limits. For example, the temperature limits might be 70° and 76°F. As you can see, Type III systems are used where tighter control is required.

Type I Cooling System

We are now ready for a more detailed look at the types of cooling systems. Let's begin by looking at the Type I system. Starting with the distilled water pumps (fig.15-7), distilled water, under pressure, flows to the temperature regulating valve. The temperature regulating valve is installed to partially bypass distilled water around the sea water-to-distilled water heat exchanger so that a constant water temperature can be supplied to the electronic equipment. As the temperature in the distilled water increases, more water is directed to the heat exchanger and less to the bypass line. This maintains the output water temperature constant. The standby heat exchanger is usually of the same design and is used when the on-line heat exchanger is inoperable or is undergoing maintenance. The heat exchanger is sized to handle the full cooling load of the

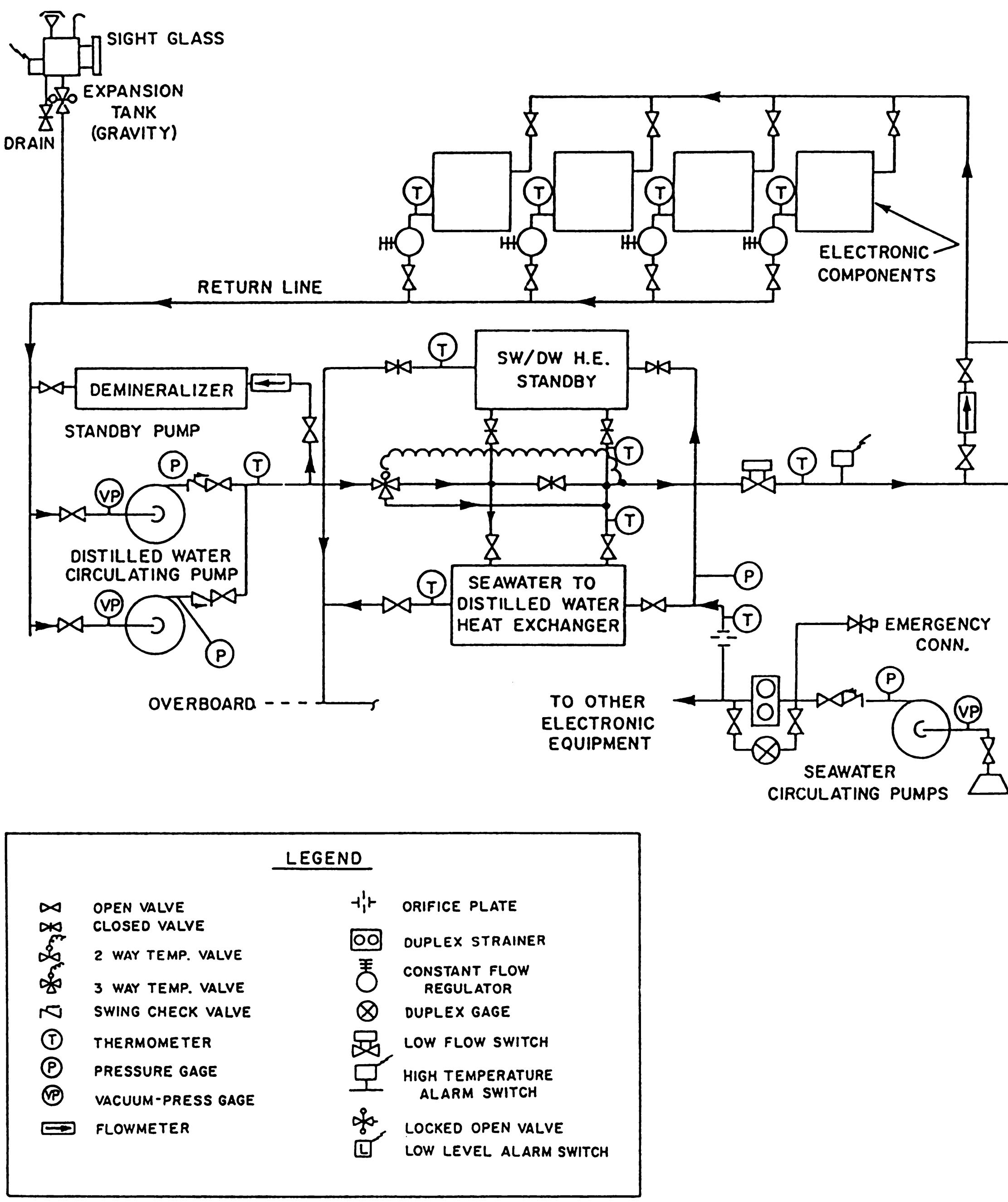


Figure 15-7.–Type I liquid-cooling system.

electronic equipment plus a 20 percent margin. From the heat exchanger, the water then goes through various monitoring devices, which check the water temperature and flow. Water temperature and flow depend upon the requirements of the electronic equipment being cooled. After the water moves through the equipment, it is drawn back to the pump on the suction side. In this way, a continuous flow of coolant is maintained in the closed-loop system.

An expansion tank is provided in the distilled water system to compensate for changes in the coolant volume, and to provide a source of makeup water in the event of a secondary system leak. When the expansion tank is located above the highest point in the secondary system and vented to the atmosphere, it is called a gravity tank. If it is below the highest point in the secondary cooling system, it is called a compression tank, because it requires an air charge on the tank for proper operation.

The demineralizer is designed to remove dissolved metals, carbon dioxide, and oxygen. In addition, a submicron filter (submicron meaning less than one millionth of a meter) is installed at the output of the demineralizer to prevent the carry over of chemicals into the system and to remove existing solids.

Type II Cooling System

The secondary system of the Type II cooling system (fig. 15-8) is similar to the secondary system of the Type I cooling system and uses many of the same components. The major difference is in the operation of the CW/DW heat exchanger. The secondary coolant is in series with the SW/DW heat exchanger and automatically supplements the cooling operation when the SW/DW heat exchanger is unable to lower the temperature of the distilled water to the normal operating temperature. The CW/DW temperature regulating valve allows more chilled water to flow in the

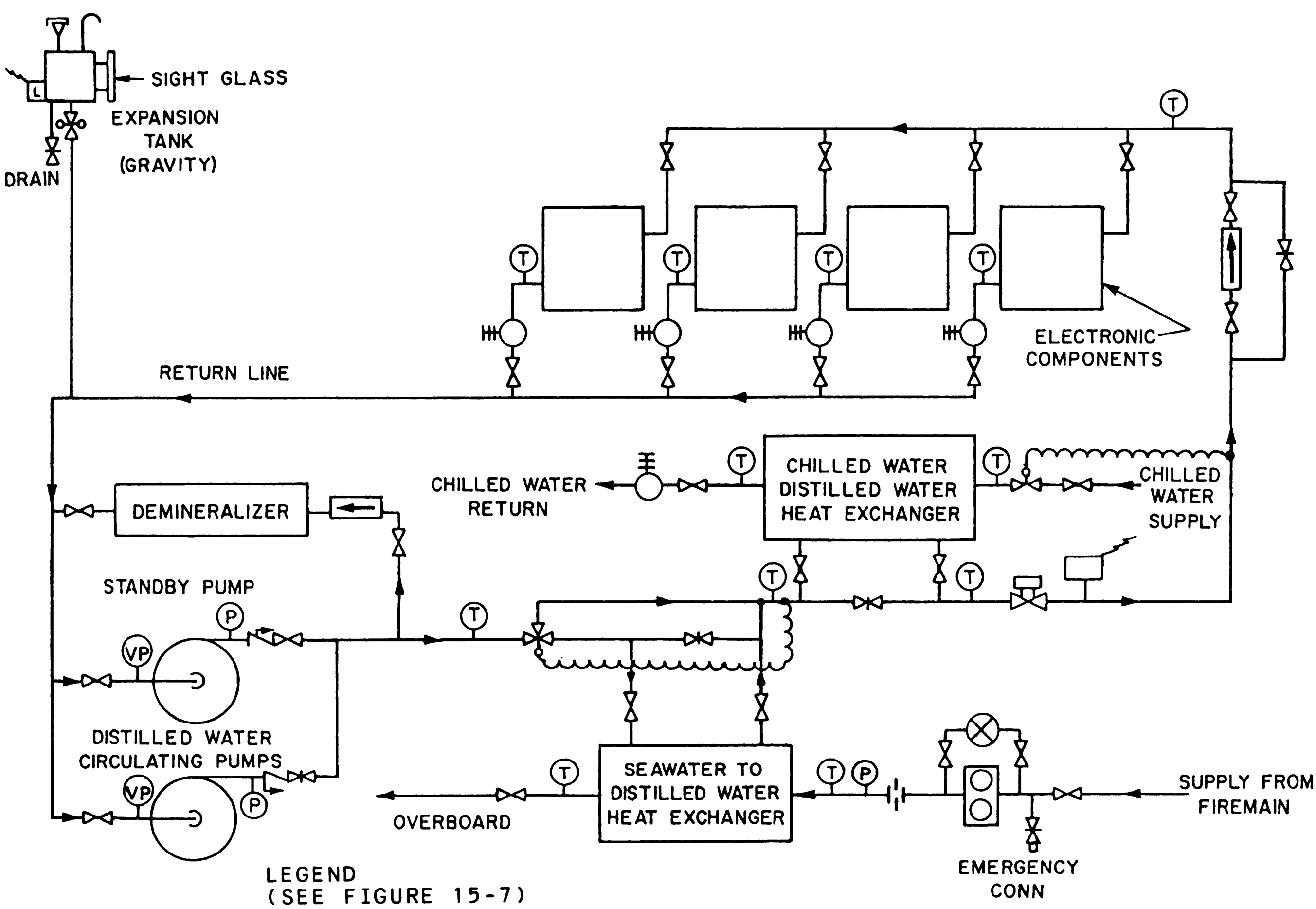


Figure 15-8.–Type II liquid-cooling system.

primary cooling system to the CW/DW heat exchanger. This causes the temperature in the secondary system to go down. Normally, this action only occurs in the event of high seawater temperatures encountered in tropic waters. The CW/DW heat exchanger is also used in the event of an SW/DW heat exchanger malfunction.

Type III Cooling System

The Type III secondary cooling system (fig. 15-9) also operates in a similar manner to that of the Type I secondary system. The major difference is in the way that the temperature of the secondary coolant is regulated. A three-way temperature regulating valve is not used. A two-way temperature regulating valve is used in the primary cooling loop to regulate the temperature of the secondary loop.

The duplicate CW/DW heat exchanger is installed parallel with the first heat exchanger and is used as a standby heat exchanger.

In the event that a malfunction occurs requiring the first heat exchanger to be removed from service, the standby exchanger can be put into service by manipulating the isolation valves associated with the two heat exchangers.

COOLING SYSTEM COMPONENTS

You should be able to identify the individual components of a typical cooling system and describe how they operate. This will aid you as EMO when you do periodic tours and inspections of your equipment.

Heat Exchangers

In the liquid coolant heat exchangers, heat that has been absorbed by distilled water flowing through the electronic components is transferred to the primary cooling system, which contains either seawater or chilled water from an air conditioning plant. In both cases (figures 15-10 and 15-11), the heat exchangers are of the shell and tube type in which the secondary coolant, distilled water (DW), flows through the shell, while the primary coolant, seawater (SW) or chilled water (CW), flows through the tubes.

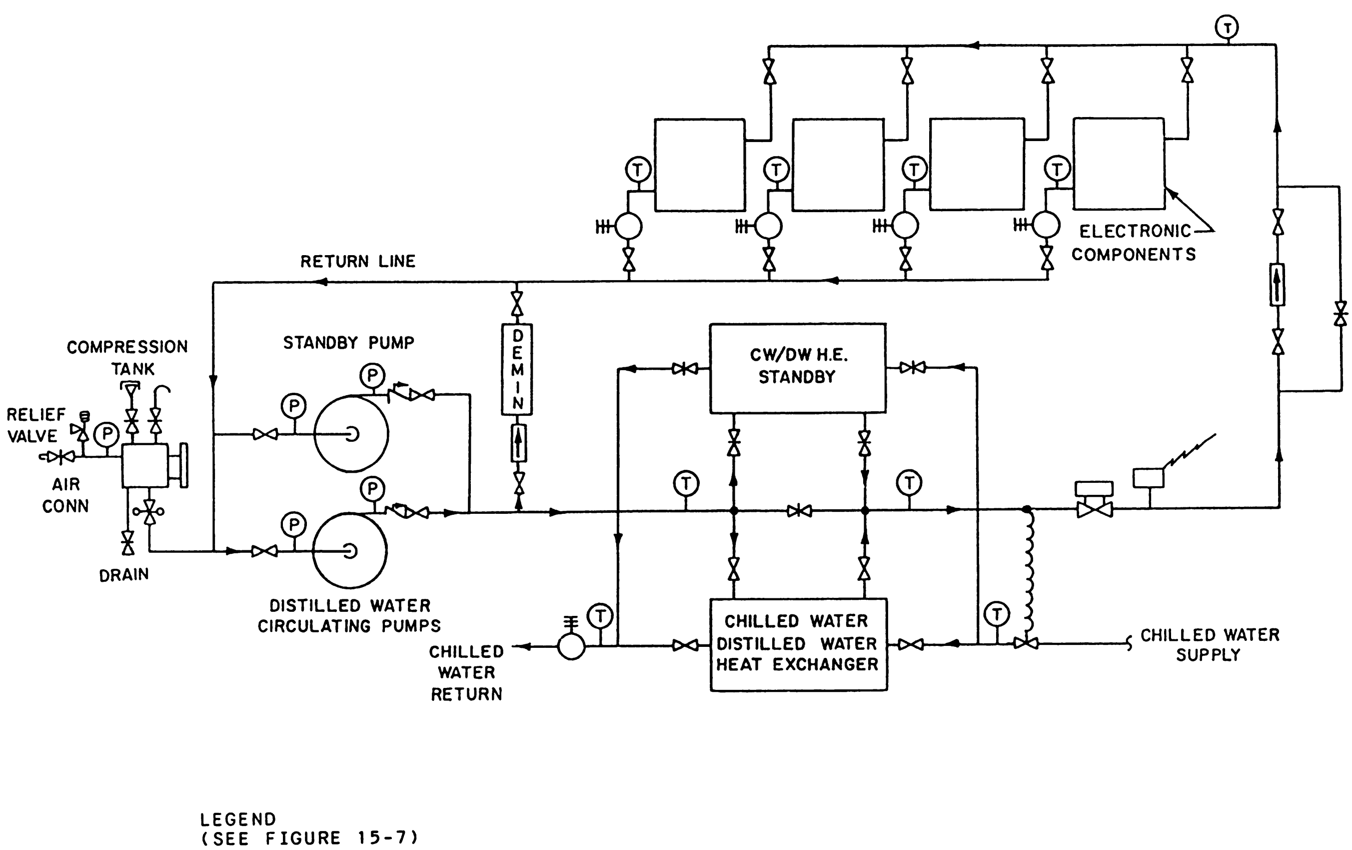


Figure 15-9.–Type III liquid-cooling system.

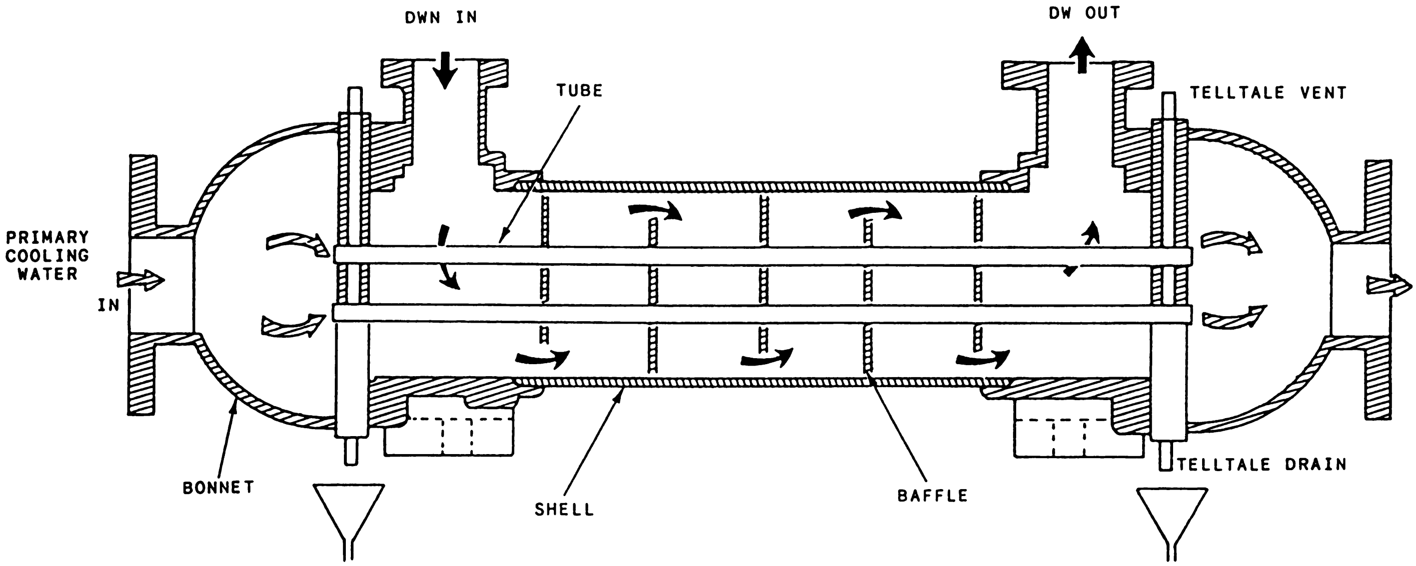


Figure 15-10.–Single-pass SW/DW heat exchanger with double tube sheets.

A single pass counterflow heat exchanger (fig. 15-10) is more efficient than the double pass heat exchanger, because there is a more uniform gradient of temperature difference between the two fluids. In figure 15-10, the primary coolant (SW/CW) flows through the tubes in the opposite direction to the flow of the secondary coolant (DW). Heat transfer occurs when the seawater flows through the tubes; extracting heat from the distilled water flowing through the shell side of the heat exchanger. The distilled water is directed by baffles to flow back and forth across the tubes as it progresses along the inside of the shell from inlet to outlet. In figure 15-10, the preferred method of double tube sheet construction is shown. Single tube sheet construction is shown in figure 15-11.

Double tube sheets are used at both ends of a tube bundle. A void space between the sheets prevents contamination of the distilled water and permits the monitoring of water loss due to tube leakage. You should be on the lookout to detect leakage at the "telltale drains," which indicates a failure of a tube joint. The type of water leaking out indicates whether the failure is in the primary or secondary system. The telltale drains should never be plugged or capped off. A leak in one of the tubes shows up as a loss of water in the secondary side of the liquid coolant system, because it operates at a higher pressure than the primary side. This is intentional and ensures that the distilled water is not contaminated with seawater when a leak develops in a heat exchanger.

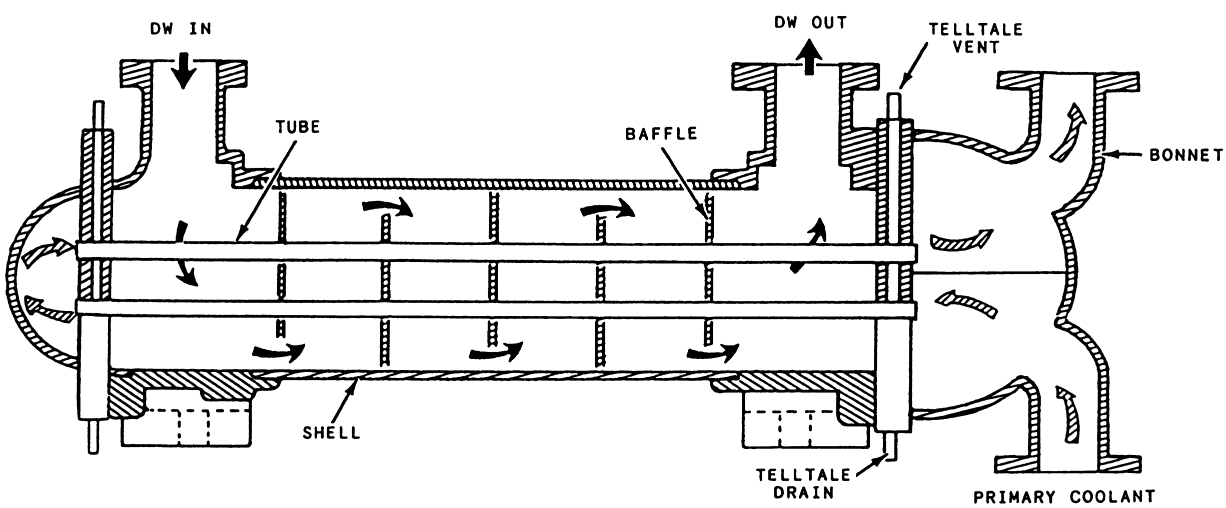


Figure 15-11.–Double-pass SW/DW heat exchanger with single tube sheets.

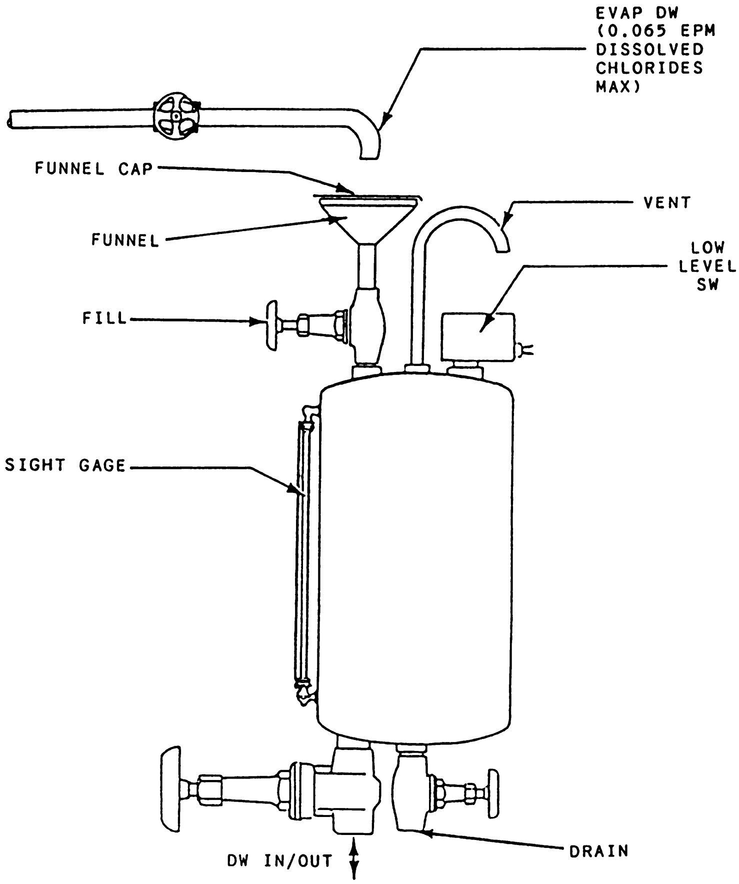


Figure 15-12.–Gravity expansion tank.

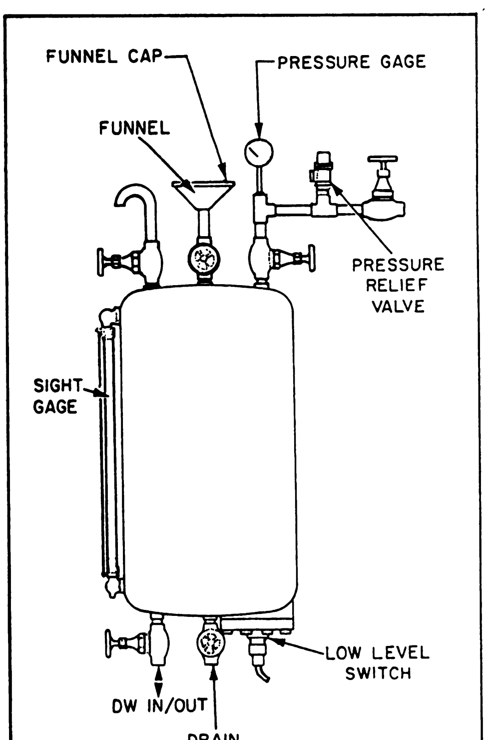


Figure 15-13.–Pressure expansion tank.

Expansion Tank

The expansion tank serves a threefold purpose in a liquid cooling system:

- It maintains a positive pressure required on the circulating pump for proper operation of the circulating pump.
- It compensates for changes in the coolant volume due to temperature changes.
- It vents air from the system and provides a source of makeup coolant to compensate for minor losses because of leakage or losses that occur during the replacement of radar equipment served by the system.

The expansion tank may be either a gravity tank or a pressurized tank. See figures 15-12 and 15-13.

Seawater Strainers

Strainers are used in the seawater cooling system to remove debris and sea life, which could clog the

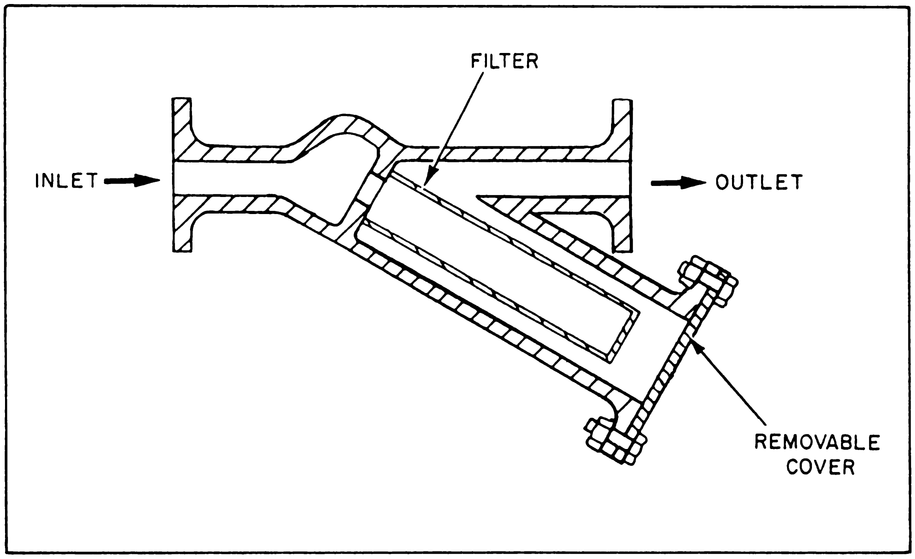


Figure 15-14.–Seawater simplex strainer.

pressure and flow control device (orifice) and the tubes of the heat exchanger. The two types of in-line seawater strainers most commonly used in shipboard liquid cooling systems are the simplex (single) and duplex (double) basket strainers. See figures 15-14 and 15-15.

Temperature Regulating Valves

The temperature regulating valve regulates the amount of cooling water flowing through a heat exchanger to maintain a desire temperature of distilled

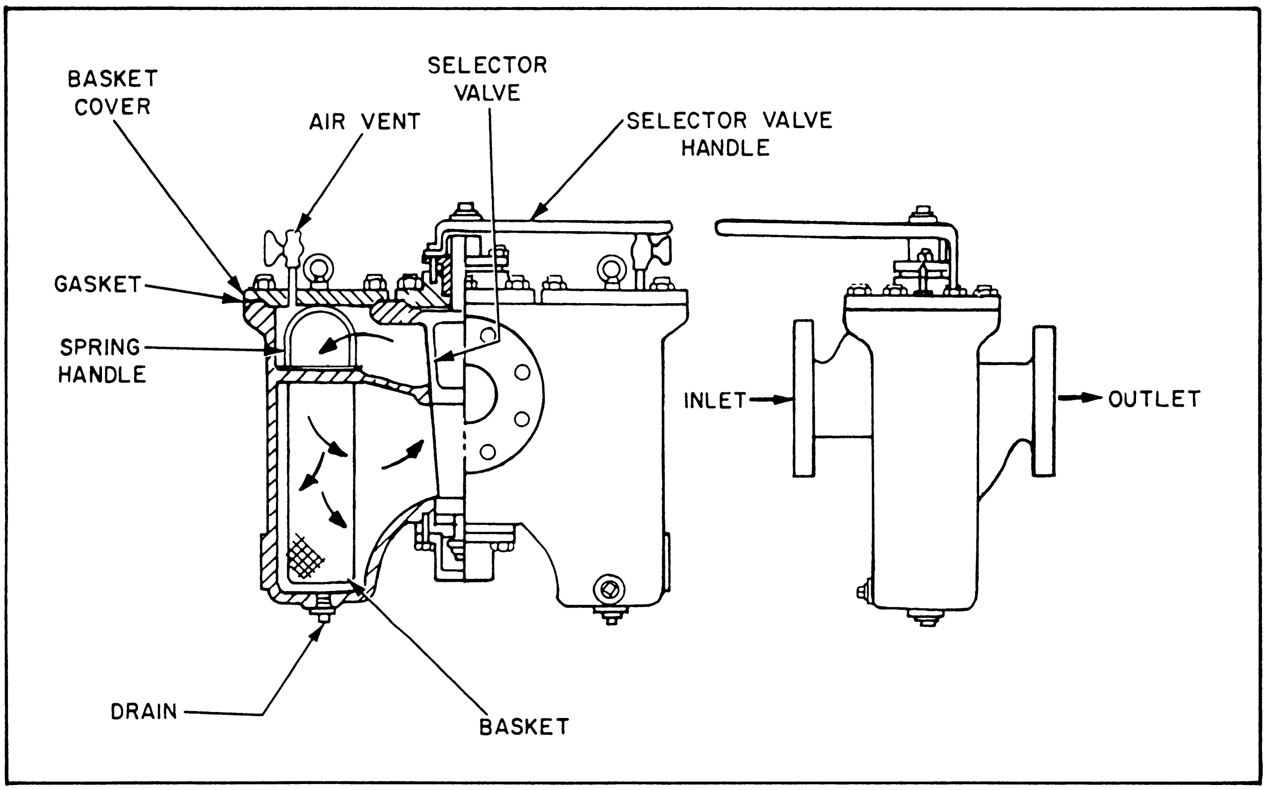


Figure 15-15.–Seawater duplex strainer.

water going through the electronic equipment. Temperature regulating is usually provided by either a three-way valve, a two-way valve, or a combination of both as shown in figures 15-16 and 15-17. The three-way valve is used where seawater is the primary cooling medium in the heat exchanger and the two-way valve is used where chilled water is the primary cooling medium.

Flow Regulators

Several types and sizes of flow regulating devices are used in both primary and secondary cooling systems to reduce the pressure or the flow of coolant through the cooling system. The basic types are as follows:

Orifice plate–the simplest design, consisting of a steel plate with a hole in it. With a constant known seawater pressure and with a given hole size, the volume of water through the device can be determined easily.

Constant flow regulator-(variable orifice)(fig. 15-18).–Used with chilled water systems, it is installed downstream from the heat exchanger. This restricts the flow from the heat exchanger and keeps the heat exchanger fully submerged for greater heat transfer.

Equipment Flow regulator–Used primarily with electronic equipment to regulate the flow of distilled

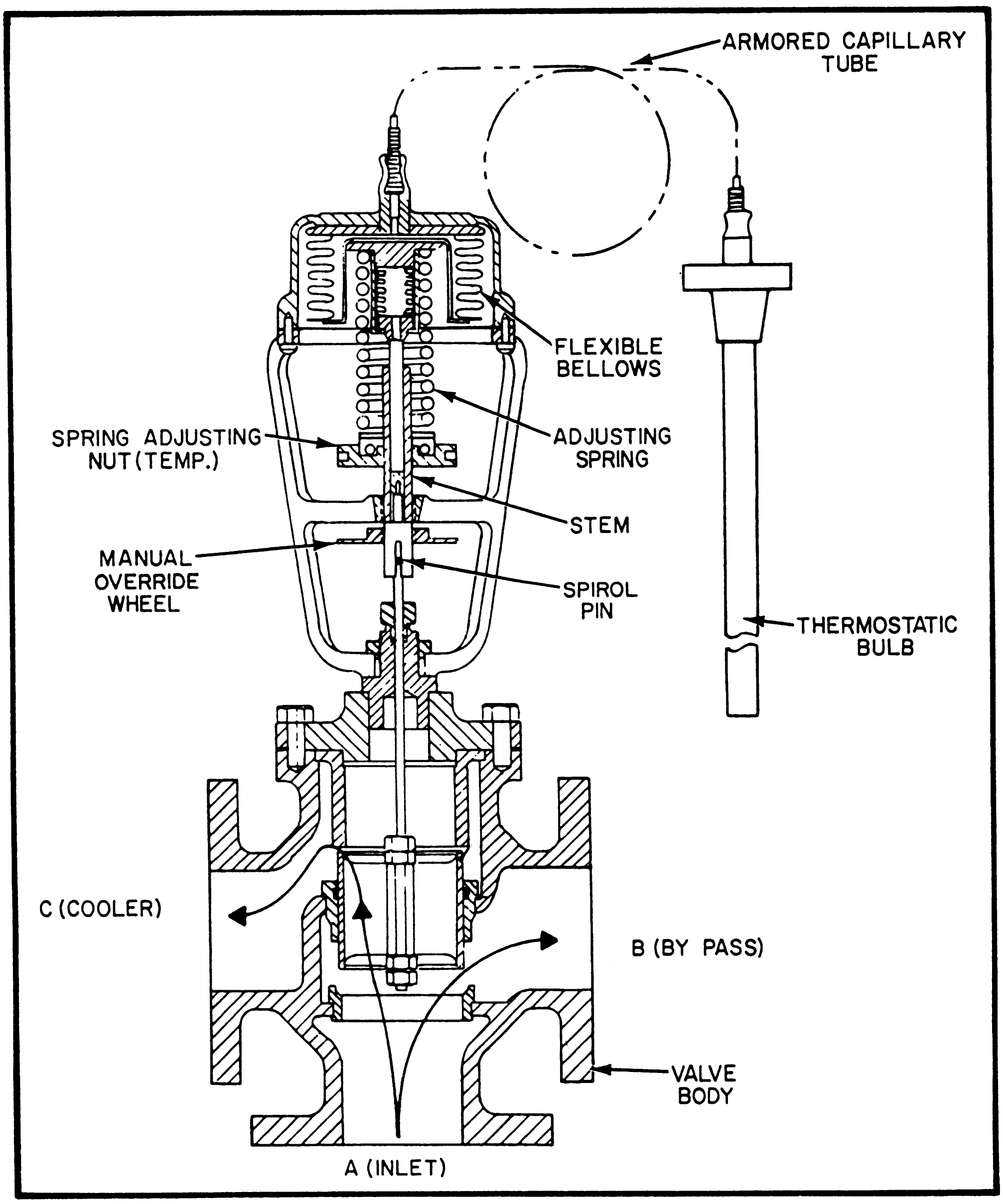


Figure 15-16.–Three-way temperature regulating valve.

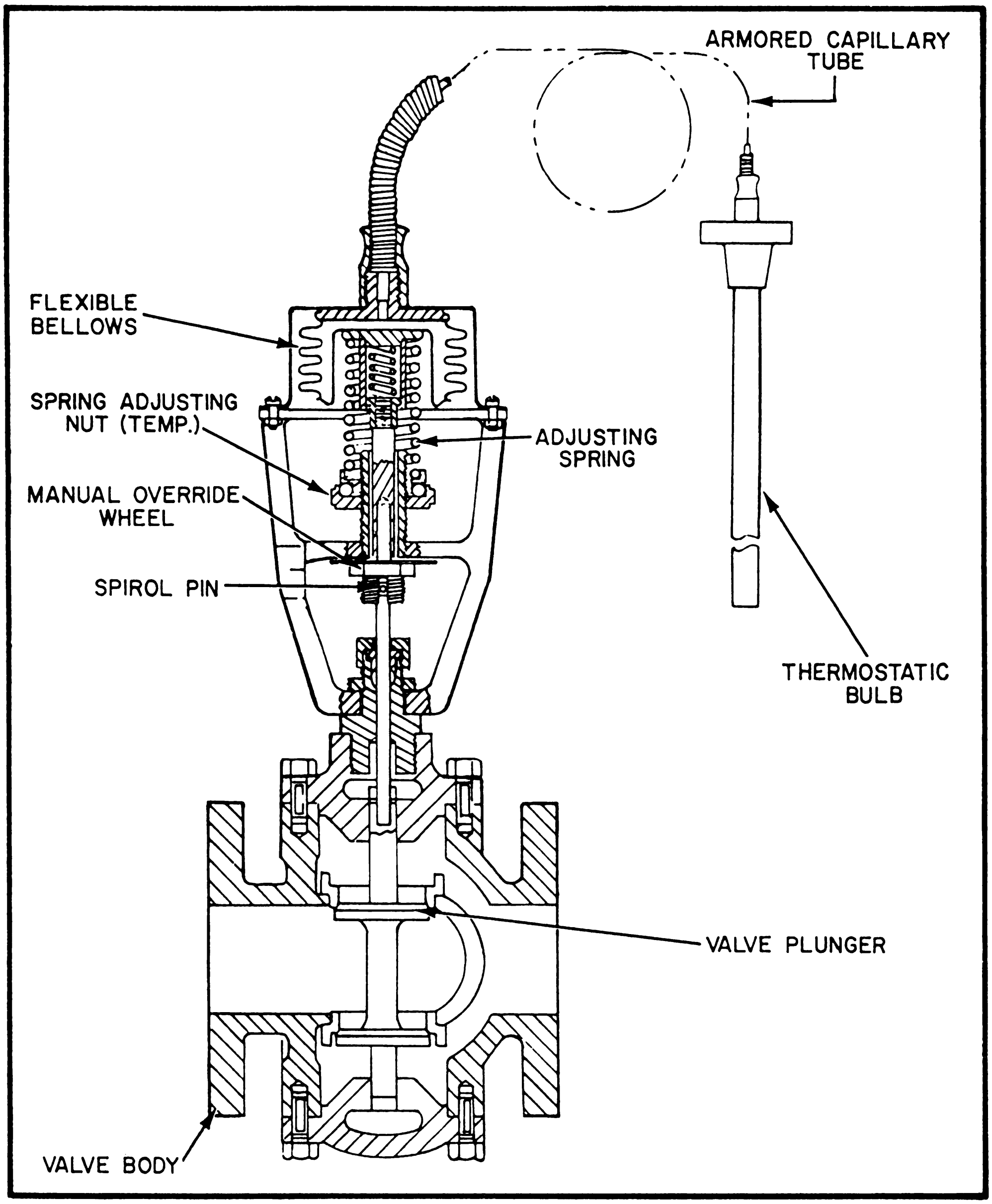


Figure 15-17.–Two-way temperature regulating valve.

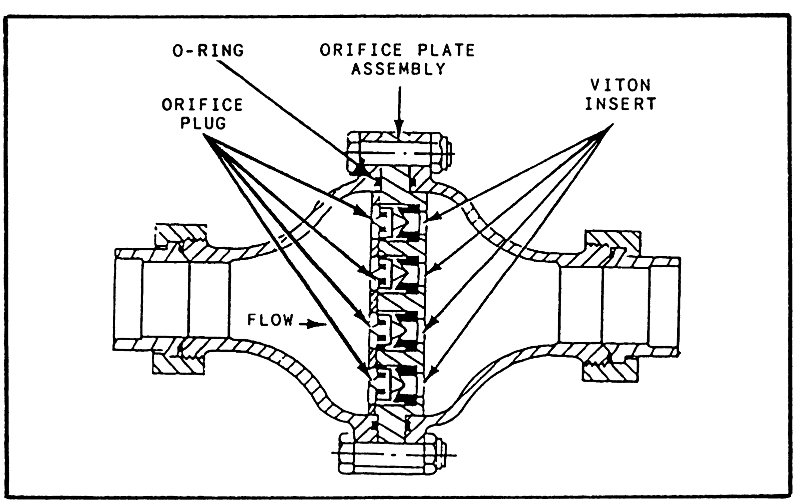


Figure 15-18.–Constant flow regulator.

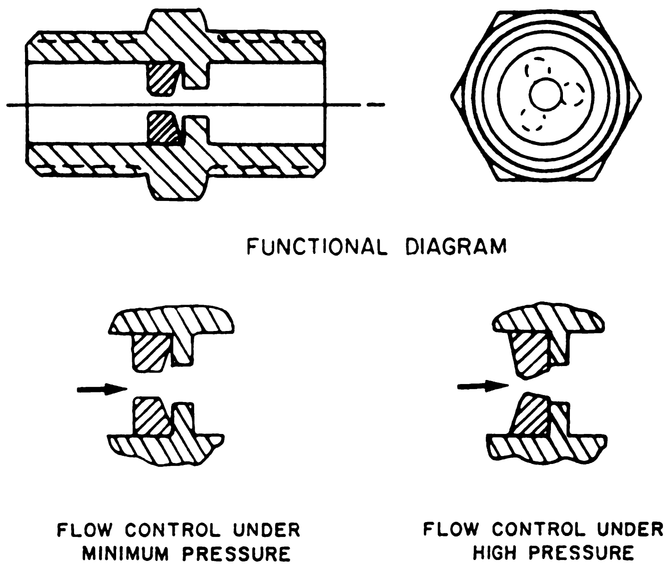


Figure 15-19.–Equipment flow regulator.

water through the individual cabinets and components. See figure 15-19.

Pressure regulating valve–(fig. 15-20) used to regulate a major section of the cooling system. Because the cooling system can handle a large amount of coolant, it usually has a pressure-relief valve to protect the equipment from being over pressurized.

Flow Monitoring Devices

Most systems incorporate one or more types of devices to monitor and ensure an adequate flow of distilled water through the electronic equipment. A low

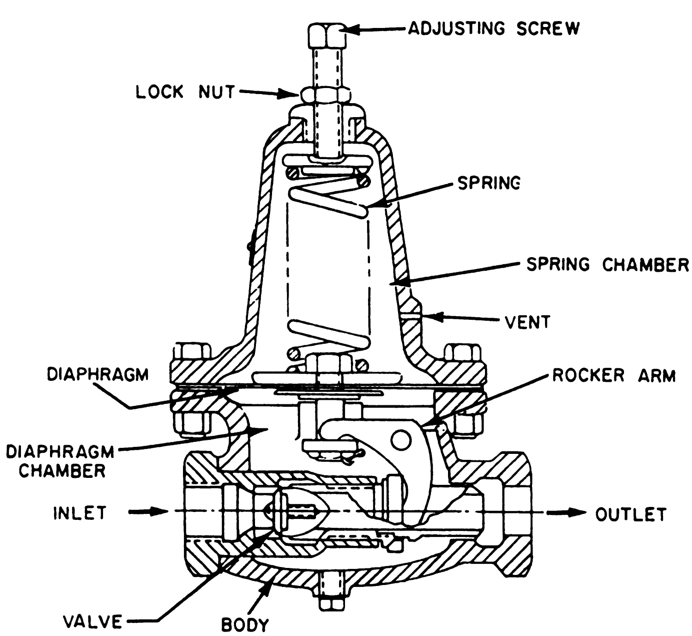


Figure 15-20.–Pressure regulator.

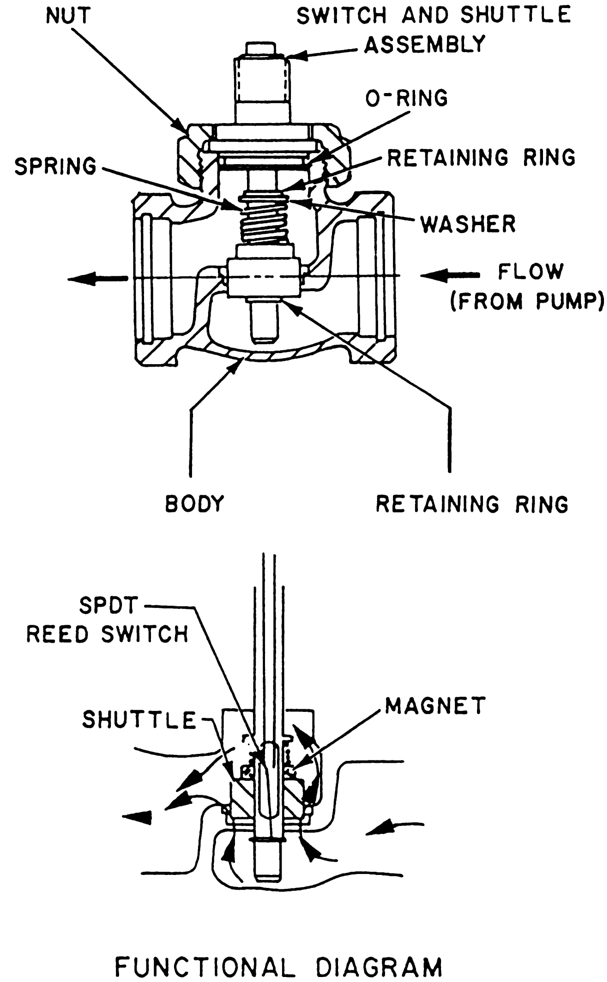


Figure 15-21.–Cooling system flow switch.

flow switch is normally found in the secondary cooling system to monitor the overall coolant flow. It is electrically connected to a common alarm circuit to warn personnel when the system flow rate drops below a specified minimum value. See figures 15-21 and

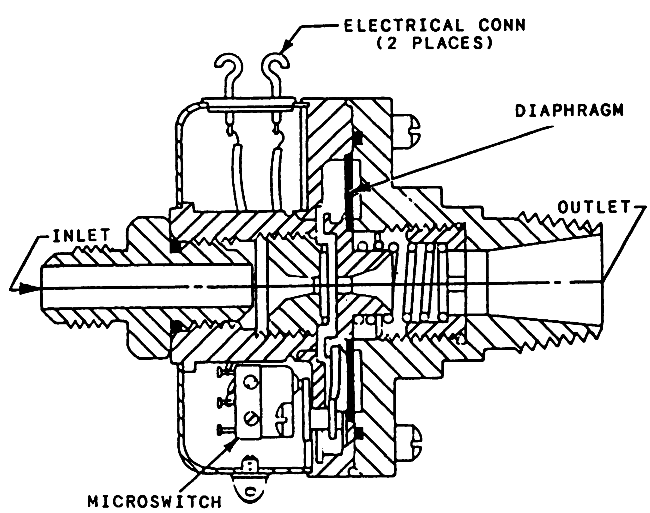


Figure 15-22.–Equipment flow switch.

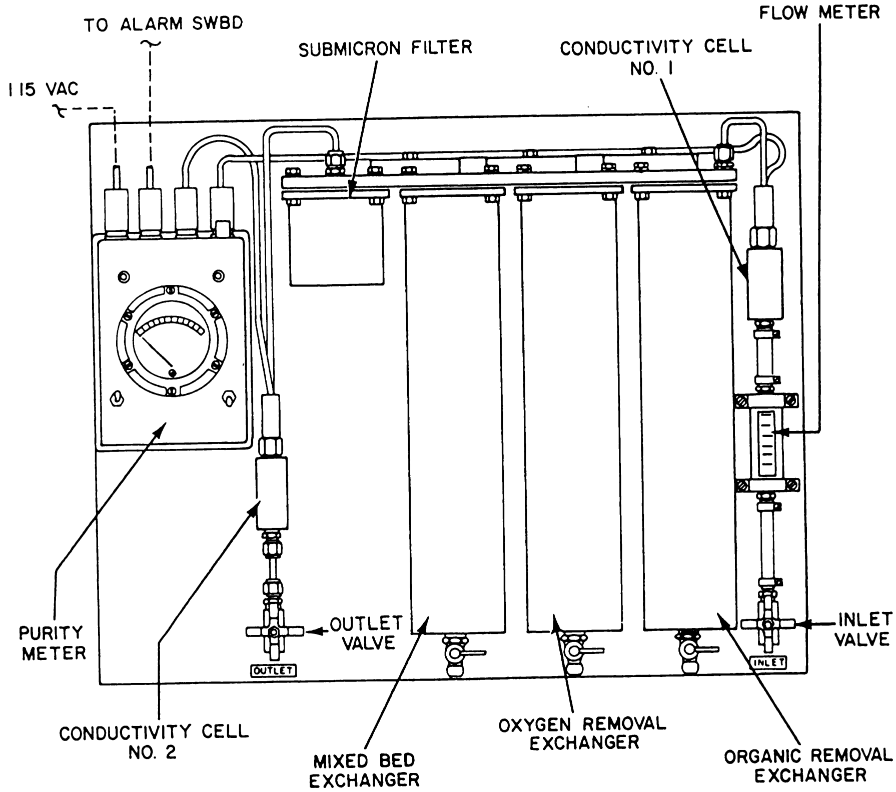


Figure 15-23.–Demineralizer.

15-22. You, as EMO, need to understand cooling systems fully, as you may be standing duty OPS or WEPS in port and may be the only person able to correct a cooling problem before a disaster strikes. At sea you will have a 24-hour duty ET, but in port you may be the first person awakened; it may be too late to awaken an ET in the duty section. Problems are not always caused by equipment failures. Some may be caused by normal operating procedures elsewhere in the ship. For example, engineers occasionally use systems that work from fire main pressure. In port, they may, without authorization, pump bilge pocket on the midwatch with only one firepump on the line. This will set off the AN/SPS-49 cooling alarm if the fire main pressure drops to 90 psi.

Demineralizer

The secondary cooling system water is maintained in an ultrapure state by a demineralizer. By maintaining the coolant at a high degree of purity, you minimize corrosion and the formation of scale in the radar unit. Corrosion or scale on a high-heat-density component, such as waveguide dummy loads and klystrons, results in the formation of a thermal barrier. The thermal barrier reduces the effectiveness of heat transfer at normal operating temperatures. This leads to premature failure of the components. A demineralizer is shown in figure 15-23. A purity meter is shown in figure 15-24.

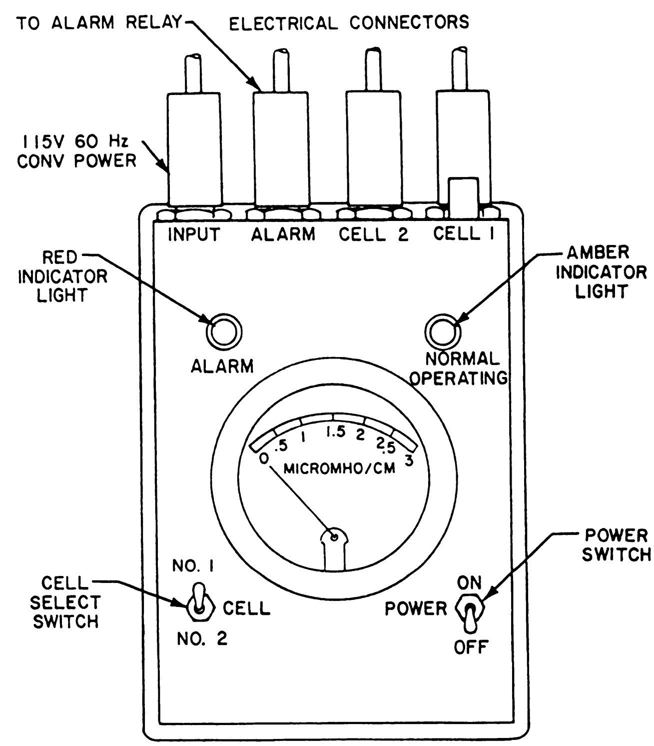


Figure 15-24.–Purity meter.

Oxygen Analyzer

In some secondary cooling systems, an oxygen analyzer is installed to measure the amount of dissolved oxygen in the liquid coolant. The presence of oxygen causes oxidation that leads to the formation of scale in the cooling system. An oxygen analyzer has an oxygen sensor installed in the supply side of the cooling system. The sensor is an electrolytic cell in an electrolyte solution or gel. A thin synthetic membrane covers the end of the sensor, which is inserted in the coolant. The synthetic membrane is gas permeable to the dissolved oxygen in the secondary coolant. This allows the oxygen to pass through the membrane. The oxygen reacts with the electrolyte, which causes a proportional change in the amount of current flow in the sensor. The sensor's electrical output is measured and displayed on the oxygen analyzer's meter. The meter is calibrated to read the oxygen content in parts per million or billion.

Coolant Alarm Switchboard

The cooling system alarm switchboard (SWBD), located in either CIC or the coolant pump room, monitors various conditions to alert you to a problem that may develop in the cooling system. When an abnormal condition occurs, the alarm SWBD indicates the fault condition with both a visual and an audible

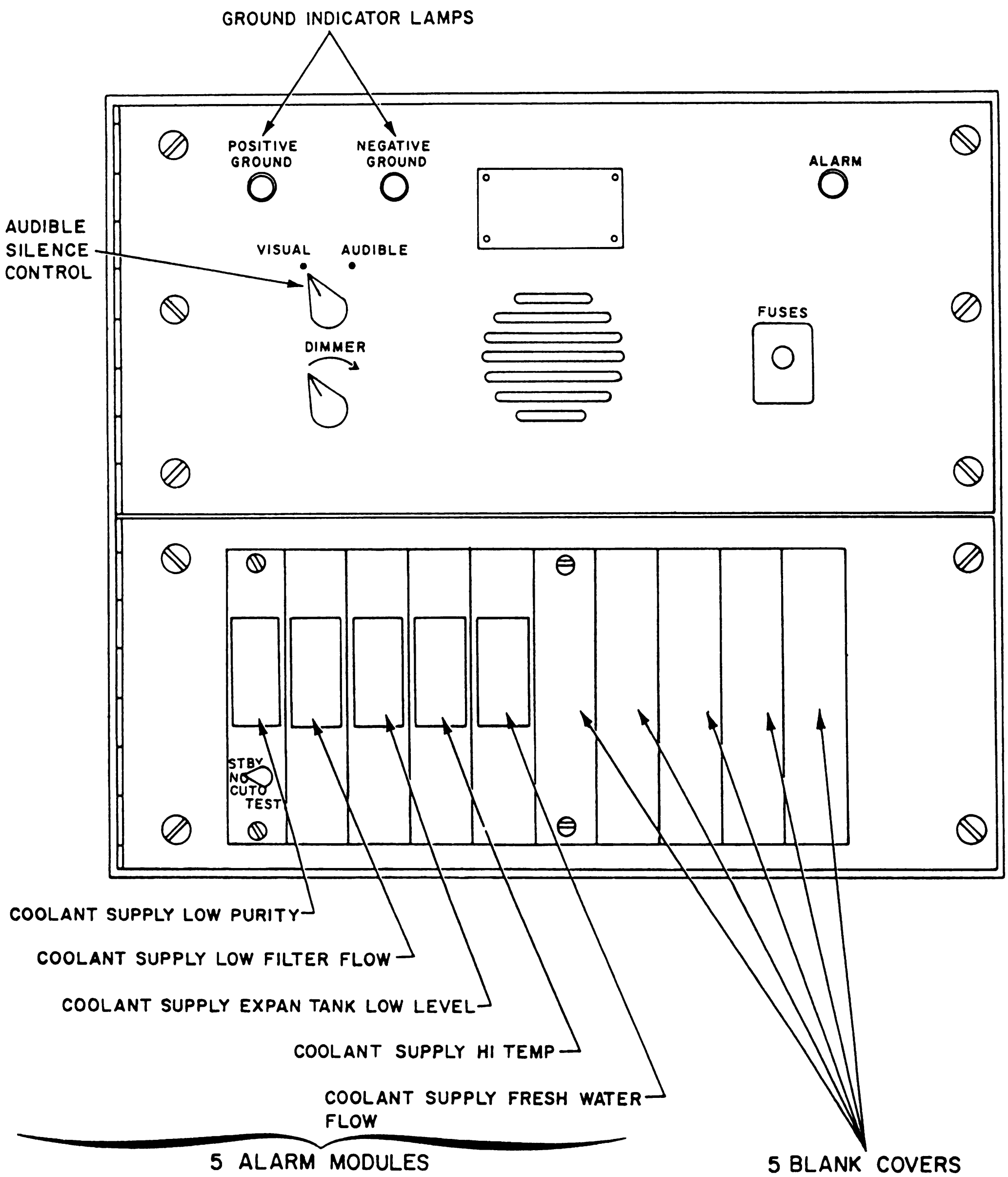


Figure 15-25.–Cooling system alarm switchboard.

alarm. The alarm SWBD usually has several remote bells and lights in CIC and other electronic spaces aboard ship to indicate that a fault condition has occurred. There are several standard types of alarm switchboards used throughout the Navy. A common type is shown in figure 15-25. An illustration of displays and audible alarms is shown in figure 15-26.

Cooling System Preventive Maintenance

Your most important responsibility in extending the life of the cooling system components and increasing the reliability of the cooling system is scheduling preventive and corrective maintenance according to the Planned Maintenance System (PMS). Properly performed preventive maintenance drastically reduces the amount of corrective maintenance necessary. When cooling systems are neglected, they deteriorate very quickly. An important part of your salt water cooling system is the sacrificial zincs. These are zinc plates that are bolted to equipment in which salt water is used. Zinc is electrochemically more reactive to salt than the other metals and allows corrosion to "prefer" zinc to steel. Some of your zincs may have been lagged over during a recent shipyard overhaul. Ensure that your technicians locate and inspect each one (use the equipment guide list [EGL]).

DRY-AIR SYSTEMS

For optimum operation today's modern high-powered radars must have their waveguide

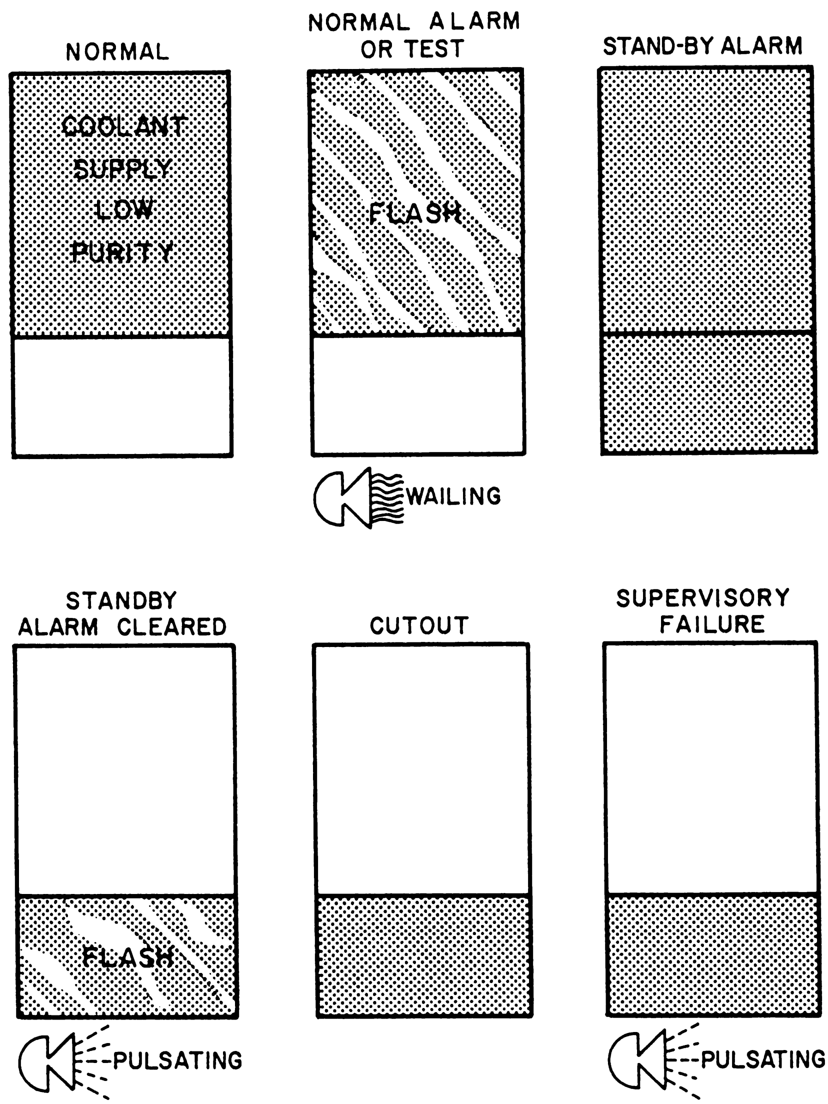


Figure 15-26.–Alarm switchboard visual displays and audible outputs.

systems, in both the low-and high-power areas, pressurized with dry air. In some waveguide systems, dry air is used primarily to increase the dielectric constant inside the waveguide to prevent rf energy from arcing inside the waveguide. Arcing causes damage to the inside of the waveguide. It also reflects a short circuit back to the power amplifier tube. Should this happen, the power amplifier could sustain major damage. Also, the use of pressurized dry air decreases the problems of corrosion, contamination, collection of moisture and oil droplets (which affect preservation). At the same time, the overall reliability of the waveguide system is increased.

High-power waveguide uses dry air pressure around 20-35 psig to reduce waveguide arcing. The increased air pressure increases the dielectric of the air.

Low-power waveguide uses dry air at between 1 and 8 psig, primarily to prevent corrosion and contamination of the inside of the waveguide.

The number of electronic equipments requiring dry air for operation has increased drastically in recent years. Central dry-air systems have been installed in many ships to overcome the problems of individual maintenance, repair, and supply support required by individual air dehydrators. However, there are still a large number of individual equipment dehydrators in use as back up systems, should a failure occur in the ship's central dry-air system.

There are several methods that can be used to remove excess moisture from the air. One method is to freeze the moisture by means of a refrigerant and then remove the frozen moisture by a mechanical means. A second method is to pass the air through a desiccant which absorbs the moisture. Some dehydrators use a combination of the two methods to remove the moisture.

Central Dry-Air System

The ship's central dry-air system is usually located in one of the ship's main engineering spaces and can be composed of a low-pressure (100 psig) air compressor, a Type I dehydrator, and either a Type II or Type III dehydrator. The air compressor compresses the air and then sends it to the Type I dehydrator (refrigerant). The Type I dehydrator removes the majority of the water and oil in both liquid and gaseous vapor forms from the air. Next, the Type II (desiccant) or a Type III (combination

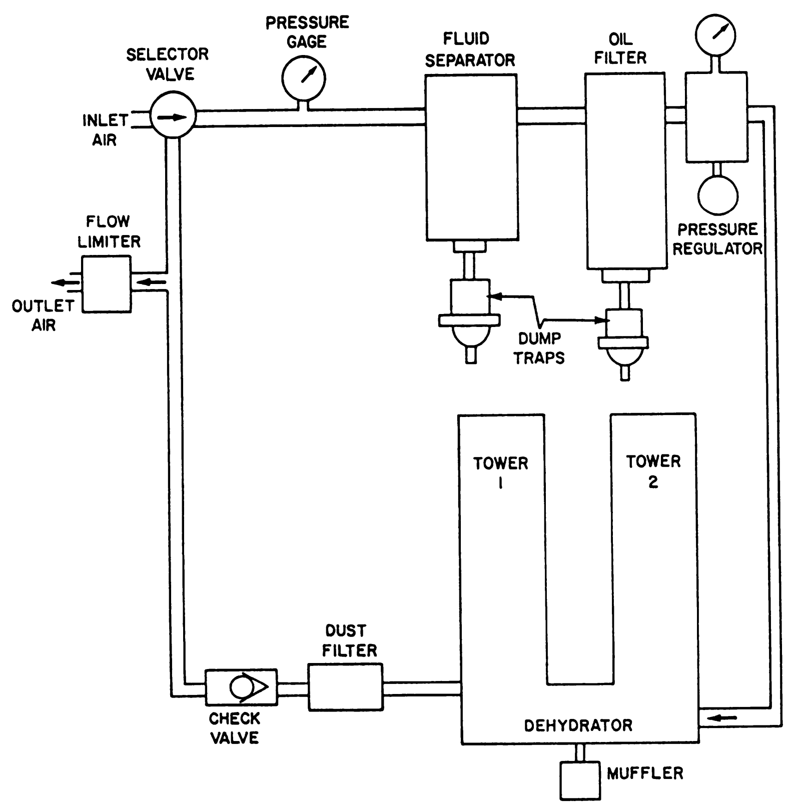


Figure 15-27.–Desiccant air dryer.

of refrigeration and desiccant) dehydrator processes the air to remove the last traces of moisture. This last bit of processing causes the air to become electronically dry. See figures 15-27 and 15-28.

Nitrogen Pressurization Systems

Nitrogen is an inert gas used to purge dry air systems of moisture prior to their operation and as a primary form of pressurization in some communications and weapons systems. For system charging, the equipment is given an initial charge of nitrogen and then is monitored and recharged as required. Nitrogen is not used in a continuous feed such as in the dry air systems described earlier; however, it serves the same basic purpose in the equipment. Always maintain a sufficient supply of nitrogen on board; use only water-pumped nitrogen; and ensure custody of the Mk-260/U recharging kit.

ELECTRICAL POWER

Part of the electronics division's routine duties will be to energize electronic equipment. This may occur every morning for daily tests or after a lengthy period of shutdown time for maintenance. There is nothing quite as frustrating as not being able to light off a piece of equipment because of a missing power input. If you know where the power is supposed to come from, maybe you can help to restore it.

NOTE: Part of specific equipment training and casualty control training for ETs involves knowledge objectives concerning source-power distribution.

A conscientious technician should always check with the electricians prior to trying to resolve any source-power problem. This is especially true on board ship. If the source power is OFF, there is a reason. The reason may be a tripped generator, a misaligned switchboard, or an open circuit breaker. The reason could also be scheduled electrical circuit maintenance, readjustment of generators or switchboards, or shifting of the load. Ensure that your technicians contact the duty electrician for the status of the power supply before they assume the worst and begin troubleshooting their own equipment.

Take advantage of shore power. This is the perfect time to accomplish PMS on your equipment. With shore power, you shouldn't be concerned with shifting loads,

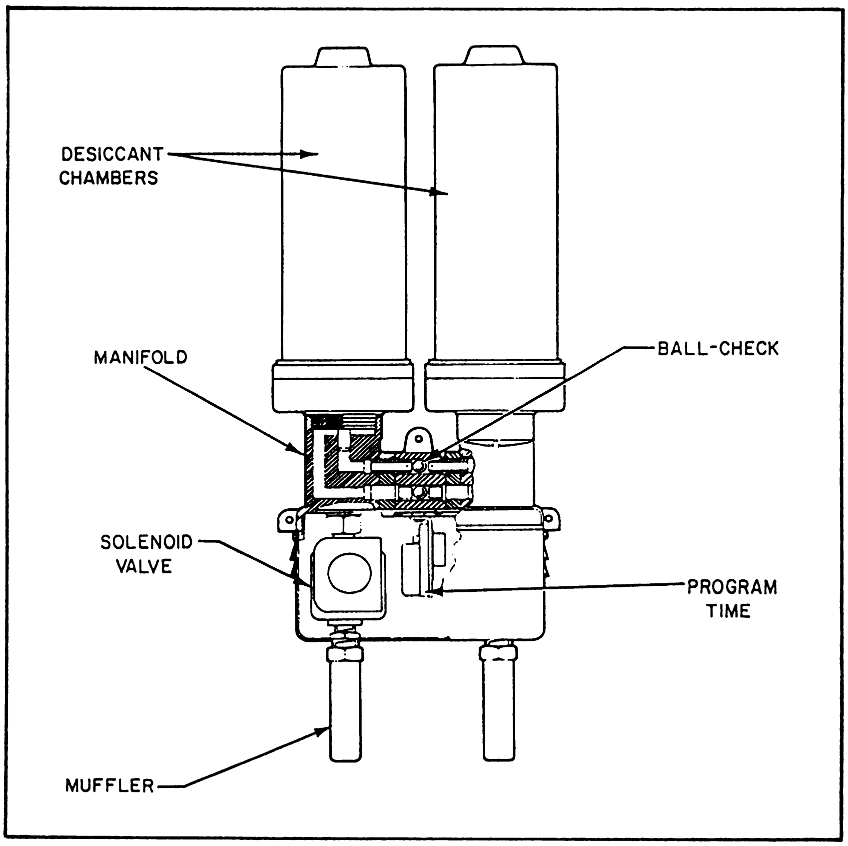


Figure 15-28.–Dehydrator.

tripped generators, and so on. Remember, the electricians are still responsible for maintaining a balanced load. Notify the duty electrician of your maintenance requirements (specifying the equipment to be energized) and ensure that the board can handle the additional load. You should know whether your equipment is on critical power and the main power panel that supplies source power to the equipment. Don't assume that because you energized equipment yesterday that it is OK to do it again today.

We will now look at a typical ship's power distribution system and then discuss the areas that are closely related to your equipment.

POWER DISTRIBUTION SYSTEM

Most ac power distribution systems in naval vessels are 440-volt, 60-hertz, 3-phase, 3-wire, ungrounded systems. Refer to the *EIMB General Handbook*, chapter 3, for important information regarding ungrounded electrical power distribution systems. The ac power distribution system consists of the power plant, the means to distribute the power, and the equipment that uses the power. (See figure 15-29.)

The power plant is either the ship's service turbine generator or the emergency diesel generator. The power is distributed through the ship's service distribution switchboards and power panels. Some large ships use load centers, which function as remote switchboards. Power is used by any equipment that requires electrical power for its operation.

EMERGENCY POWER

If the ship's service distribution system fails, the emergency power distribution system supplies an alternate source of electric power to a limited number of selected loads that are vital to the safety of the ship. This system includes one or more emergency diesel generators and switchboards. The emergency generator is started automatically when a sensor detects the loss of normal power.

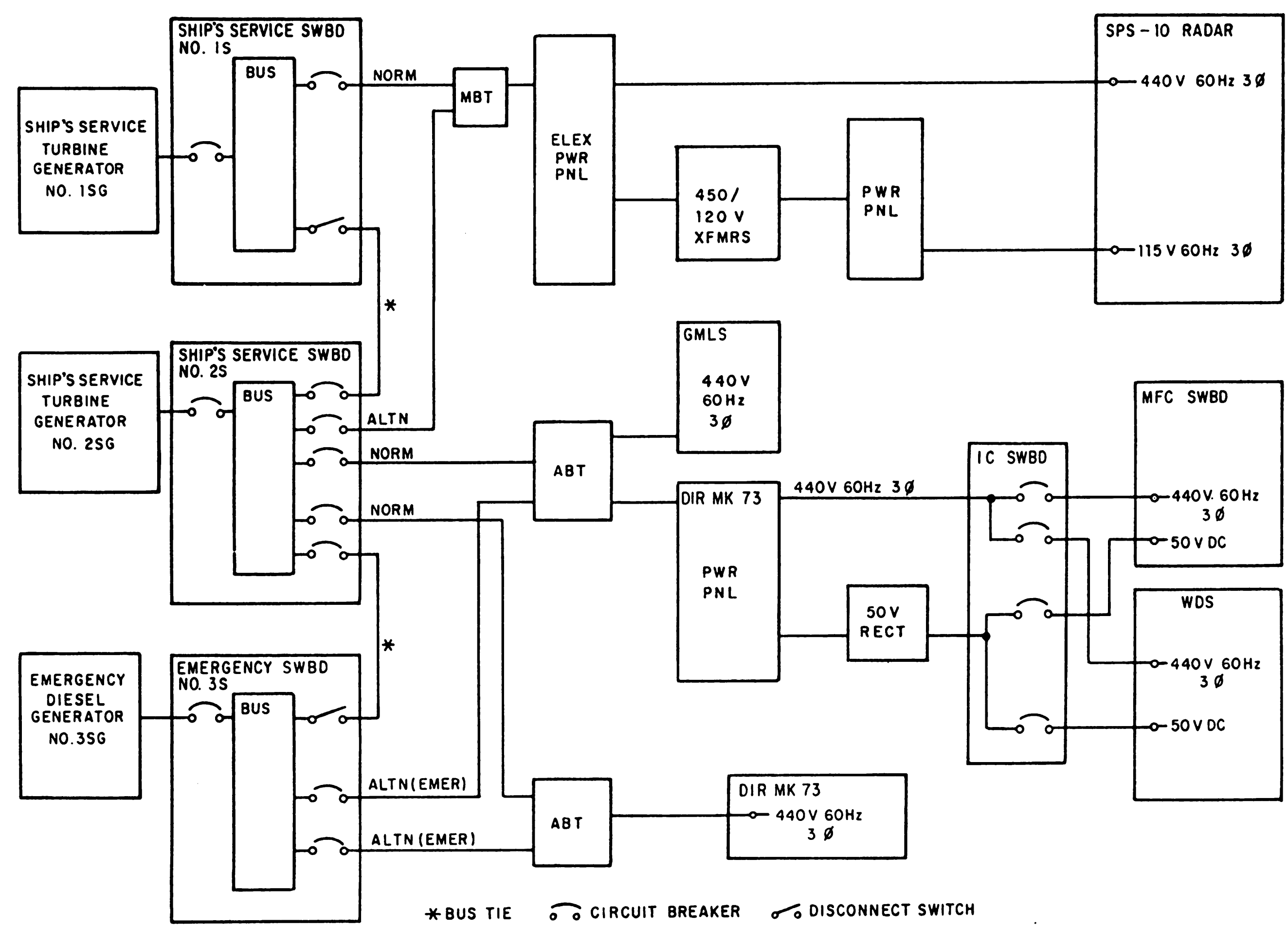


Figure 15-29.–60-Hz distribution (partial).

The operation of the ship's service generators, the emergency generators, and the distribution switchboards is the responsibility of the ship's engineers. You will not become involved within this area of responsibility. There will be times, however, when you will be concerned because your electrical power requirements are not being met; and for that reason, you will request that the appropriate engineering personnel provide you with assistance. Needless to say, it will be to your advantage if you can communicate in terms with which the engineering personnel are familiar.

BUS TRANSFER EQUIPMENT

Bus transfer equipment is installed on switchboards, at load centers, on power panels, or on loads that are fed by both normal and alternate or emergency feeders. Either the normal or alternate source of the ship's service power can be selected. Emergency power from the emergency distribution system can be used if an emergency feeder is provided.

Automatic bus transfer (ABT) equipment is used to provide power to vital loads, while nonvital loads can be fed through manual bus transfer (MBT) equipment. For example, the interior communications (IC) switchboard is fed through an ABT, whose alternate input is from emergency power. A search radar might be fed through an MBT to prevent power fluctuations.

POWER DISTRIBUTION

Power distribution is directly from the ship's service switchboards to large and important loads, such as missile launchers and directors. Distribution to other loads is through power distribution panels and, if applicable, load centers.

LOAD CENTERS

The IC switchboard is the nerve center of the interior communications system. All interior communications circuits and some electronic circuits are energized through the IC switchboard. Relay supply voltages, synchro excitation, and some 400-Hz power pass through this switchboard. Some of these supply voltages may be routed from the IC switchboard directly to the combat systems equipment. Most of them, however, are also routed through the missile fire control switchboard. Larger ships usually have two IC switchboards (one forward and one aft), while smaller ships have one centrally located IC switchboard.

60-HERTZ POWER

Many of the bigger loads in the combat system use 440-volt, 60-Hz, 3-phase power as a power source. This supply is also sent to transformers for conversion to 115-volt, 60-Hz, 3-phase power for distribution where needed. Additionally, it is used as an input to the 50-volt dc rectifier at the IC switchboard. The 50-volt dc rectifier output is distributed throughout the combat system as a relay supply voltage.

400-HERTZ POWER

The 440-volt, 400-Hz, 3-phase power is made up in motor generator (MG) sets that are fed by the 440-volt, 60-Hz power. (See figure 15-30.) The 400-Hz supply is

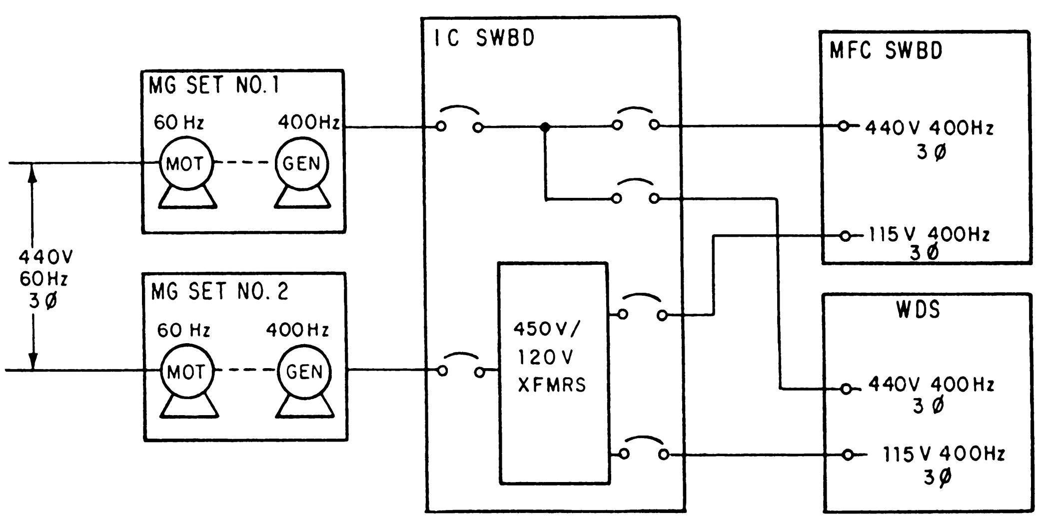


Figure 15-30.—400-Hz distribution (partial).

the primary source of power for some of the combat systems. Distribution is primarily through the equipment switchboard via the IC switchboard. Besides the 440-volt, 400-Hz signal, 115-volt, 400-Hz power from regulated and unregulated transformers is supplied when required. In some systems the 115-volt, 400-Hz power is used as the input to a voltage regulator for generation of a 115-volt, 400-Hz precision supply.

MISCELLANEOUS POWER

Many other supply voltages are used in the electronic systems and subsystems. They are usually used as reference voltages for specific functions. For example, 12-volts ac is used as a reference in some systems.

When the technicians are missing power inputs to their equipment, they work backward from the load to the source. Usually, the power panels and bus transfer units that feed the equipment are located in close proximity, possibly in the same space, or outside in the passageway.

Keep in mind that many suspected casualties have been corrected merely by restoring an inconspicuous power input or signal reference, sometimes after hours of troubleshooting.

MAINTENANCE OF SUPPORT SYSTEMS

The following are the CNO guidelines for support system maintenance responsibilities. These guidelines are very specific and have been reinforced by the type commanders.

–**DRY AIR** system operation and preventive maintenance from the inlet coupling of the air control panel to the electronic equipment being served is the responsibility of the appropriate combat systems rating.

–**COOLING WATER** system operation and preventive maintenance starting at the saltwater strainer and including all of the secondary loop is the maintenance responsibility of the appropriate combat systems rating.

–Operation and maintenance of all combat systems support systems not assigned to combat systems ratings is the responsibility of the appropriate engineering rating.

–Engineering ratings will perform all casualty maintenance on combat systems support systems.

Training in maintaining support systems comes in several forms. The most common are OJT and PQS; remember PQS is mandatory. However, other training exists and must be used to maintain support systems in a high state of readiness. Among the other types of training are short courses offered at the Readiness Support Groups, Intermediate Maintenance Activities, and Mobile Technical Units. Additionally, various class C schools offer support systems training.

CLOSED-CIRCUIT TELEVISION

Closed-circuit television (CCTV) systems are inherently a part of today's shipboard life. In addition to being used for entertainment, they are used in the work routine of the ship. CCTV makes it possible for shipboard personnel at remote locations to view or monitor various operations, and to exchange vital information rapidly.

One closed-circuit TV system installed aboard ship is the Shipboard Information, Training, and Entertainment (SITE) II system. The SITE II system is shown in figure 15-31. This system is used for entertainment, training, combat information, flight operations, and secure information purposes. You may have a SITE I system, which is a larger version of the SITE II. When the system is used to transfer tactical information from the CIC to remote stations, the TV camera is fastened to the overhead in the CIC so that it overlooks the plotting board. The video output of the camera is sent to viewer units. From these video signals, the viewer units reproduce and display the data on the plotting board. Thus, cognizant personnel are instantaneously and accurately informed of any changes in a tactical situation.

Television systems are also used aboard aircraft carriers for briefing pilots before a mission. When the system is used for this purpose, a viewer unit is installed in each ready room. The TV camera is arranged so that it picks up the briefing officer and any pertinent charts or displays. In this way, all pilots concerned are briefed in one session.

Another use for CCTV is port briefs and shipwide training. The most popular use of CCTV, however, is for crew entertainment. News, various television programs, and movies are distributed to activities with the SITE system installed. There are stringent guidelines that must be followed when handling these programs. Consult NMPCINST 1710.1 for specific information regarding custody and handling of SITE TV movie programs.

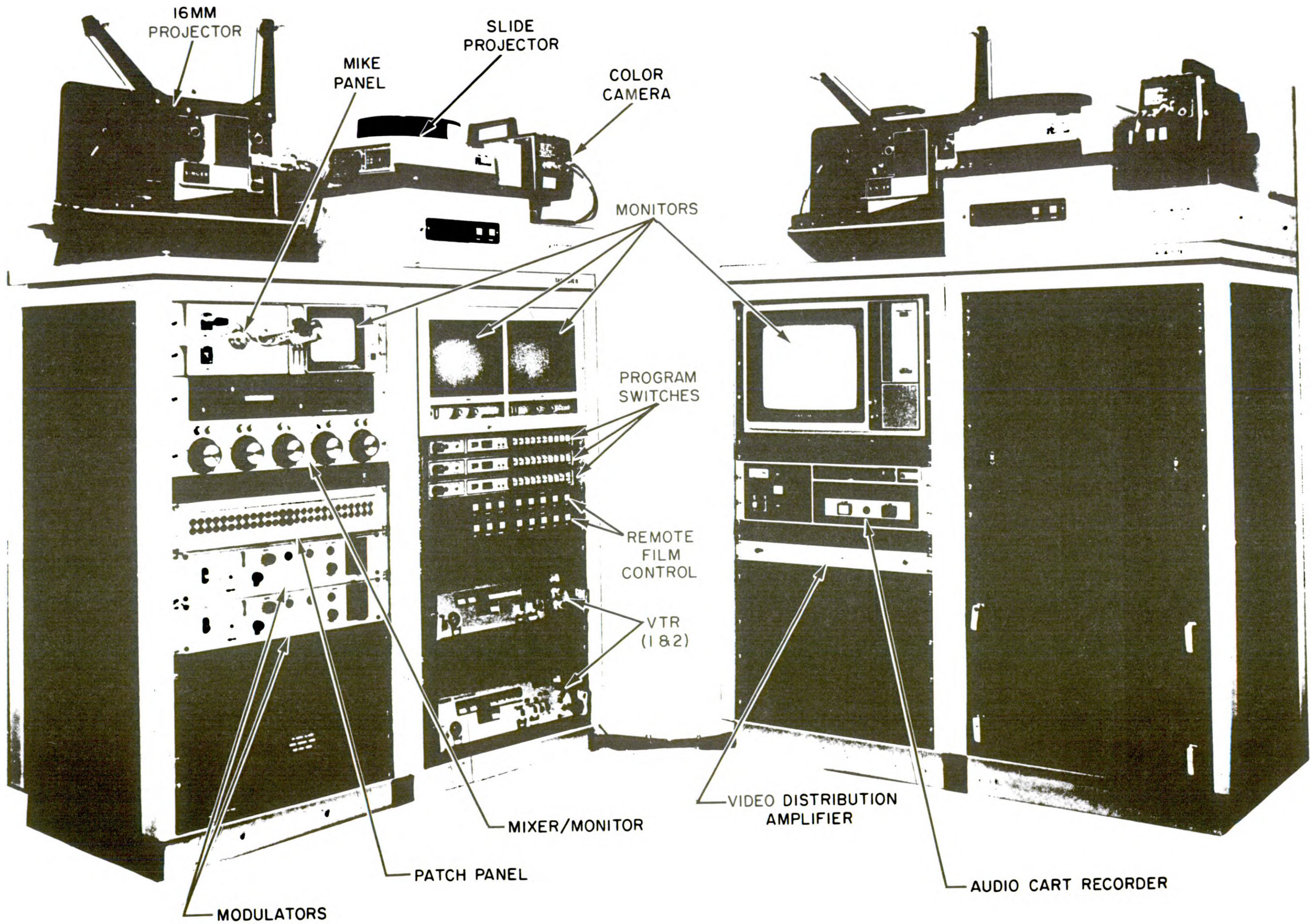


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Figure 15-31.–SITE II television system.

ELECTRONIC WARFARE

Electronic warfare (EW) involves the entire electromagnetic spectrum from the lowest radio frequencies through microwaves, infrared, visible light, and ultraviolet. It is a military activity that can influence the control and employment of the total electromagnetic environment. Management of EW must be integrated into the operational command structure to ensure that EW actions are planned and executed as an integral part of naval operations. EW involves employment of electromagnetic equipment, systems, tactics, and techniques for the purpose of the following:

1. Determining hostile activity in the electromagnetic spectrum
2. Exploiting hostile use of the electromagnetic spectrum
3. Advancing naval use of the electromagnetic spectrum

Electronic warfare is military action involving the use of electromagnetic energy to determine, exploit, reduce, or prevent hostile use of the electromagnetic spectrum. It is also action that retains friendly use of the electromagnetic spectrum. Figure 15-32 shows the functional relationships of EW operations. There are three divisions within EW:

1. Electronic warfare support measures (ESM)
2. Electronic countermeasures (ECM)
3. Electronic counter-countermeasures (ECCM)

ESM is the use of passive (non-transmitting) equipment to intercept enemy electromagnetic emissions. ECM is the use of active electronic and nonelectronic equipment to jam enemy transmissions or to deceive the enemy. ECCM is the means by which the effect of enemy jamming on our own equipment is reduced.

To ensure the continuing freedom of the seas, the objective of naval EW is to provide operational commanders with an integrated capability to take action using the electromagnetic spectrum, to be aware of hostile intent, to counter hostile action, and to protect own or friendly forces.

This objective includes:

1. Determining the existence, location, disposition, and threat potential of all significant weapons, sensors, and communications systems that use electromagnetic radiations
2. Denying an enemy the effective use of his own electromagnetic systems by destroying them, degrading them, or rendering them ineffective
3. Ensuring the effectiveness and security of fleet electromagnetic capability regardless of intentional or unintentional counteraction from any source

In planning a tactical mission, the tactical commander must consider all aspects of EW including the capabilities of own forces and that of the enemy. EW policy and plans must be established and promulgated along with timely directives delegating authority and assigning responsibilities. Provision must be established for updating these directives and promulgating the changing intelligence picture that

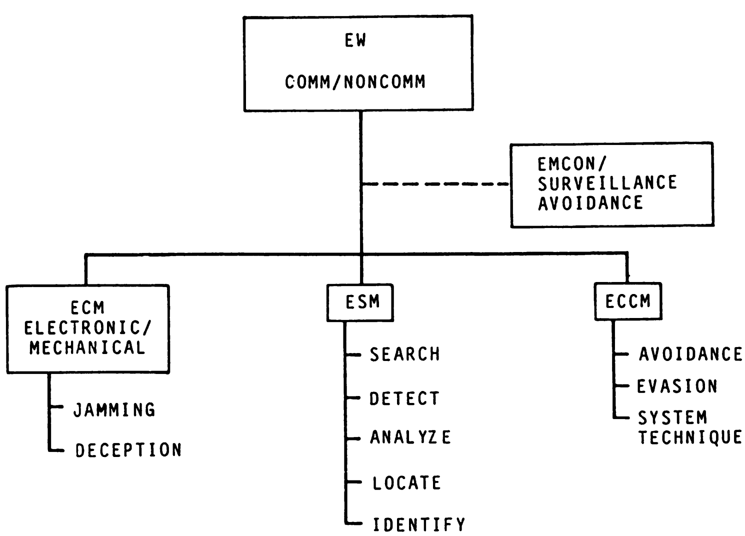

Figure 15-32.–Functional relationships of EW Operations.

affects the EW posture of the force. General EW plans are provided in all fleet and force operation orders.

Successful application of EW requires that the responsible officers have a thorough knowledge of the EW capabilities of all units available for the operation.

The objective of EW in support of fleet operations is to provide detection and to permit timely reaction to an airborne, surface, or subsurface threat. Therefore, rapid and efficient reporting procedures are essential if EW information is to be useful on a force level.

ESM SYSTEMS

ESM equipment is used to detect, locate, analyze, and record electronic emissions throughout the electromagnetic spectrum. It provides U.S. forces with the capability to gain tactical and strategic intelligence on enemy electronic activity of all types while remaining undetected by the enemy. ESM is also used to obtain information on new electronics equipment worldwide.

The fundamental piece of equipment in any ESM system is the intercept receiver, which governs the general capabilities and limitations of the system. The overall system is affected by all basic and associated system components.

Intercept receivers are classified as narrow-band and wide-band according to methods of searching the frequency spectrum. Intercept receivers detect enemy electromagnetic emissions as a function of frequency and provide selected signal outputs to displays, signal analyzers, recorders, and warning devices. Receivers may be capable of automatic signal processing and identification, thereby providing threat warning for preprogrammed threats. Outputs of these receivers may also be used to automatically gate ECM equipment including deception repeaters and chaff launching devices.

Discrimination circuits that respond to certain signal characteristics may be provided with any receiver to accept or reject appropriate signals for display. Pulse signals that originate on board may be blanked by an interference blanker, which receives pretrigger pulses from all ownship's radar transmitters that interfere with the intercept receiver.

ECM

Electronic countermeasures (ECM) is that major subdivision of electronic warfare involving actions taken to accomplish the following:

1. Prevent or reduce the effectiveness of enemy use of electronic equipment
2. Prevent or reduce the effectiveness of the enemy's electromagnetic radiation use tactics
3. Exploit the enemy's use of electromagnetic radiation

Jamming ECM is the deliberate radiation, reradiation, or reflection of electromagnetic energy with the objective of impairing the use of electronic devices, equipment, or systems being used by an enemy. The purpose of jamming is to deny the enemy full use of his electromagnetic sensors and control systems.

Deception ECM (DECM) is the deliberate radiation, reradiation, alteration, absorption, or reflection of electromagnetic energy in a manner intended to mislead an enemy's interpretation or use of information received by his electronic system. There are two categories of deception:

1. **Manipulative deception** is the alteration or simulation of friendly electromagnetic radiations to accomplish deception.
2. **Imitative deception** is the introduction into enemy channels of radiation that imitates his own emissions.

ECCM

Electronic counter-countermeasures (ECCM) is the major subdivision of electronic warfare that concerns actions taken to ensure our own effective use of electromagnetic radiation despite the enemy's use of countermeasures. It is easy to assume that all the electronic warfare officer has to do is to place a transmitter at the same frequency as the enemy's radar and deny him position information. This is an ideal situation that seldom is realized, and no assumption should be made that this can be done. However, such action may serve to reduce an enemy's effectiveness and provide the few extra seconds needed to escape that threatening situation.

Electromagnetic noise, another means of jamming radar systems, is the random fluctuation of the electromagnetic field picked up by an antenna. It is displayed on a radar scope as scatter (flickering returns which can mask the returns of real signals). Noise jamming is an artificial means of increasing the amplitude of the noise picked up by a particular radar receiver. Whether or not an echo will be detected by a particular radar receiver depends primarily on the ratio of signal power to noise power.

SURFACE SHIP ELECTRONIC WARFARE

The threat to U.S. Navy ships today is as significant as it has ever been and even more pervasive. While the undersea submarine threat remains largely the purview of major global powers and mine warfare is generally limited to territorial waters, the airborne threat is global in nature and continues to increase in both quality and quantity. Any nation desiring an anti-ship capability can purchase anti-ship missiles (ASMs) and targeting systems for relatively low cost on the world market.

The ability of Navy ships to detect and defeat threat ASMs depends on integrated shipboard combat systems comprising active sensors, hard-kill weapons (missiles, guns), passive sensors and soft kill (electronic countermeasures) systems. To be successful against today's airborne threats, defense in depth must be used to great effect. Surveillance systems must be detected and destroyed or blinded. Targeting radars must be denied accurate bearing and range, and ASMs must be detected and defeated once in flight toward their target.

AN/SLQ-32

As a primary contributor to the effectiveness of ships in this scenario, electronic warfare (EW) provides the ability to see without being seen, to jam surveillance and targeting and to defeat anti-ship missiles. In the Navy today, this EW mission is carried out almost exclusively by the AN/SLQ-32 system with attendant Mk-35 decoy launching systems. Designed in the late 1970s and fielded in the 1980s, this EW system is now installed or is scheduled for installation on every major ship class in the Navy as well as on ships in several foreign navies.

The SLQ-32 was conceived under a design-to-price philosophy intended to produce three modular variants tailored to support varying ship class requirements. The SLQ-32(V)1 variant is installed on smaller amphibious, service and some frigate classes to provide threat warning only, coupled with a decoy-launching capability. The SLQ-32(V)2 variant is installed on frigates and several classes of destroyers. Like the (V)1, this version provides passive warning and decoy-launch capability with expanded frequency coverage. The SLQ-32(V)3 is an active system which contains all the (V)2 receiver capabilities with the addition of a multibeam, roll-stabilized transmitter in the primary threat frequency region. This transmitter produces high effective radiated power (ERP) and multiple waveforms capable of providing both countertargeting and anti-ship missile defense. This system also provides for control of the Mk 36 decoy launchers. Thus, the SLQ-32(V)3 operator has the ability to simultaneously employ both passive and active electronic countermeasures (ECM)[1].

For more detailed information on EW equipments, refer to the EW rate training manuals.

INFRARED EQUIPMENT

Infrared equipment belongs to a family of devices that use electro-optics for communication, surveillance, detection, and navigation. Also included are image-intensifying night observation devices, low level television, and lasers.

Infrared equipment is designed to create, control, or detect invisible infrared radiations. The equipment is of two types, transmitting and receiving. The transmitting (source) equipment produces and directs the radiations. The receiving equipment detects and converts the radiations into either visible light for viewing purposes, or into voice or code signals for audible presentation.

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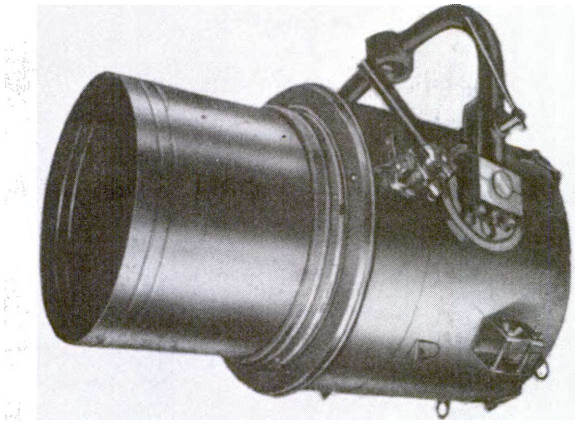

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Figure 15-33.–The VS-18( )/SAT infrared hood on 12-inch search light.

Infrared devices can be used for weapon guidance, detection of enemy equipment and personnel, navigation, recognition, aircraft proximity warning, and communications. Depending on its application, the equipment is either passive or active. The active method uses both transmitting and receiving equipment, whereas the passive method requires only receiving equipment.

The infrared spectrum, which extends from the upper limits of the radio microwave region to the visible light region in the electromagnetic spectrum, is divided into three bands: near infrared, intermediate or middle infrared, and far infrared. Note: The frequency spectrum is defined in chapter 10. Devices operating in the near and middle bands are used for ranging, recognition, and communications. They normally have a maximum usable range of 6.5 to 10 miles. Equipment that operates in the far infrared band is used for ranging, missile guidance, and the detection and location of personnel, tanks, ships, aircraft, and the like. This equipment normally has a maximum usable range of 12 miles.

Perhaps the most widely used infrared transmitting gear is the VS-18( )/SAT Hood, with filter lens. It is mounted on the standard Navy 12-inch searchlight (fig. 15-33). It blocks most of the visible light so the searchlight cannot be seen at a distance. The light is operated in the same manner as an ordinary communication searchlight. Design variations to the VS-18( )/SAT Hood are used on nonmagnetic minesweepers with the 8-inch signal light, and hand signal lamps.

Another type of infrared transmitting equipment is a 360‘ light. These lights are generally installed in pairs on yardarms (fig. 15-34) and are located on the majority of naval ships. These lights, designated AN/SAT-( ), are operated in the same manner as yardarm blinkers. They can be used as a steady source for "point of train" (pot) purposes, or they can be used for signaling or recognition purposes.

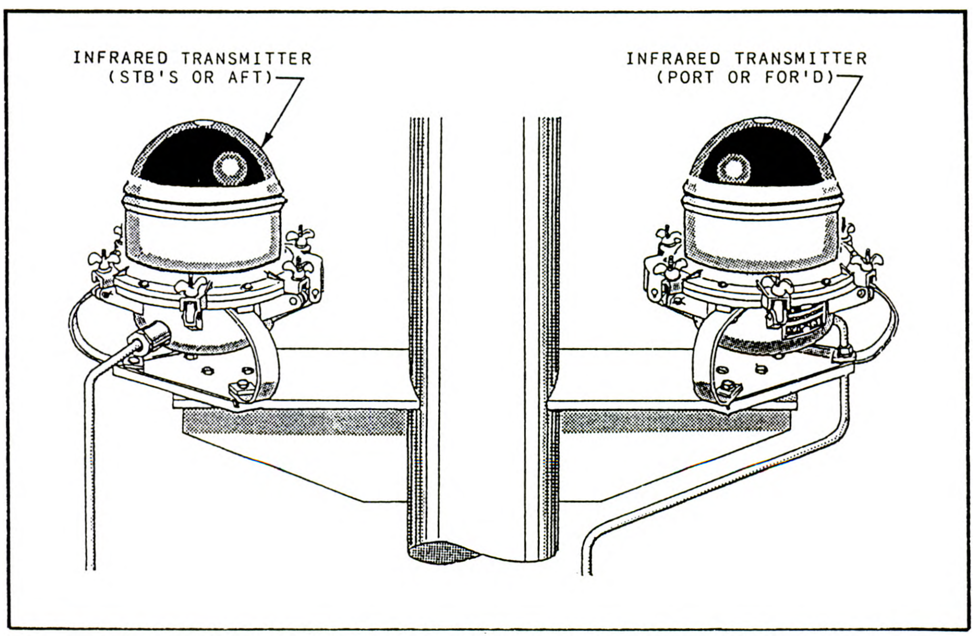


Figure 15-34.–Infrared Yardarm Beacons AN/SAT-( ).

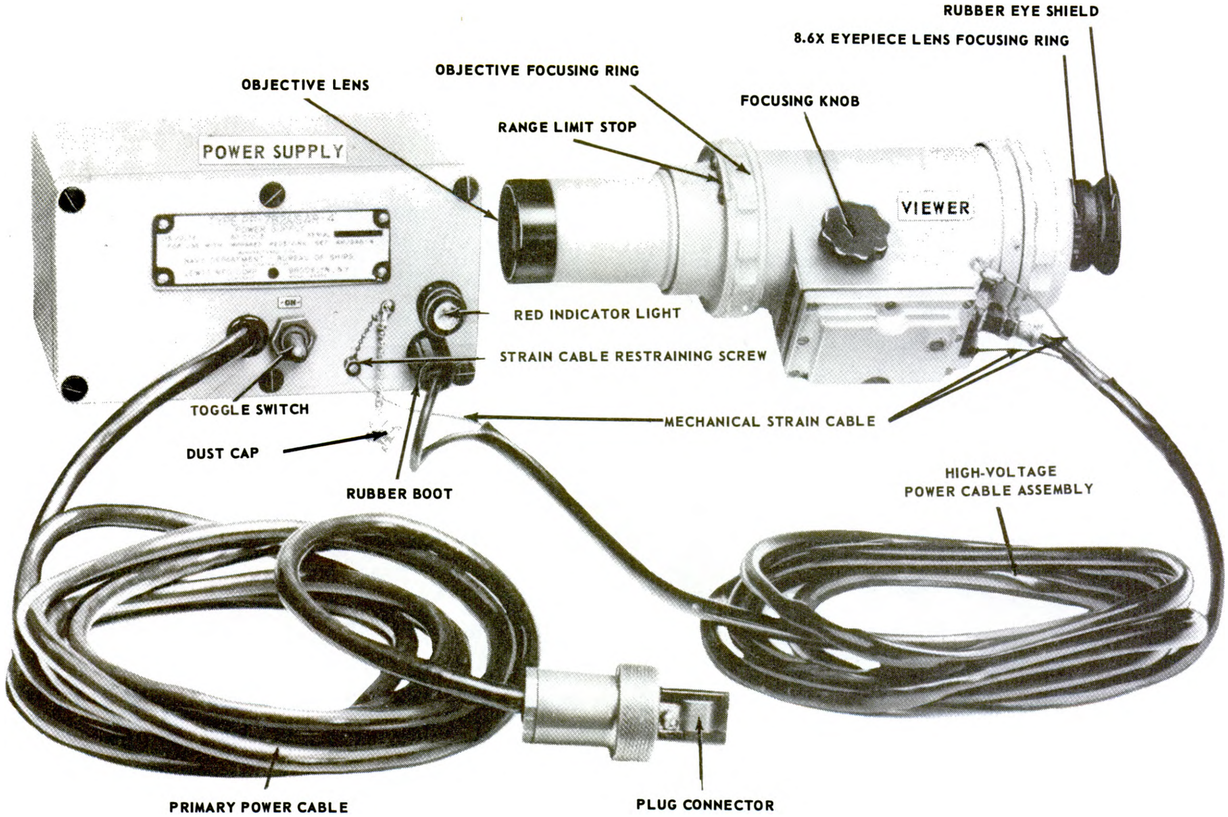


Figure 15-35.–Electronic Infrared Receiver AN/SAR-4. 62.11

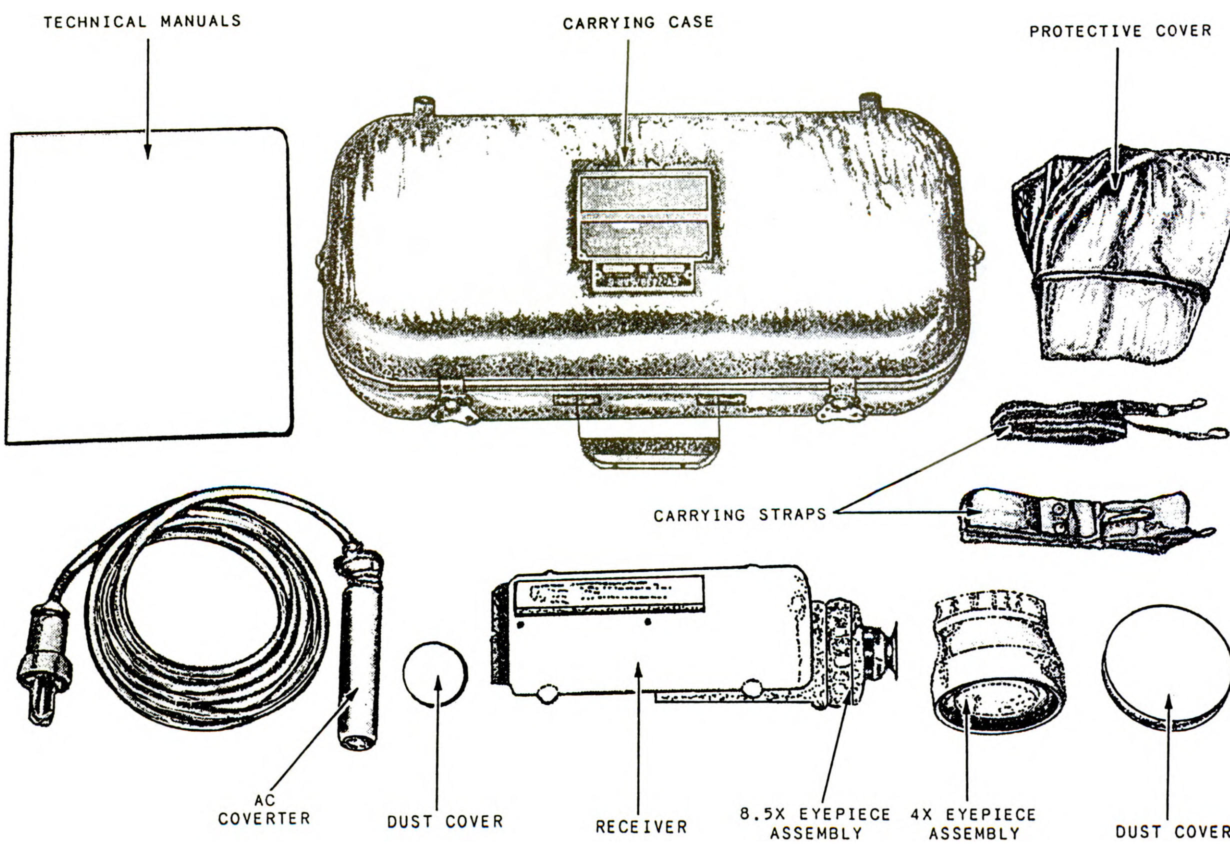
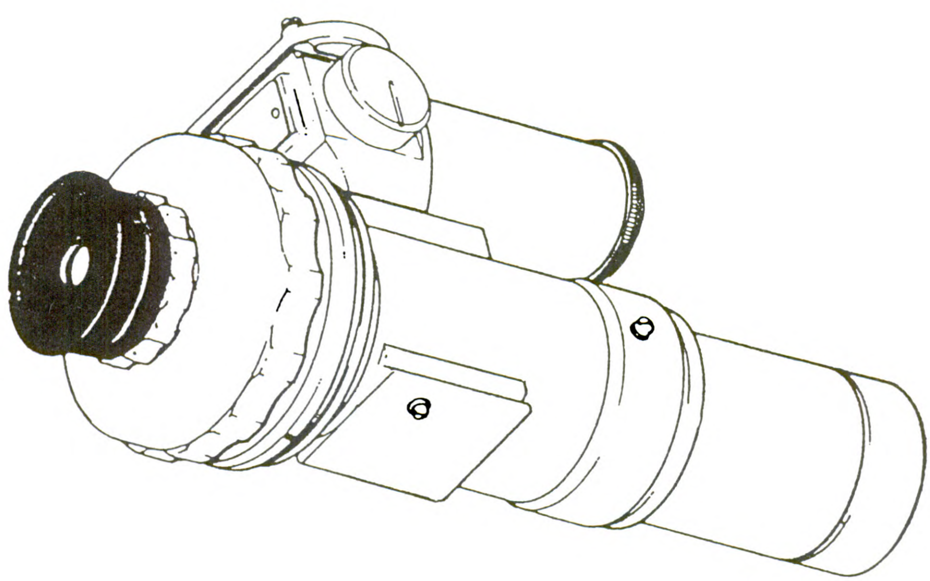


Figure 15-36.–Electronic Infrared Receiver AN/SAR-6. 120.50

Voice-tone equipment units are not in general use at the present time. They work by modulation of a light beam, which is received and amplified by a photocell receiver.

Electronic infrared viewers convert the infrared rays to visible light. They must be used to detect signals from the VS-18()/SAT or AN/SAT-(), or to observe a night scene illuminated by an infrared source.

The AN/SAR-4() viewing set (fig. 15-35) is a very old set still used in the fleet. It consists of two main units: (1) a 115 volts ac converted to 20,000 volts dc power supply, and (2) the viewer unit, which consists of a sealed housing and two interchangeable sets of lenses. The housing contains an image converter tube that produces an image of the infrared scene on a phosphorescent screen. The AN/SAR-6 viewing set (fig. 15-36) is similar to the AN/SAR-4 except that it has an internal battery power supply instead of a separate power unit. The AN/SAR-7 viewing set (figure 15-37) is similar to the AN/SAR-6 but is smaller and lighter. The Type T-7 AN/PAS-6 Infrared Metascope (figure



- NOMENCLATURE AN/SAR-7, AN/SAR-7A
- NSN AN/SAR-7 5850-00-885-8942
  AN/SAR-7A, 5850-00-999-3736
- WEIGHT 5 LBS
- MAGNIFICATION
- POWER REQUIREMENTS
  AN/SAR-7: 2 EA BA-30, OR
  2 EA "D" ALKALINE
  AN/SAR-7A: 1 EA BA-42, OR
  1 EA "C" ALKALINE
- FIELD OF VIEW 20 DEGREES

Figure 15-37.–AN/SAR-7 night vision sight.

15-38) is an active (light emitting) hand held, infrared-sensitive viewer for detection and general use. The metascope also has a built-in infrared illuminator (light source) to render it capable of viewing objects without being detected by the naked eye.

THERMAL IMAGING

Thermal imaging is a process by which changes in temperature are visually displayed in the viewfinder as changes in color.

The Mast Mounted Sight (MMS), figure 15-39, is an all-weather electro-optic system consisting of a low light television system, thermal imaging system, and laser rangefinder/target designator. Some typical applications for the MMS are mine avoidance, target identification/acquisition, and navigation.

The hand held thermal imager (HHTI), figure 15-40, is primarily a damage control device to aid in the location of injured personnel in smoke filled compartments. It may be used anywhere, however, such as small boat reconnaissance. Its range is 700 yards.

The AN/KAS-1 thermal imager, figure 15-41, is a bridge mounted unit having a range of 3200 yards.

NIGHT VISION DEVICES

Passive night vision sights (NVS) are those which emit no visible or infrared light. The Mk 37 NVS and Mk 36 NVS are primarily bridge mounted units you will see in the fleet. See figure 15-42. The NVS uses an image intensifier tube to amplify received light, thus enhancing or allowing vision under nighttime or similar conditions of low illumination.

NIGHT VISION DEVICES MANAGEMENT

As EMO you probably would not have to have your technicians repair any of these devices. They are very reliable; however, ensure you have an ample supply of proper batteries, if needed. If one of these devices does need repairs, treat it as you would any other electronic

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Figure 15-38.–Infrared Viewing Scope (METASCOPE).

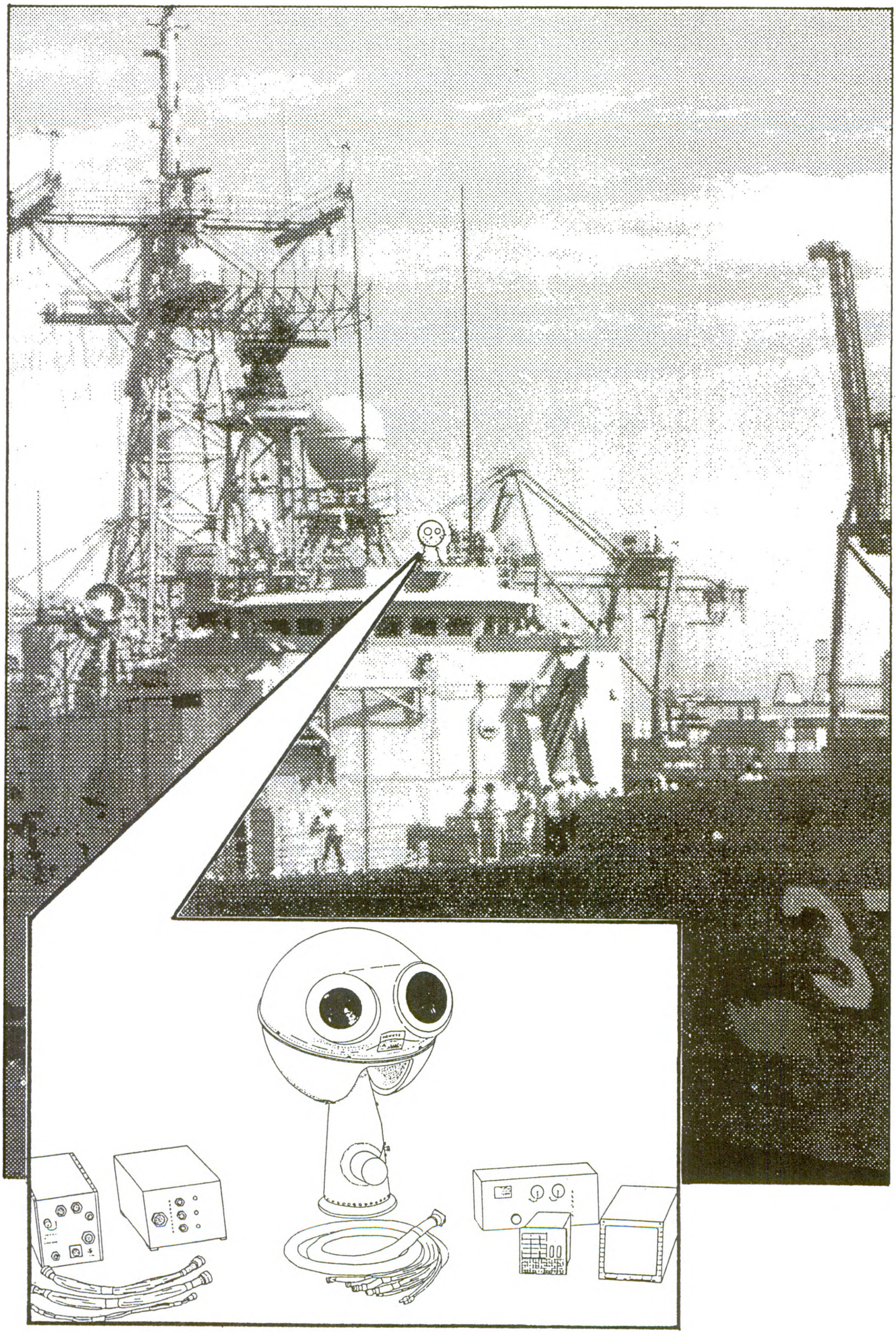

Figure 15-39.–Mast Mounted Sight (MMS).

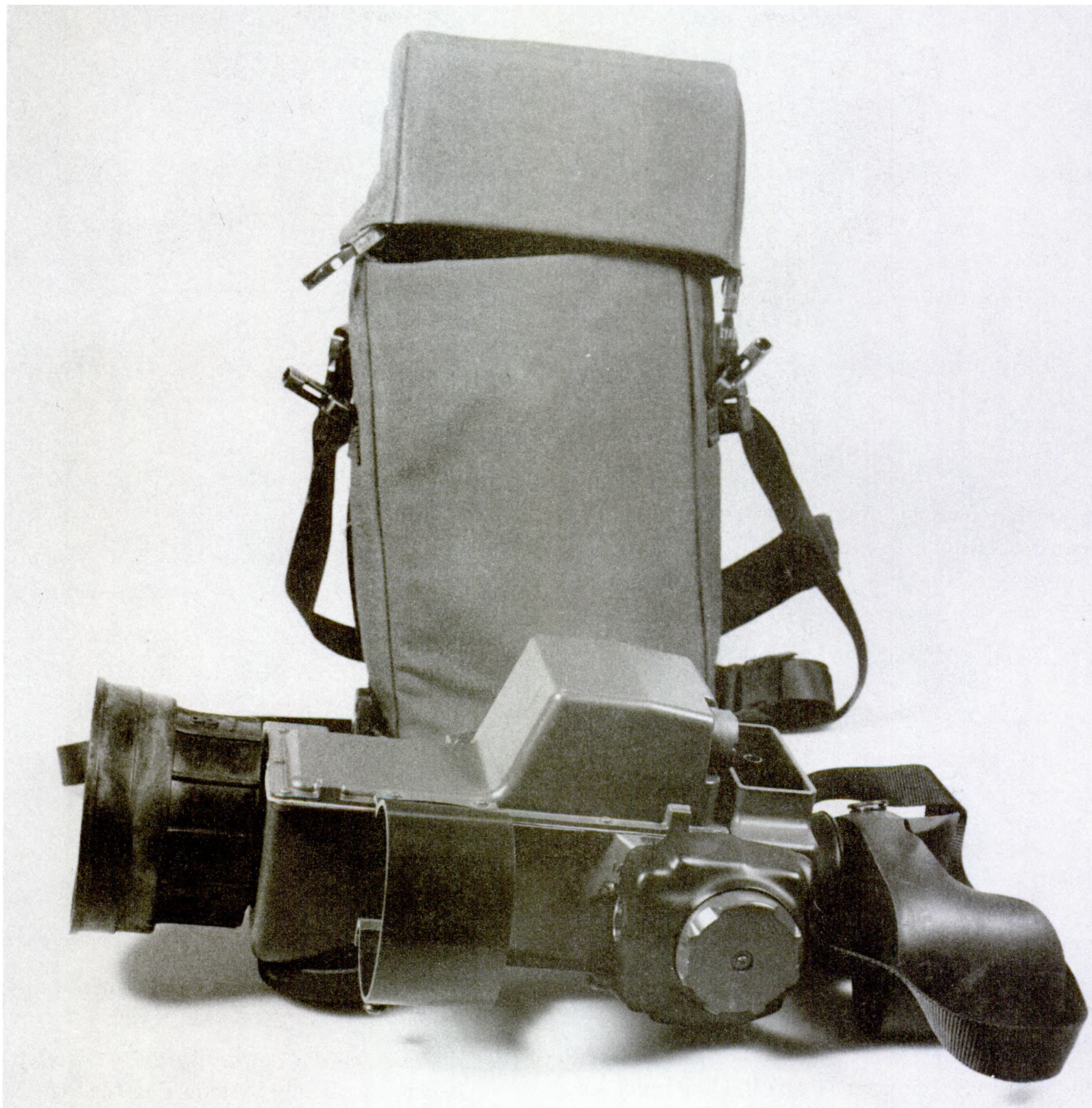

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Figure 15-40.–HHT1 handheld, thermal imager.

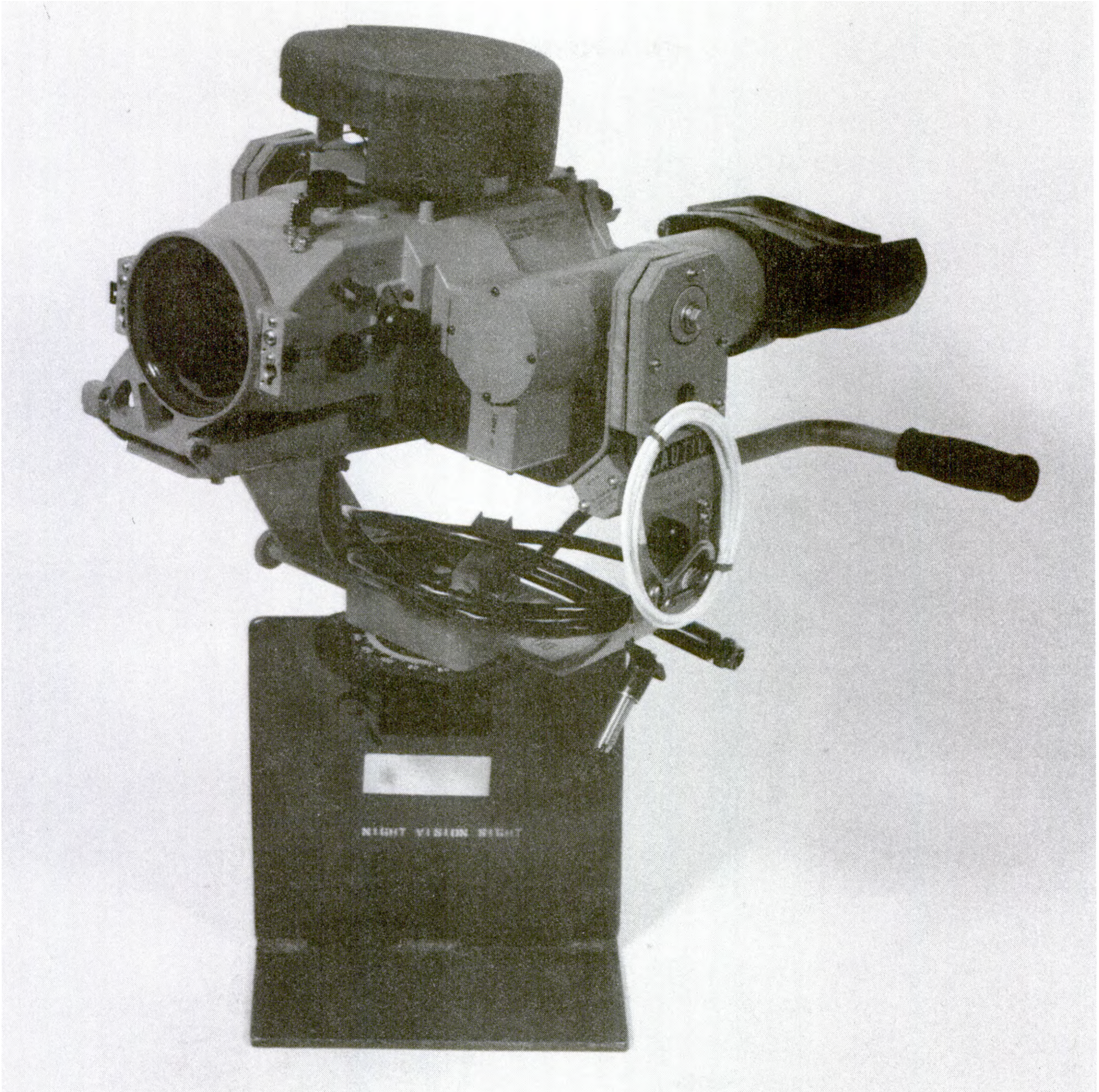

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Figure 15-41.–AN/KAS-1 thermal imager.

equipment that you "mail in" for repair. Have your technicians give it a cursory examination. Do not, however, allow them to break any factory seals in the process.

Night vision equipment is classified as ordnance equipage and allowances have been established for all fleet units. Each command or activity that has a requirement for the use of night vision devices should have an approved allowance for such equipments. Possession of these items requires adequate safeguards for both their accountability and physical security. Although unclassified, they have been designated as Sensitive Ordnance hardware. Therefore, strict control of these items is mandatory.

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Figure 15-42.–Mk 37 night vision sight.

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CHAPTER 16

COMBAT SYSTEMS

OVERVIEW

Some ships, especially combatants, may have the electronic division organized by combat systems (CS) rather than in an operations configuration. This chapter will point out the differences.

OUTLINE

Organization

SERT

OCSOT

CSOSS

COMBAT SYSTEMS ORGANIZATION

Surface combatants with complex, integrated combat systems have a combat systems department in lieu of a weapons department. Basically, a combat systems department consolidates the technical divisions of the operations and weapons departments. Figure 16-1 shows the divisions assigned to combat systems, weapons, and operations departments; it also shows the standard designations for these divisions.

COMBAT SYSTEMS OFFICER (CSO)

The CSO is the combat systems department head. He is responsible for the supervision and direction of the unit's combat systems, including ordnance equipment. Specific duties are detailed in OPNAVINST 3120.32. The relationship of the CSO and his assistants is shown in figure 16-2.

ASW Officer

Ships with shipboard antisubmarine warfare (ASW) armament and a combat systems department have an *ASW Officer*. The ASWO is responsible to the CSO for matters concerning submarine detection, classification, and attack.

Weapons/Battery Control Officer

Ships with shipboard missile or gun armament and a combat systems department have a *Weapons/Battery Control Officer*. He is responsible for assisting the CSO in supervising the duties of the Ordnance Officer, the Fire Control Officer, and the Gunnery and/or Missile Officer, as described below.

ORDNANCE OFFICER.–Ships with shipboard gun and/or missile armament and a combat systems department have an *Ordnance Officer*, who assists the CSO in the operation and maintenance of the gun and missile armament and associated equipments, except for the missile armaments assigned specifically to the ASW officer. In instances where multipurpose missile armaments are installed, the ordnance officer is responsible for their operation and maintenance.

FIRE CONTROL OFFICER.–Ships with shipboard gun and/or missile fire control equipment and a combat systems department have a *Fire Control Officer*, who assists the CSO in the operation and maintenance of weapons designation and fire control equipment, and attack aids used in firing and controlling guns and missiles.

GUNNERY AND/OR MISSILE OFFICER.–Ships requiring additional groups in the combat systems department may also have a *Gunnery and/or Missile Officer*.

Nuclear Weapons Officer

Ships with nuclear weapons and a combat systems department have a *Nuclear Weapons Officer*, who assists the CSO in safety, preservation, assembly, testing, inspection, surveillance, and processing of nuclear weapons, excluding nuclear missile weapons and their associated equipment.

DEPARTMENT	ONE DIVISION	OVER ONE DIVISION	FUNCTION
COMBAT SYSTEMS	BATS		COMBAT SYSTEMS
		CA	ANTISUBMARINE WARFARE
		CB	BALLISTIC MISSILES
		CC	COMMUNICATIONS
		CD	TACTICAL DATA SYSTEMS
		CE	ELECTRONICS REPAIR
		CF	FIRE CONTROL
		CG	GUNNERY, FIRE CONTROL, ORDNANCE
		CI	COMBAT INFORMATION CENTER
		CM	MISSILE SYSTEMS, FIRE CONTROL
		CN	NAVIGATION
		CO	GUNNERY AND GUIDED MISSILES
		CP	PASSIVE ASW SYSTEMS
		CS	COMMUNICATIONS INTELLIGENCE
		MAR	MARINE DETACHMENT
		CX	ELECTRONICS REPAIR
		CZ	INTELLIGENCE
WEAPONS	WEPS	1-6	GUNNERY AND DECK SEAMANSHIP
		F	FIRE CONTROL
		F-1	MISSILE FIRE CONTROL
		F-2	ANTISUBMARINE WARFARE
		F-3	GUN FIRE CONTROL
		G	ORDNANCE/GUNNERY
		G-1	GUNNERY, MAIN BATTERY
		G-2	GUNNERY, SECONDARY BATTERY
		G-M	GUIDED MISSILES
		MAR	MARINE DETACHMENT
		MT	BALLISTIC MISSILES
		ST	SONAR
		TASS	PASSIVE ASW SYSTEMS
		TM	TORPEDOES
		W	NUCLEAR WEAPONS ASSEMBLY
OPERATIONS	OPS		OPERATIONS
		FIRST	DECK SEAMANSHIP
		QA	METEOROLOGICAL/OCEANOGRAPHIC SERVICES/MAPPING, CHARTING AND GEODESY/ PHOTOGRAPHY
		OC	COMMUNICATIONS (AIR TRAFFIC CONTROL ON LPH, LHA, LHD, CV, AND CUN)
		OD	DATA PROCESSING
		OE	ELECTRONICS REPAIR
		OI	CIC AND ELECTRONIC WARFARE
		OP	PHOTOGRAPHY/PHOTO INTELLIGENCE
		OS	COMMUNICATIONS INTELLIGENCE
		OX	ELECTRONICS REPAIR
		OZ	INTELLIGENCE, CRYPTOLOGIC OPERATIONS

Figure 16-1.–Division designations.

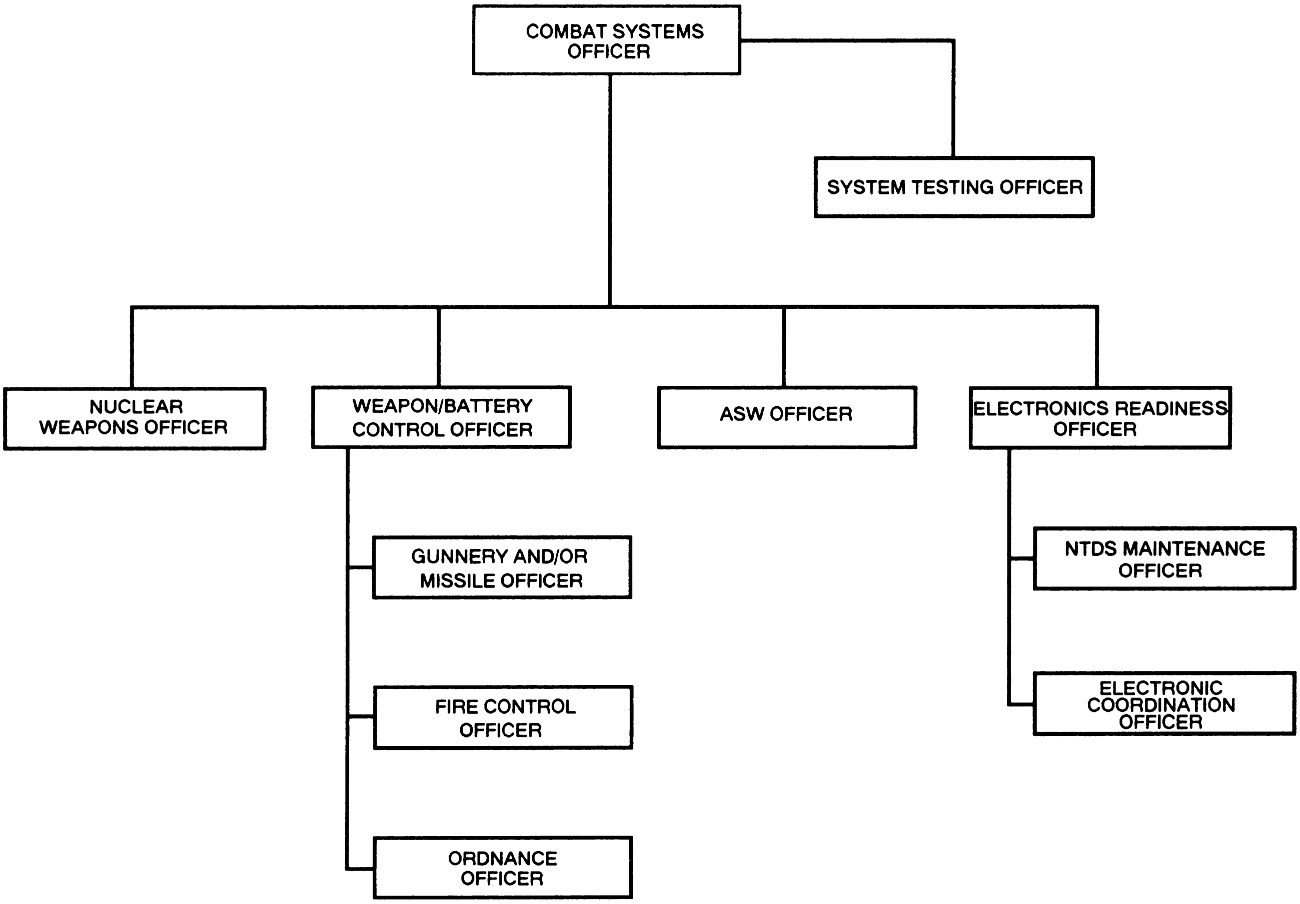


Figure 16-2.–Sample combat systems organization.

Electronics Readiness Officer

Ships with a combat systems department have an *Electronics Readiness Officer (ERO)*, who assists the CSO in supervising the duties of the Computer (NTDS) Maintenance Officer and the Electronic Coordination Officer, as described below.

COMPUTER (NTDS) MAINTENANCE OFFICER.–The *Computer (NTDS) Maintenance Officer* assists the CSO in the duties that relate to NTDS and computer maintenance.

ELECTRONICS COORDINATION OFFICER.–The *Electronics Coordination Officer* assists the CSO in the duties normally assigned to the Electronics Material Officer.

Electronics Readiness Officer (ERO)

The ERO is responsible for evaluating the operations readiness and for monitoring the maintenance of the combat systems, including the unit's search and detection equipment, command and control equipment, and fire control equipment. These duties include those described in chapter 1 of this manual.

Systems Testing Officer (STO)

Ships with a combat systems department also have a *Systems Testing Officer (STO)*. The STO is responsible, under the CSO, for the integration and management of combat system maintenance efforts, evaluation of combat systems material and operational readiness, and combat system alignment. The STO's specific duties include the following:

- Maintaining knowledge of prescribed combat system-level standards of performance for normal and casualty modes of operation.

- Directing and functionally integrating combat systems and sub-systems to achieve the optimum combat system material readiness status.
- Maintaining maximum combat systems material readiness through management of corrective maintenance efforts of the combat system, including recommendations for maintenance priorities and scheduling of corrective maintenance.
- Coordinating with other departments the required maintenance of related support subsystems.
- Keeping the CSO and other departmental officers in their areas of responsibility informed of the material readiness of the combat systems and the results of combat system tests.
- Assisting the CSO in evaluating combat system operational readiness.
- Maintaining the proficiency of the ship's electronics readiness team through training of team personnel and recommending assignment of specific subsystem technicians to the team. The exact composition of an electronics readiness team (number of personnel, rates, and ratings) and the exact duties varies with the configuration of the combat system.
- Initiating and reviewing internal reports on the operation and material readiness of the combat systems and subsystems.

SHIP ELECTRONIC READINESS TEAM

The shipboard organization, as defined in the *Standard Organization and Regulations of the U.S. Navy*, OPNAVINST 3120.32, places the Ship Electronic Readiness Team (SERT) under control of the Systems Testing Officer (STO). On a combat system configured ship, the STO is responsible to the CSO, while on a standard configured ship, the STO reports to the operations and weapons department heads. Extensive coordination and cooperation between the major branches of the operations and weapons departments are required for the SERT to coordinate the preventive and corrective maintenance efforts effectively at the combat system level. As a result of this functional relationship, the SERT should have direct access to the leading petty officers of each subsystem group within the operations and weapons departments. Because a combat system does not include all maintenance and operational departments of the ship, the team must seek advice and obtain cooperation from all departments in implementing a system-level maintenance program. The scheduling process must never be delegated solely to officers or enlisted personnel. The participation of both is highly desirable and necessary.

To successfully integrate maintenance activities, all officers and other key personnel must understand each division's unique maintenance problems, the problems of the combat system, and those of departments not defined as part of the combat system. Although the combat system does not encompass the entire ship nor include all departments, it cannot function without the fullest cooperation and advice of these additional departments. To be effective, the SERT must have a close working relationship with senior enlisted personnel of these departments.

Successful maintenance programs depend on personnel initiative and the amount of effort applied to diagnostic testing, proper execution of Planned Maintenance System (PMS) testing concepts, proper conclusions obtained from testing, and appropriate corrective action that leads to system operation restoration after casualty repair. Variances in results obtained from these activities depend largely on the proficiency of both maintenance personnel and maintenance management personnel. These variances are easily controlled through effective personnel management and training. Senior personnel are essential in obtaining this control.

SERT ORGANIZATION

The SERT organization (fig. 16-3) recommended by the combat system personnel training and management plan consists of senior petty officers having extensive experience in subsystem and equipment maintenance. The SERT is an official part of the command organization, and is assigned specific responsibilities that are primary, rather than collateral, duties. The SERT is administratively controlled by the STO, and is responsible to the STO for ensuring combat system maintenance management and providing liaison with all subsystem personnel.

The SERT is trained as a unit in combat system operation, preventive and corrective maintenance, maintenance management, and training, using the combat system technical operations manual as the basic vehicle. The SERT organization must be flexible, to adapt the available talent to the combat system configuration's use of assigned personnel.

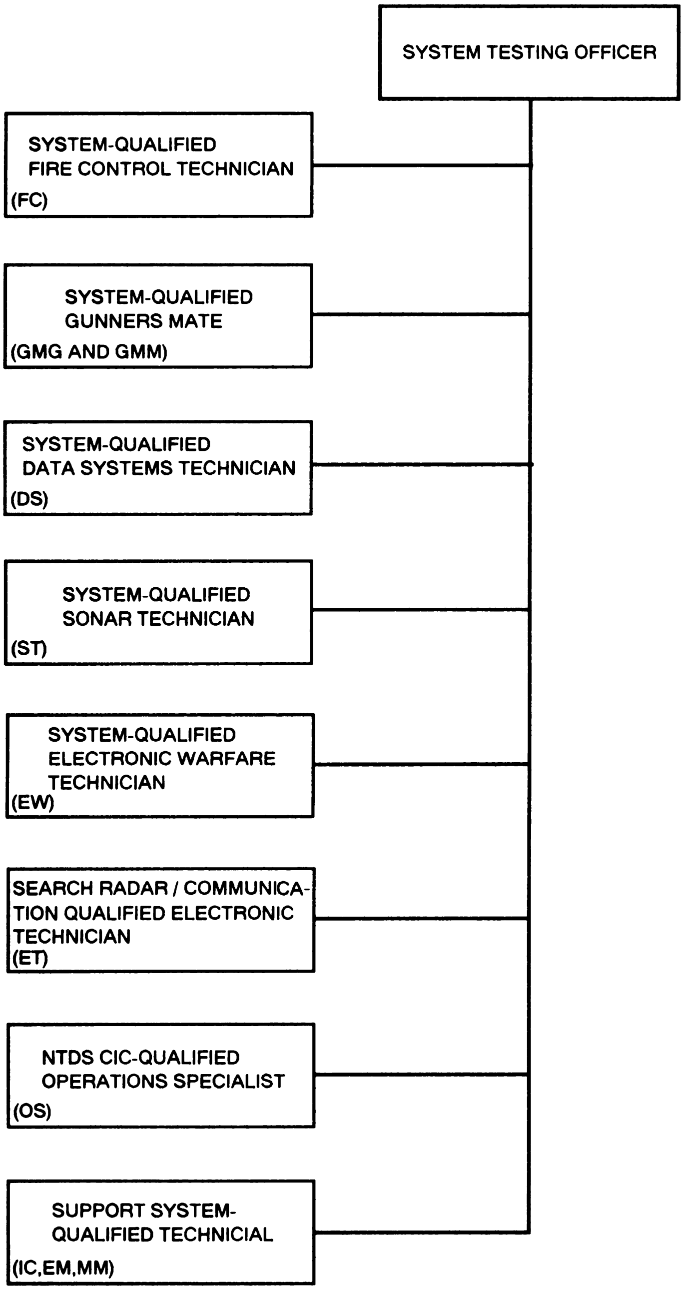


Figure 16-3.–Ship Electronic Readiness Team (SERT) Organization.

PERSONNEL QUALIFICATIONS

Personnel assigned to the SERT must be senior petty officers who have demonstrated an ability to comprehend the complex details of a combat system and who are recognized as the best maintenance talent available for at least one subsystem. The SERT members should demonstrate knowledge in the following topics:

1. PMS philosophy
2. PMS scheduled and corrective maintenance
3. Planned maintenance during overhaul
4. Maintenance data system
5. Combat system, subsystem, and equipment operation
6. Ship alteration, ordnance alteration, and field change configuration levels
7. Combat system, subsystem and equipment maintenance, and maintenance scheduling
8. Ordnance pamphlets, ordnance data, and NAVSEA manuals
9. Combat system, subsystem, and equipment tests
10. Logistic support

The lack of formal training in these subjects does not necessarily disqualify personnel for assignment to the SERT. The SERT can provide whatever additional training is required, due to the technical expertise of other members of the SERT.

SERT AUTHORITY

Shipboard policy makers must exercise great care when establishing the SERT authority limits within the shipboard organization. A shipboard instruction should specifically define both the authority and responsibilities of the SERT. The total combat system integration process depends on clear definition of these responsibilities and authority. Authority granted the SERT should promote organization and proper material and personnel readiness. The SERT cannot be held responsible for combat system readiness without the authority needed to accomplish its assigned tasks.

USE OF THE SERT

The SERT, to be used effectively during condition I, condition III, and in port, should establish the lines of communication discussed in the following paragraphs to provide rapid, up-to-date information on the availability of the combat system.

Condition I (General Quarters)

During condition I, the STO should be assigned a general quarters station in the Combat Information Center (CIC) and should be able to give the Tactical Action Officer (TAO) the present and changing status of combat system availability on a threat basis. The remaining SERT members should be assigned as roving evaluators for the subsystems with which they are most familiar. If possible, without affecting the overall combat system operation, the roving evaluator duty should be rotated as SERT members become familiar with all areas.

Condition III

During condition III, at least one SERT member should be on watch in CIC and should have the responsibility of reporting combat system status to the TAO. The remaining SERT members should pursue their regular duties of testing, instructing, and evaluating maintenance activities.

In Port

In port, at least one SERT member must be assigned to each duty section so the duty officer will know the actual status of the system at all times. SERT personnel must not confine their knowledge to a particular subsystem, if the organization is to function properly during condition III and in port.

SERT RESPONSIBILITIES

SERT responsibilities are broadly defined as maintenance management, readiness assessment, and operational training guidance required to ensure a high level of combat system readiness. Specific responsibilities include:

1. Integrating and managing PMS for the combat system.
2. Determining mission-related material readiness.
3. Managing the corrective maintenance effort for the combat system, including fault isolation, data reduction, and data analysis.
4. Monitoring the operation of the equipment during condition watch exercises and ship or fleet operational exercises.
5. Evaluating combat system material and operational readiness and providing internal or external reports as necessary.

PMS Management

PMS management includes supervision of actual maintenance actions and all forms of effort needed to plan support maintenance events. Therefore, the management task involves controlling all combat system PMS activities, including PMS tasks for the combat system, subsystems, and equipment. PMS management is one of the major SERT functions. The SERT provides the foundation for maintenance through proper planning and execution.

Certain PMS procedures at the combat system level are more oriented toward operator proficiency, with summary observation of combat system performance. The management guidance in the PMS manual and the Cycle and Quarterly Schedules is primarily equipment- and department-oriented. This guidance provides minimum maintenance requirements for the subsystems and equipment covered under the PMS concept. The interdependence of equipment and subsystems within the combat system, the variations of available manpower, and the dedication of subsystems to operations during conditions I and III present a management challenge to the SERT. PMS scheduling and execution, supported by documentation and maintenance training, lead to fault detection which, when combined with impact evaluation, provides a base for readiness assessment. Maintenance management ensures that detected faults are isolated and followed by corrective action. Effective corrective maintenance includes logistic control and, with respect to parts availability and readiness assessment, the determining of the priority of each corrective maintenance requirement. The loop is closed by follow-up action that includes verification or retesting and complete shipboard and maintenance data collection subsystem reporting.

Material Readiness Assessment

Material readiness assessment involves the correlation of no-go faults or degradation detected by tests or operation. The test or operation impact evaluation is matched against the combat system's ability to perform assigned missions. Readiness assessment is probably the most difficult task facing the SERT, in that the assessment requires the ability to provide an up-to-the-minute status of the combat system capabilities and limitations. To assess the readiness status, the SERT must know the results of all combat system tests and the minute-to-minute availability of the combat system, its subsystems, and equipment. This includes all support functions, such as primary power, chilled water, dry air, and sound-powered telephones. Readiness assessment is directed toward four major missions: Antiair Warfare (AAW), Antisubmarine Warfare (ASW), Antisurface Ship Warfare (ASU), and Amphibious Warfare (AMW). The tactical environment can change the impact of a fault or degraded function on mission capability. For instance, loss of the moving target indicator capability can be more significant when operating close to land masses than in the open sea. Readiness assessment is a vital factor in determining alternative selections of on-line equipment and subsystems. **Material readiness assessment should be approached from the functional readiness aspect rather than the equipment up or down status aspect for the following reasons:**

1. Complex, multifunction electronic equipment is seldom completely down and less frequently all the way up. Normally, one or more functions are in some state of degradation.
2. The impact of a functional fault may be different for each mission capability.
3. The complex design of the combat system allows for some functional redundancy and provides for functions to interface through equipment boundaries.
4. The test results and operational fault directories, which are the entry into readiness assessment, are functional in nature.

Readiness assessment uses two basic techniques: quantitative and qualitative. Quantitative techniques require extensive mathematical manipulation and are reported either numerically or graphically. Past shipboard experience has indicated that without computer support, quantitative assessment is unwieldy, and numerical reporting either lacks meaning or requires extensive explanation. Without guidance material and reporting form support, quantitative assessment will vary with personal experience patterns. Qualitative assessment, its main value being an application to engineering analysis, is based on system knowledge, experience, and judgment and is normally reported in verbal form.

The impact of no-go conditions, revealed by the execution of PMS of each subfunction on the major function, is determined for each mission capability. A four-state readiness criteria for each major function can be assigned as:

1. Fully combat-ready
2. Substantially combat-ready
3. Marginally combat-ready
4. Not combat-ready

Fully combat-ready status indicates that all equipments associated with that function are in the highest state of readiness with respect to that function. *Substantially combat-ready* indicates that, although all equipments may not be fully operational, redundancy permits the mission to continue with a high probability of success. *Marginally combat-ready* indicates a function that can be performed with a much reduced probability of success. *Not combat-ready* indicates complete loss of function. These readiness criteria provide the ingredients for summary readiness reports in each mission capability. The mission summary report should be supported by a combat system daily fault report listing the subfunction faults of the day, their individual impact, alternative recommendations, and expected time of repair.

Material readiness does not end with successful completion of tests and scheduled maintenance. A group tests or scheduled maintenance that provides a 100-percent guarantee of material readiness has never been devised. In addition to testing, visual inspection for cleanliness, corrective maintenance, quality control, and complete integrity are necessary SERT responsibilities. Material inspections, conducted by or at the direction of the commanding officer, are excellent vehicles for accomplishing these tasks. Furthermore, assigning SERT personnel to inspection teams or conducting random equipment inspections without prior notice can provide excellent results. Such inspections should be for electronic and mechanical material readiness and preservation. The SERT representatives should provide, in writing, results of such inspections to cognizant authorities and provide follow-up inspections to ensure that necessary corrective action is taken.

Corrective Maintenance Management

Corrective maintenance consists of two basic categories: fault isolation and corrective action. The SERT is responsible for directing fault isolation at the combat system level and corrective maintenance management at all subsystem levels, and for coordinating corrective maintenance in related support subsystems. The SERT responsibility for corrective maintenance includes coordinating fault isolation efforts and subsequent impact evaluation. The latter responsibilities determine the priority of each corrective maintenance requirement. Another responsibility includes follow-up action by verifying or retesting and complete shipboard and maintenance data collection system reporting.

Effective management of corrective maintenance must consider combat readiness before, but not excluding, efficient use of manpower. Both of these factors closely relate to ship employment and tactical environment. Occasions will arise when more corrective maintenance requirements exist than can be handled simultaneously by the available manpower. Other occasions will arise when parallel faults exist that require the same personnel or the same system interface for fault isolation. When these conditions occur, management considerations for readiness and manpower availability should govern priority determination. The PMS measurements are made against a go/no-go tolerance structure. As the SERT collects and evaluates PMS results, faults should be weighed against impact evaluation, the tactical situation, complexity of fault isolation, and available manpower to determine the priority of corrective actions. Faults that are deferred, if left to accumulate, tend to degrade overall system readiness. Therefore, as soon as the situation permits, deferred faults should be repaired. For faults detected during operation, priority for repair must be scheduled by the SERT.

Faults detected within the combat system must be isolated to a replaceable or repairable subunit, or to an alignable interface before actual corrective action can be completed. Many factors are involved in accomplishing this isolation, the most important being a thorough knowledge of the system, supported by complete system and equipment documentation. The majority of subsystem and equipment documents present fault isolation support in one of two types of manuals. These are (1) procedures that address symptoms in preselected logic steps and in reference tables, logic chart, or logic diagram format; and (2) support materials based on flow diagrams and relay ladders.

Following priority designation and fault isolation, corrective maintenance management must ensure corrective action, verification by retest, and the completion of required reports. Since some faults tend to be repetitive, records of fault symptoms, identification, and corrective measures should be kept for SERT reference.

Monitoring Operational Readiness

Since overall readiness assurance is a function of operational readiness (personnel proficiency) and material readiness, the SERT's responsibility for operational training cannot be underemphasized. The operational readiness goal is to achieve the maximum combat system capability for each mission and its variants under constantly changing conditions of material readiness. Three basic techniques are available to assess personnel readiness: use of PMS tests, use of simulators or computer programs, and monitoring of ship or fleet exercises. In all the techniques, hardware must be in a fully operable state for accurate assessment of personnel capabilities, since equipment malfunctions tend to mask true assessment.

PMS was primarily designed to test hardware. However, selected tests provide some measure of operator proficiency by the use of high-level procedural instructions and time-tagged event printouts in a tactical mode of operation. These tests do not provide a capability for assessing proficiency of all combat system personnel.

The video signal simulator, with its computer programs, provides capabilities for assessing console operator proficiency. However, the computer programs are limited in their ability to assess combat system operator capabilities.

One method to evaluate the total combat system personnel capability is by actually monitoring ship or fleet exercises, as described in the COMTAC publications FXP-1, -2, and -3. These exercises include:

1. AAW exercises
2. ASU exercises
3. ASW exercises
4. AMW exercises
5. Electronic warfare exercises
6. Ship control exercises
7. Intelligence gathering exercises

When deficiencies in personnel performance are uncovered, the SERT must provide guidance for operational training. Since the SERT possesses the knowledge and training capability, it is uniquely qualified to assist the Ship Training Officer in identifying the required content of subsystem and combat system training. This training applies to both officers and enlisted personnel.

A basic rule to follow when conducting an operational readiness evaluation is that personnel manning a station should be familiar with:

1. The intended purpose of all switches, indicators, and controls; and the impact each has on other subsystems or on combat system equipment.
2. Communication links available at the station and with the other stations.
3. Knowledge of and compliance with specified communication disciplines.

4. Knowledge that the lack of communication discipline is an internal hazard to the combat system or the ship.

Test Selection and Scheduling

With the advent of PMS, an integrated approach to testing was developed. This approach is based on first defining all functional test requirements. These requirements are then subjected to a critical examination through an engineering analysis in which each function, parameter, and characteristic is examined for its importance, and for its reliability based on the circuit elements performing the function and their expected mean time between failure. This places a test periodicity (daily, weekly, monthly, quarterly, semiannually, annually, and cyclically) on each function. Critical functions are assigned a high periodicity regardless of reliability, while less critical functions may be assigned a periodicity consistent with their reliability. Related functions are grouped by periodicity and functional interdependency into tests having one of the previously defined periodicities. This integrated testing concept results in a management problem that is a SERT responsibility.

The tactical situation is the governing element in controlling manpower and equipment available for scheduled maintenance. Scheduling is a critical element of preventive maintenance management and requires a thorough knowledge of the intent and conditions of each Maintenance Requirement Card (MRC). Important conditions include in-port and at-sea requirements, outside service requirements, navigational support requirements, combat system operational usage, ship control requirements, emission control conditions, computer program requirements, subsystem interdependency, impact on computer program capability, adverse weather conditions, time requirements, and manpower requirements. From these conditions, the Quarterly Schedule can be developed based on the ship's employment schedule. Heavy maintenance scheduling should be directed toward in-port and independent ship exercises during nonthreat environment periods (particularly for those procedures requiring long periods of operational equipment downtime). If the employment schedule changes, the PMS schedule may require modification. Daily and Weekly Schedules should be developed with the exact ship steaming readiness condition and operational situation as the governing factors. Subsystem interdependence and manpower usage are also critical in scheduling. One method of efficient daily scheduling is the series-parallel approach (fig. 16-4) that addresses TERRIER system maintenance requirements for a

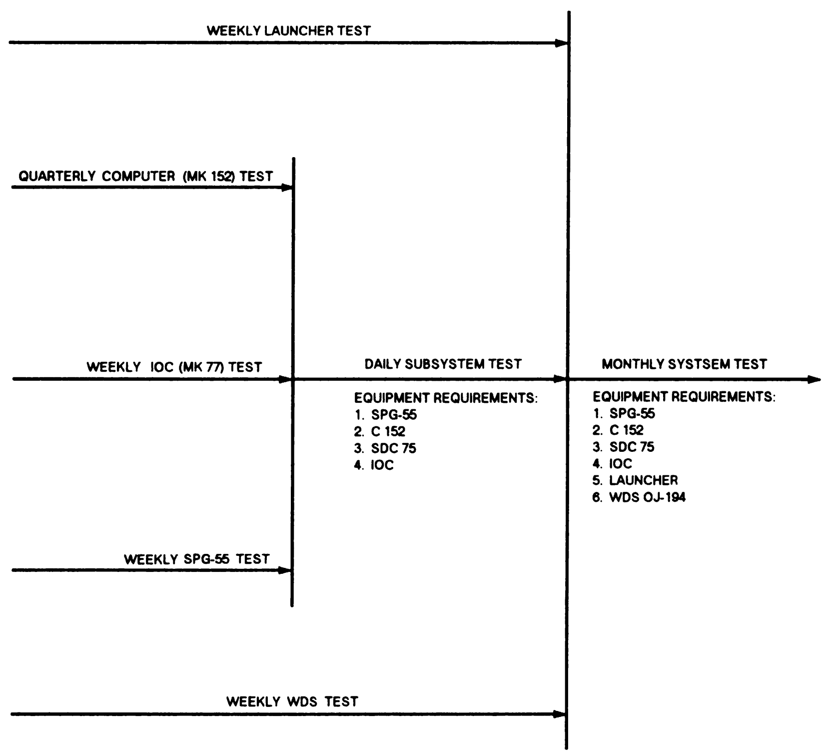


Figure 16-4.–Typical subsystem test schedule.

representative day at sea under normal steaming conditions. A variation of this diagram could place some of the parallel equipment tests after the system tests. Figure 16-5 uses a similar technique applied to the combat system for a representative day under steaming readiness condition III. In this case, the figure addresses limited test capabilities due to equipment being on line for condition III. On-line equipment is not available for testing; off-line equipment is available for equipment and subsystem testing. Equipments such as Fire Control Systems 1 and 2 (FCS 1 and 2) and FCS 5 and 6 should be alternated during condition watches to allow testing of all equipment. If surface operations are ordered, Radar Set AN/SPS-10C could be placed on-line and Radar Set AN/SPS-48C could be taken off-line for testing and maintenance.

Preventive maintenance management includes the following actions:

1. Ensuring that all events take place as scheduled
2. Coordinating manning and equipment availability for interdependent testing
3. Providing adequate safety measures
4. Ensuring the availability of required supporting systems
5. Coordinating the actions of command and tactical operation personnel
6. Ensuring fault isolation and corrective maintenance follow-up
7. Ensuring the completion of required reports

The *Combat System Technical Operations Manual (CSTOM)* contains readiness assessment and fault isolation diagrams indicating the test that requires the fewest ship resources, verifies each combat system interface function, and aids the SERT in managing preventive maintenance.

SUBSYSTEM	SEARCH RADAR				WEAPONS						
					MFCS		LCHR	CIWS			
OPERATIONAL TEST CONDITIONS	SPS-48E	SPS-49	SPS-67	CDS	FCS-1 FCS-2	FCS-5 FCS-6	LCHR 1 LCHR 2	MT 21 MT 22	EW	UFCS	HARPOON
ON-LINE TACTICAL SYSTEMS	X			X	X		LCHR 1	X	X	X	X
OFF-LINE SYSTEMS PERFORMING EQUIPMENT, SUBSYSTEM, AND COMBAT SYSTEM TESTS											
EQUIPMENT TESTS		X									
MISSILE SUBSYSTEM TESTS						X	LCHR 2				

Figure 16-5.–Typical Condition III testing availabilities.

Readiness Assessment Reporting

The SERT is responsible for collecting all scheduled test results, evaluating the impact of detected faults (based on corrective maintenance requirements), and defining the results of corrective maintenance as they relate to functional readiness assessment. This evaluation also extends to faults detected through operator observation. Where functional operability is concerned (established by adhering to the periodicity of the PMS schedule), confidence in the operability of the equipment is as important to readiness status reporting as the detection and evaluation of faults.

The PMS procedures in the various combat system elements have been developed by several agencies under general specifications. Sometimes, fault identification and reporting procedures may vary for a particular MRC. When this happens, the SERT takes action to solve the problem.

After readiness assessment is completed, readiness status must be reported in a brief, easy-to-understand form that presents a clear picture of the combat system's capabilities. This is done most effectively by addressing the status of a major function as it relates to a mission capability. Figure 16-6 provides a sample method of presenting a mission summary report to a four-state

	FUNCTION	STATUS	REMARKS
	DETECTION AND ENTRY		
	TRACKING AND IDENTIFICATION		
	THREAT EVALUATION AND WEAPON/ ASSIGNMENT		
ENGAGEMENT AND ENGAGEMENT ASSESSMENT	ELECTRONIC WARFARE		
	CIWS		
	UFCS		
	TERRIER		
	HARPOON		

STATUS LEGENT: FCR-FULL COMBAT READY
SCR-SUBSTANTIALLY COMBAT READY
MCR-MARGINALLY COMBAT READY
NCR-NOT COMBAT READY

Figure 16-6.–Sample mission summary report.

qualitative functional readiness assessment (describe earlier). This summary report sample also provides a brief description of the effect on the major functional area resulting from an assumed subfunction fault. Supporting information on specific subfunction faults related to the summary report sample can be provided in a combat system daily fault report form. Figure 16-7 provides a sample method of presenting daily fault information. Report forms of this type (or similar type) should be developed by the SERT to fit the ship's requirements. The combat system daily fault report is the responsibility of the SERT and should provide sufficient information to enable the weapons officer to develop the mission summary reports.

The SERT must evaluate, monitor, and report system status during competitive and fleet exercises. This includes organizing and instructing observers, preparing recording forms, defining data requirements, collecting and evaluating data, and preparing a composite internal report. Such reports should be limited to an evaluation of combat system material and personnel readiness during the exercise.

Alignment Logs

During PMS activities and exercises, the SERT is responsible for determining the mechanical and electrical alignment of inter-related combat system

LEGEND: D - DEFERRED
M - MANDATORY

COMBAT SYSTEM DAILY FAULT REPORT

MAINTENANCE STATUS	FAULT	IMPACT					ALTERNATIVE	ETR	NOTE
		AAW	ASW	ASU	AMW	CCC			
D	SPS-48E FINAL AMPLIFIER DOWN	REDUCED 3D DETECTION RANGE	NA	NA	NA	NA	3D 3RD STAGE DRIVER	1630	
M	CW1 KLYSTRON FCS-2	REDUCED MISSILE FIRE POWER	NA	REDUCED MISSILE FIRE POWER	NA	NA			NO PART CAS REPT

Figure 16-7.–Sample combat system daily fault report.

functions. The SERT must also assess the impact of a misalignment on the mission. Instructions to subsystem and equipment personnel must include the need for caution when making adjustments to equipment and subsystems, which may in turn affect the total combat system alignment. Alignment tests and efforts to reestablish reference standards are complex and time consuming and frequently require shore facilities, ideal environmental conditions, and extensive data collection and reduction. Realignment efforts (caused by incomplete or inaccurate reference data) resulting in inefficient use of manpower and resources must be avoided. Experience has shown that unnecessary alignment efforts can be avoided if reference data are kept current, accessible, and in a form that can be interpreted by all team members. A combat system alignment smooth log (if not already in effect) must be maintained and kept current and accurate. The total combat system alignment manual for each ship class explains the purpose of total combat system alignment, provides the necessary management data for the analysis and troubleshooting of alignment problems, and provides step-by-step procedures necessary for combat system alignment.

COMBAT SYSTEM TECHNICAL OPERATIONS MANUAL

Because sophisticated combat system integration has been rapidly replacing the earlier nonintegrated single-system concept on ships, the CNO has directed that all ships with tactical data systems be provided with a *Combat System Technical Operations Manual (CSTOM)*. The CSTOM is the only shipboard document that provides the user with the total integrated combat system concept. CSTOM is a top-level publication that emphasizes SERT support, especially readiness assessment and management. It contains intersystem signal distribution, fault isolation diagrams, fault impact tables, and tabular technical data describing combat system equipment capabilities and limitations. CSTOM also provides comprehensive lists of combat system publications as an aid in locating required data.

The Class-of-Ship CSTOM contains and organizes the technical data needed by shipboard personnel to operate and maintain the integrated combat system, to maintain material and personnel readiness, and to define significant capabilities and limitations of the combat system. The combat system is considered relative to its ability to integrate all subsystems for performing the basic combat system functions. These functions are detection and entry, tracking and identification, threat evaluation and weapon assignment, and engagement and engagement assessment.

In addition to system and subsystem integration, and operational and maintenance personnel readiness, the CSTOM provides two more, equally important, functions. The CSTOM supports the SERT in maintaining on-line combat system readiness. Also, the CSTOM is intended for use in classroom training and self-instruction. It has specially designed text and art so you do not have to prepare student handouts. Pictorial diagrams used throughout the CSTOM (instead of conventional block diagrams) make it easier for the user to recognize the physical and functional relationships of equipment and subsystems. Furthermore, data presented are from elementary to detailed levels, thus providing both shipboard combat system personnel and classroom personnel with needed orientation to various levels.

The CSTOM is structured into several volumes, parts, chapters, and sections, which are identified by a simple unit numbering scheme.

COMBAT SYSTEM TESTS

Combat system tests are the highest level tests that can be performed to verify combat system readiness or alignment. These tests are normally automated, computer driven tests, which are controlled and monitored by the CDS. The following paragraphs describe the combat system level tests that are currently available.

OVERALL COMBAT SYSTEM OPERABILITY TEST

The Overall Combat System Operability Test (OCSOT) is used to identify the current readiness state of the entire combat system and its personnel. This test provides a controlled scenario by which system responses to defined parameters are compared with controlled standards. The results are evaluated to determine the nature and degree of any degradation of system performance, as compared to the defined standards. Execution of any phase of the OCSOT will require that certain stations, systems, equipments, and consoles be manned and committed to support the scenario as part of their on-line operation. OCSOT is a weekly PMS check.

COMBAT SYSTEM ALIGNMENT TEST

The combat system alignment test provides the capability to demonstrate the alignment between the various shipboard sensors.

Any of the sensors can be designated as either reference sensor or sensor under test. The relative alignment is measured by comparing position data from the sensor under test to the data supplied by the reference sensor. The test data is displayed on the test console for comparison and a hard copy printout for record can be provided. Normal operation of the test sensor is precluded while this test is conducted.

COMBAT SYSTEM INTERFACE TEST TOOL

The Combat System Interface Test Tool (CSITT) provides the ability to test the generation, transmission, reception, and accuracy of data which cross specific combat system interfaces. A digital program, resident in a CDS computer, is designed to test, through a KCMX, a multiple number of combat system interfaces. The CSITT provides a numeric display on the selected test console for use by the operator to determine the status of the interface under test. The interfaces that can be tested are as follows:

- Underwater Battery Fire Control System (UBFCS)
- Search radar (including the search radar interface via the analog to Digital Converter CV-2095)
- Missile Fire Control System (MFCS)
- Support subsystem (ship heading, roll and pitch, and speed, and wind speed and direction)

Normal operation of portions of the CDS is precluded while this test is conducted. We have only addressed combat system level testing in this section. Each individual system has System Operability Tests (SOTs) that provide the capability to examine and verify the system accuracy and interface operability. For more detailed information on individual system level testing, refer to the appropriate CSTOM.

COMBAT SYSTEMS OPERATIONAL SEQUENCING SYSTEM (CSOSS)

Maintenance of the highest possible levels of readiness is the objective of CSOSS. Successful accomplishment of key evolutions, performed by trained personnel taking autonomous actions at assigned stations, using standard methods is the basis for maximum readiness. This process created the *People-Places-Procedures* concept on which CSOSS is based. Equally important are the safety and security of systems and people. Because most of a ship's operational life is expected to be spent in peacetime conditions, CSOSS and related training provide a disciplined way to learn how to perform readiness-related evolutions in all conditions and situations.

CSOSS USER'S MANUAL

The *CSOSS User's Manual* is intended for individual study by CSOSS users of all types. Appendices are class-specific, covering the class' configuration, and the CSOSS package is adapted to that configuration.

The user's manual explains the CSOSS structure and its proper shipboard use including methods of learning and practicing CSOSS-supported evolutions. It contains six sections and four appendices, as listed below, and provides sequential and comprehensive coverage of CSOSS structure and usage guidelines.

SECTION 1–INTRODUCTION

SECTION 2–FUNDATIONAL CSOSS

SECTION 3–CSOSS COMPONENTS

SECTION 4–CSOSS COMPONENT RELATIONSHIPS

SECTION 5–LEARNING TO USE CSOSS

SECTION 6–TRAINING

APPENDIX A–CLASS SPECIFIC ORGANIZATION

APPENDIX B–CLASS SPECIFIC STATUS BOARDS

APPENDIX C–LIST OF EFFECTIVE PAGES

APPENDIX D–FEEDBACK REPORT

Examples of procedures and support data are included in the user's manual to aid in understanding the various formats and key coordination information. CSOSS uses a simple system of identifiers, themselves used as references in procedures and as a link between all procedures. This system is demonstrated in the manual so that when you study the procedures in the CSOSS books and use the cross-reference, you will more easily understand the processing for all evolutions.

This section is a summary of the information contained in the *CSOSS User's Manual* and only provides general information. For specific CSOSS information, refer to the *CSOSS User's Manual* for your ship class.

ESSENTIAL CSOSS RELATIONSHIPS

Recall that CSOSS is an effective shipboard system because it always uses the people-places-procedures relationships, which are a fundamental part of the shipboard environment. Procedures are the major physical part of CSOSS, but CSOSS is most effective when training and use are based on ALL three relationships. The relationships are designed to include PEOPLE to take actions, PLACES where those actions are taken, and the PROCEDURES provided by CSOSS to accomplish those actions.

Figure 16-8 is a simplified view of how CSOSS relates to the combat system. It shows the fundamental CSOSS elements, including the CSOOW (Combat System Officer of the Watch). It also shows the distribution of CSOSS procedures throughout the combat system. The primary interaction with the engineering plant is through the CSOOW to the EOOW. The mutual support achieved by the CSOOW/EOOW interface effectively integrates engineering and damage control with the combat system.

Figure 16-8 also shows the important distinction between the technical providers under the CSOOW and the tactical users under the TAO (Tactical Action Officer). The integration of these two organizations is the key to CSOSS use and effectiveness.

The PEOPLE are combat system personnel of every rate, coordinated by the CSOOW and are the most vital part of the concept. They are integrated by CSOSS procedures and internal communications under CSOOW coordination to achieve maximum possible tactical readiness.

The PROCEDURES provided by CSOSS contain the step-by-step readiness actions that implement combat system readiness-management strategies. CSOSS procedures contain specific processes which form functional "threads." Each thread is actually the

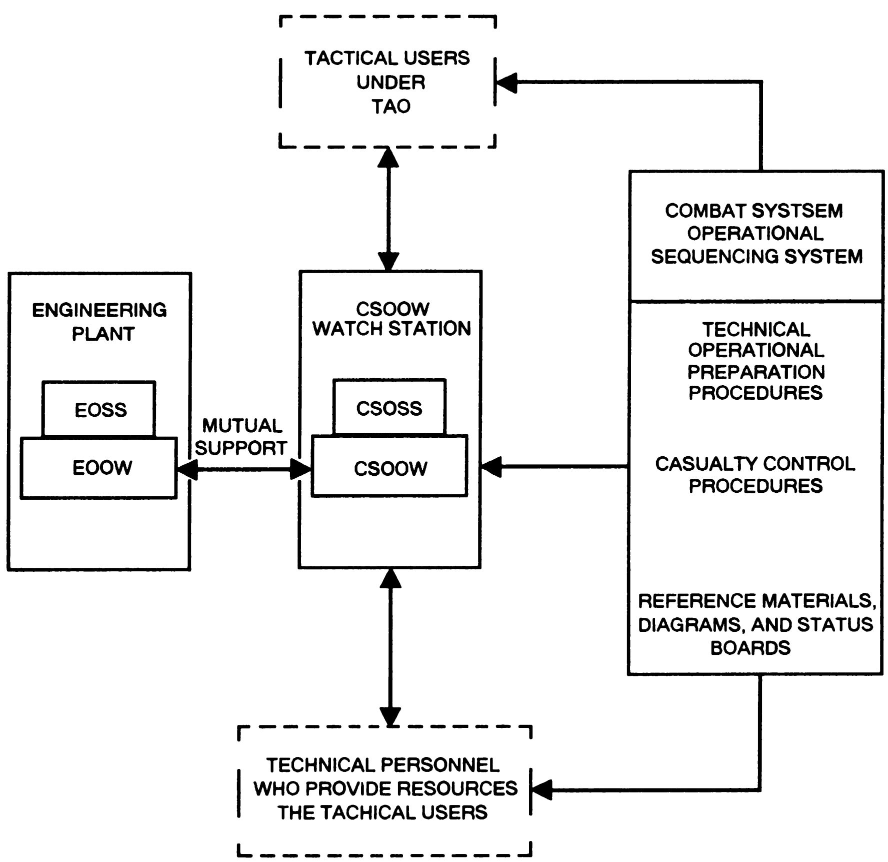


Figure 16-8.–CSOSS and the combat system.

written step-by-step procedure to accomplish a specific task, such as initializing the Gun Weapon System. Each task may involve numerous personnel around the ship, each performing a prescribed part of the scripted procedures. All actions are "threaded" together by the coordination and communication directions that are part of each CSOSS procedure set.

In summary, the interactions of CSOSS throughout the whole ship provide an integrated readiness methodology, which gives the commanding officer a composite readiness picture. This top level view assures better control of both technical and tactical operations within a stable environment. Because CSOSS is modeled after the Engineering Operational Sequencing System, EOSS, there are several relationships and dependencies between CSOSS and EOSS. These relationships and dependencies are described as they affect CSOSS and the organization. The direct link between the combat system and the engineering plant is achieved by the combination of people, places, and procedures in both systems. Unlike EOSS, however, CSOSS functions mainly within the technical operations area, with the tactical operations being provided by tactical-employment procedures not part of CSOSS. The distinction between the technical operations provided under the CSOOW and the tactical operations under the TAO is important to remember, because the subsequent integration of these two organizations is the key to CSOSS use and effectiveness. Training at all levels and under all conditions is critical to achieving maximum results, and is the key to getting the full value from CSOSS as a readiness tool.

CSOSS READINESS STRATEGIES

There are various strategies associated with CSOSS for supporting combat system readiness. A CSOSS readiness strategy is the general plan for controlling and using system resources under all expected conditions. From the strategies are developed specific procedures and supporting data. The following are brief descriptions of the basic strategies for the technical operations that CSOSS supports.

Configuration Control

This strategy provides standardized procedures for combat system initialization and activation to any required level of operation. It covers the entire combat system, elements, or subsystems as related entities, single equipment on a unit-by-unit basis, and support services or facilities as may be required. It also provides for configuration changes used in normal operation and as required for casualty or emergency situations. Additionally, it covers restoration to normal configurations from casualty configurations, following correction of abnormal conditions.

Casualty Control

This strategy provides for handling of casualties with system impact, which may be equipment-caused (failed circuit cards, etc.), damage induced, or functional (loss of ship's power, loss of a system), and any emergencies with associated hazards (fire, explosion), and personnel injuries. Restoration of function by reconfiguration to casualty or backup facilities or modes is part of casualty control. This strategy also provides for training technician watchstanders to immediately reconfigure or restore the system, thus eliminating delays in finding a specific technician.

Limited Tactical Support

This strategy provides CSOSS-formatted detailed checklists and procedural guidelines. They are used to activate watch stations, to assure correct procedures for relieving and assuming watches within the combat system, and to provide support for exercise firing and ordnance handling.

Maintenance Support

This strategy allows CSOSS use in reconfiguring systems for maintenance and associated testing. This assures positive control of systems in threat situations for rapid transition from maintenance to tactical modes.

Readiness Assessment/Training Support

This strategy includes using on-line, built-in system monitoring capabilities as the first level of assessment. It also provides control of reconfiguration for off-line or stand-alone testing and training. These are generally achieved by trained personnel using available procedures, supported by their system knowledge and understanding of the CSOSS materials installed.

These strategies are incorporated throughout the CSOSS manual showing how personnel, CSOSS procedures, and functional areas are organized to accomplish required evolutions.

CSOSS SHIPBOARD USER CONSIDERATIONS

There are five essential points concerning effective CSOSS use.

CSOSS User Environment (How CSOSS is to Be Used)

Standard environment assumes a specific configuration, used in all conditions as needed and applicable. Documented procedures use the best available information sources (people and publications). The most correct procedures for equipment control are incorporated for users.

Casualty Processing

CSOSS processes major hardware/system casualties, the effects of internal circuit failures on the combat system, and the effects of HM & E casualties.

Equipment Fault Detection

CSOSS isolates failed units to permit trouble-shooting and repair (technician and technical manuals). It also provides available redundant or emergency configuration and restores repaired units to an on-line configuration. Maintenance and repair information remains in technical publications, not in CSOSS.

CSOSS and SERT

The SERT uses CSOSS for standardized personnel technical training and qualification, using the Combat System Training Team (described below) as the training team. The SERT is the top level pool of readiness and maintenance expertise that coordinates comprehensive and focused casualty control drills and training. The SERT continues to function under the Systems Testing Officer (STO) for standard responsibilities.

CSOSS and the CSTT

The CSTT uses drill guides to set up exercises, and personnel respond using CSOSS procedures. The CSTT evaluates, scores, and provides direct feedback. The CSTT is made up of SERT members, who are the most qualified in all areas, augmented by tactically qualified personnel as necessary to support the technical-tactical relationships required for maximum combat system readiness.

SPECIFIC ASSUMPTIONS FOR CSOSS DEVELOPMENT

All CSOSS procedures can be used in any configuration by trained personnel under CSOOW coordination. Required casualty-control procedures, which are the baseline for both training and actual operations, were based on an assumed equipment configuration. In the development phase of CSOSS, it is assumed that the ship is underway and minimally configured as follows:

- Launcher (if applicable) in standby, launcher power on
- Gun(s) manned, motors running as required
- Fire Control System (Gun and/or Missile) up and on-line
- SLQ-32 up (ESM)
- All consoles up
- UWS up, sonar mode as required by mission
- Search radars in radiate, ADT systems (if applicable) operating
- Harpoon up, enable key off
- Torpedo room manned as required by mission
- IFF up
- Communication plan effect
- LAMPS on alert 30
- CIWS up in remote, mode as required
- GYRO on line
- Key casualty control stations manned as required (CSOOW, CSRO, SUPERVISORS)

VIEW FROM THE TOP

As shown in figure 16-9, CSOSS completes the view of the whole ship for the commanding officer with readiness management applied to all the major functional areas. CSOSS and EOSS are key procedural systems, which provide many of the unifying and integrating methods in standardized form. All of the other "unifying" elements in the boxes below the diagram are also vital and will be discussed throughout this section.

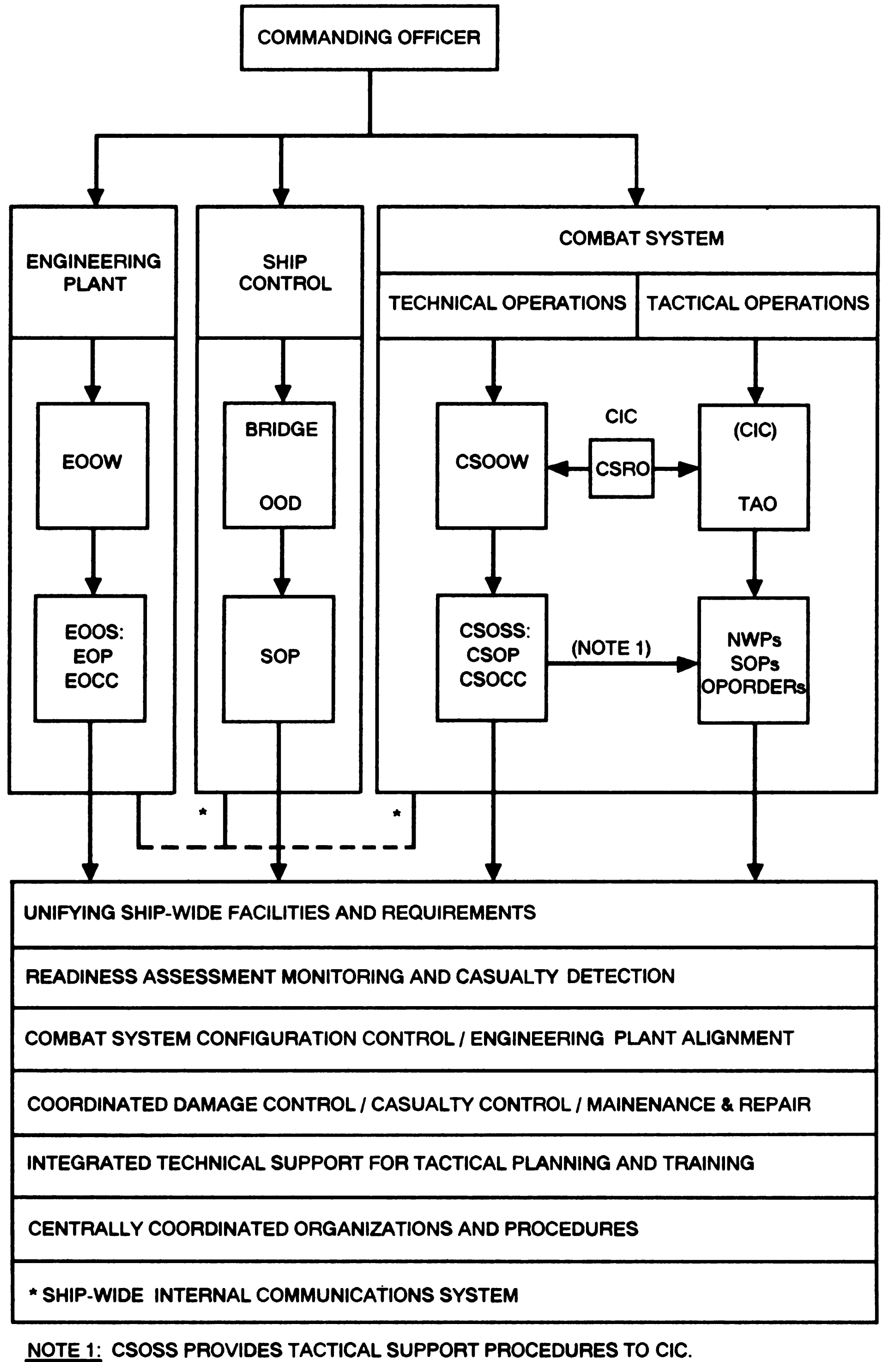


Figure 16-9.–View from the top.

THE CSTOM/CSOSS CONNECTION

CSTOM and CSOSS are connected by the technical operations they support. CSTOM establishes technical operations *requirements* for readiness matters, while CSOSS provides step-by-step technical operations *procedures*.

CSTOM and CSOSS share the common objective of readiness support at several levels. These top level tools have a complementary effect, in which CSOSS is the comprehensive single source of ship specific *procedures* and CSTOM a comprehensive source of *detailed information*. CSOSS provides the detailed and standardized procedures for readiness management and system control, but it also uses simplified "snap-shot slices" of large scale diagrams and tables found in CSTOM, tailored for specific users. CSOSS similarly extracts data from all other publications listed in

CSTOM to assure standardized presentation of correct procedures and support data. Remember, CSTOM is detailed information; CSOSS is procedures.

On ship classes without CSTOM, CSOSS helps fill the void, as a comprehensive source of readiness support and management, system control, and technical operation information.

FUNDAMENTAL CSOSS

This section provides details of basic CSOSS organization, communications, and terminology. Understanding these basics is essential to becoming an effective user of the CSOSS organization, CSOSS procedures, and other material in the wide range of situations, which can occur on board a ship.

BASIC ORGANIZATION

The integrated organization of technical "providers," (fig. 16-10) provides technical resources to the tactical "users" to fit the ship's condition of readiness. All stations in the CSOSS organization are tied together by shipboard internal communications.

This organization of the ship's personnel into the functional groups required to accomplish all readiness-related tasks also facilitates coordination of those tasks in all conditions. The CSOSS organization is at maximum reaction capability at Condition I, and

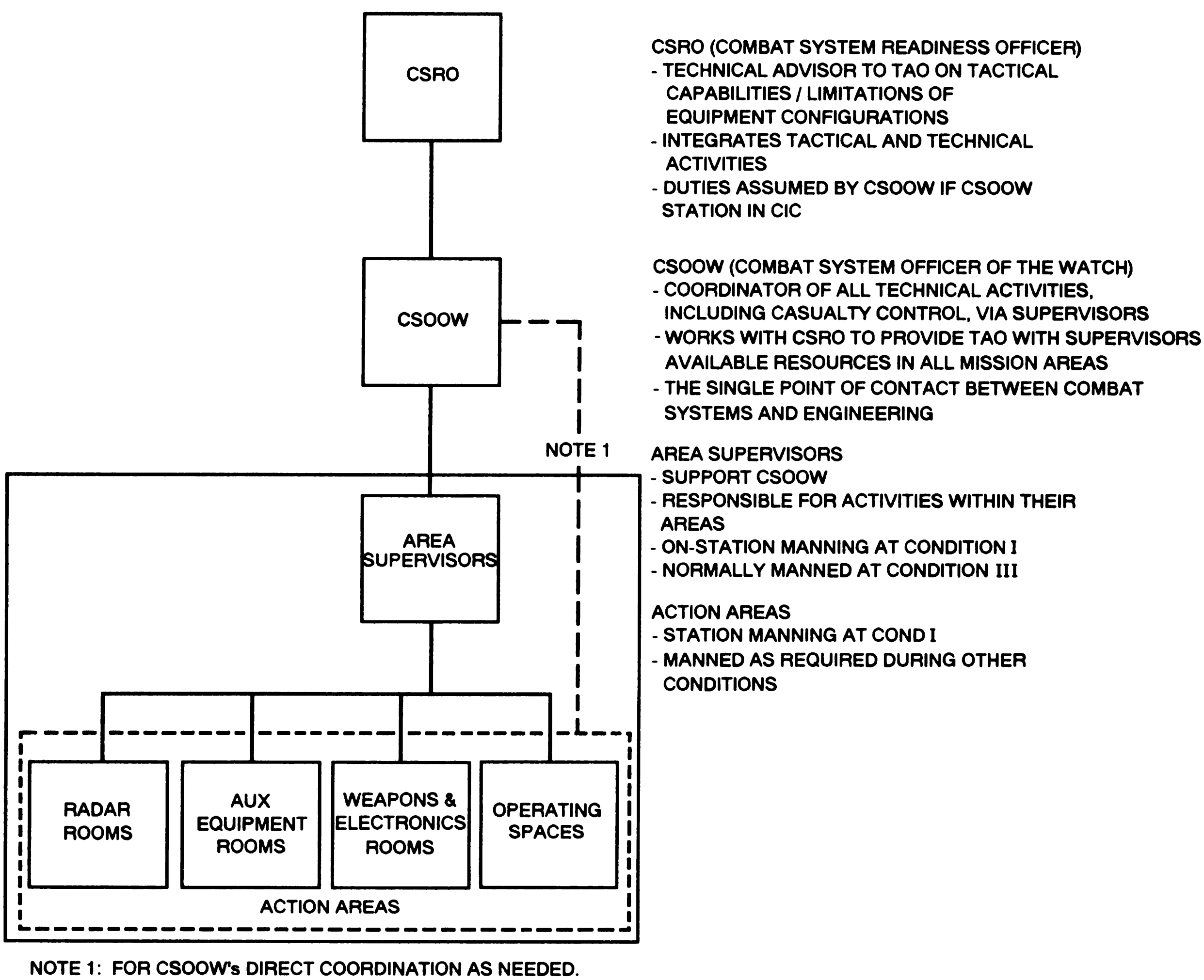


Figure 16-10.–Basic CSOSS organization.

less in other conditions. For example, a Condition I CSOSS-supported casualty-control/repair organization, closely coordinated by CSOOW, distributes repair personnel throughout combat system spaces. In other conditions, the CSOOW's role remains the same, but manning is reduced in most spaces. In port, the LPOs run the organization with the Duty Combat Systems Officer of the Watch maintaining centralized coordination of evolutions as required. This approach has helped reduce the problem of combat system partitions, which traditional administrative organizations impose, and encourages a higher level of cooperation and mutual support by all hands in all conditions. Crew members will find it easier to work with each other because CSOSS prompts communications between departments and divisions.

COMMUNICATIONS

For all ship's evolutions, an effective communications network is vital. CSOSS is no exception. Communications must be timely and concise to provide status information for readiness assessment and to base decisions for casualty responses. All CSOSS procedures contain directions for the minimum communications required to accomplish each action area's task. In some cases direct quotes are used to assure that specific information is reported. In other cases, procedures indicate that actions must not be taken until specific verbal directions or reports are received. In all cases, tight circuit discipline must be maintained to keep the amount of traffic to a minimum, and reduce confusion and delay. The need for correct and standardized communication procedures during operation, changes in system status, and casualty response cannot be overemphasized. Basic communication paths and content are shown in figure 16-11. Standard communications and status phrases are listed in table 16-1.

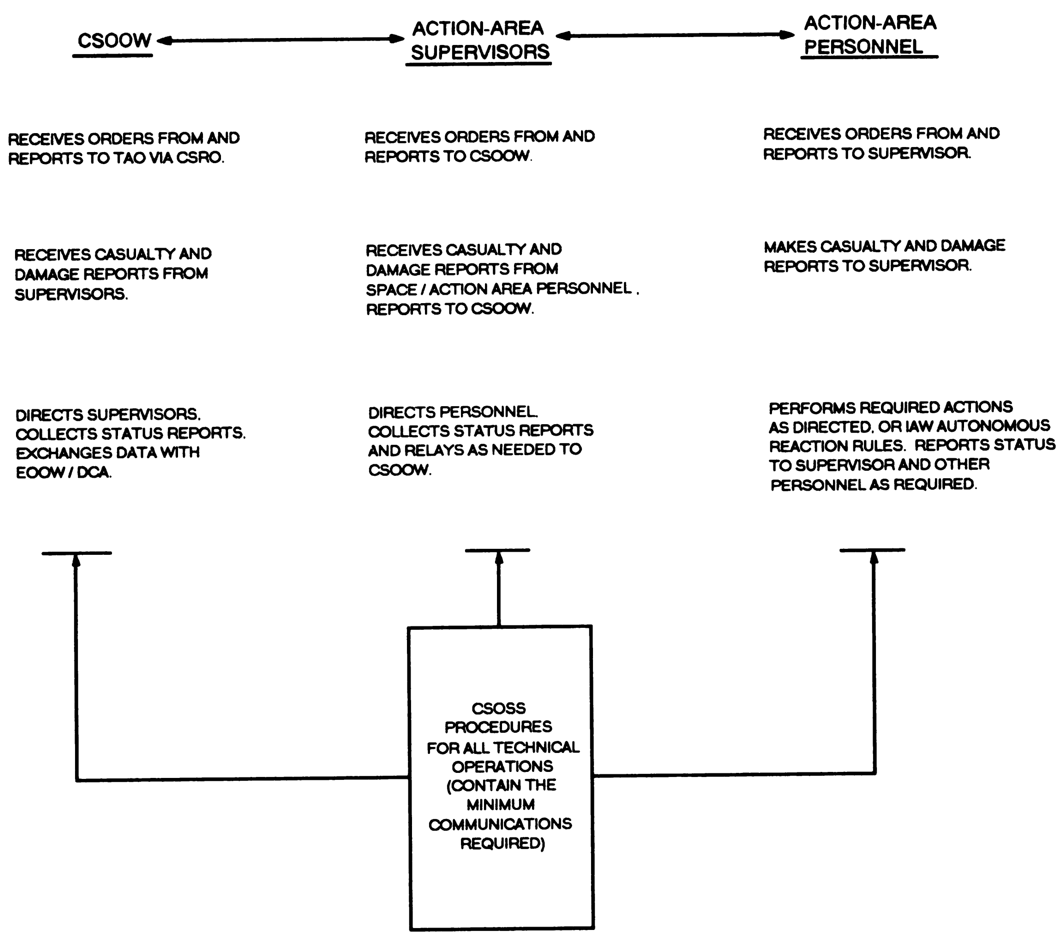


Figure 16-11.–Basic communications paths.

SYSTEM DATA TABLE STANDARD COMMUNICATIONS AND STATUS PHRASES	CSOSS ID SDT 1/CSOSS
REFERENCED BY:	

I. SAFETY ADVISORIES

WARNING:

USED TO ALERT PERSONNEL TO AN ACTION OR SERIES OF ACTIONS THAT IF NOT STRICTLY ADHERED TO MAY RESULT IN INJURY TO PERSONNEL. WARNING WILL ALWAYS PRECEDE THE ACTION OR SERIES OF ACTIONS TO WHICH IT APPLIES.

CAUTION:

USED TO ALERT PERSONNEL TO AN ACTION OR SERIES OF ACTIONS THAT, IF NOT STRICTLY ADHERED TO, MAY RESULT IN DAMAGE TO EQUIPMENT. CAUTION WILL ALWAYS PRECEDE THE ACTION OR SERIES OF ACTIONS TO WHICH IT APPLIES.

NOTE: Used to alert personnel to essential information, projected final results, or highlight a particular condition. Notes normally precede the action or series of actions to which they apply.

II. COMMUNICATIONS STANDARD PHRASES

Order: Indicates an action or series of actions that must be directed and controlled. When an order is given, there will be a report that the action or series of actions has been completed.

When Ordered: Used to indicate an action or series of actions that must not be performed until ordered by the CSOOW or Action Area Supervisor.

Report: Used to indicate when to report completion or status.

When reported: Used to indicate an action or series of actions that must not be performed until report of previously ordered action or series of actions is received.

When required: Used to indicate an action or series of actions that may or may not be required to be performed, depending on the particular situation or circumstance.

Assistance required: Indicates an action in one or more watch areas that requires more than one person to accomplish.

Verify: Used to alert personnel to a condition or action that must exist prior to commencing an action or series of actions. The operating personnel are required to coordinate by communications with each other that the required situation or condition does exist.

CODE: CSOSS SYSTEM	DATE: 10/1/88	CHG: 2	PAGE 1 of 2

SYSTEM DATA TABLE STANDARD COMMUNICATIONS AND STATUS PHRASES	CSOSS ID SDT 1/CSOSS

Ensure: Indicates a condition or an action that should have been previously accomplished; however, when not accomplished, action must be performed prior to continuing with procedure.

Notify: Used to indicate vital information that must be passed to other watchstanders.

Direct: Used by supervisory and command personnel to cause an ordered action or series of actions to be performed by action area personnel in a specific manner or to a specified (directed) level of operation.

When Directed: Means to execute the ordered action in the specific variations or manner only when that specific direction is received.

As directed: Means to follow the specific direction as provided for the situation.

Uncontrollable: Used to indicate a situation that requires immediate response to stop cascading effects to minimize damage to equipment or injury to personnel.

Controllable: A casualty control term used to describe actions to be accomplished in preventing an abnormal condition from cascading to a casualty that may cause the loss of equipment or restrict system operations until corrective action can be accomplished.

Optimum: Describes the best equipment combination and system configuration for a given combat system condition.

Energize: The act of closing an electrical circuit breaker or switch at a main power supply.

Deenergize: The act of opening an electrical circuit breaker or switch at a main power supply.

Open: The action of opening a valve to allow full flow of fluid or, in the case of electrical components, positioning a circuit breaker to interrupt current flow.

Close: The act of positioning a circuit breaker or switch to permit current flow. The act of positioning a remote control circuit actuator (pushbutton and toggle switches or remote hydraulic lever) in order to shut a valve.

Shut: The action of closing a valve to prohibit fluid flow.

Unseat: Used to describe the act of opening a valve sufficiently to restrict fluid flow to a low, but greater than minimum, rate.

Crack open: The act of opening a valve sufficiently to permit fluid flow at a minimum rate as compared to normal flow.

Shift: Action(s) required to exchange components or change a system mode of operation.

CODE: CSOSS SYSTEM	DATE: 10/1/88	CHG: 2	PAGE 2 of 2

CSOSS TERMINOLOGY AND DEFINITIONS

The following are basic CSOSS terms and their definitions:

- **ACTION AREA**–Where CSOSS-supported actions are taken, as identified in the procedures.

- **AUTONOMOUS**–The concept of expediting casualty control by taking immediate action to control a casualty without first making a report and receiving an order to proceed.

- **CAPABILITY**–The total effect of designed features, including ordnance, hardware, software, people, and procedures. Maximum capability means no degradation due to casualties, lack of ordnance, lack of people, or incorrect operations.

- **CASUALTY CONTROL**–Action against any type of casualty, however caused, to stop any cascading system degradation, and to quickly restore maximum possible capability.

- **CONFIGURATION CONTROL**–Action to initialize equipment and systems into any required operational configuration; includes activated (ON) and deactivated (OFF) states.

- **CSOCC**–Combat System Operational Casualty Control, the subsystem of CSOSS procedures that are used by personnel to handle specific casualties in an orderly and rapid manner.

- **CSOOW**–Combat System Officer of the Watch, the unifying watch-station for all CSOSS-based operations. CSOOW is the central coordinator for all aspects of technical operations in the combat system.

- **CSOP**–Combat System Operational Preparations, the subsystem of CSOSS procedures that contains configuration control procedures. Initialization is a major part.

- **CSRO**–Combat System Readiness Officer, located in CIC. The CSRO is technical advisor to the TAO on casualty impact and reconfiguration actions, and advises the CSOOW on tactical mission requirements and priorities that must be supported by technical operations. On some ship classes manning may dictate that CSRO duties be combined with CSOOW duties.

- **CSTT**–Combat System Training Team; includes SERT members who are the most qualified in all areas of the combat system, and provides CSOSS-based training through insertion of known casualties.

- **ESS**–Electronic Support Systems; the many radars, communications and navigation systems that are under the control of the ESS Supervisor.

- **OPERATIONS**–Divided into "Technical Operations," which the technical providers perform for system configuration and casualty control, and "Tactical Operations," which the users perform in the employment of systems.

- **ORGANIZATIONS**–Administrative–normal departments, divisions, and work centers. Casualty control–primarily the CONDITION I/III Technical organizations, which are combat system oriented for integrated operations.

- **READINESS**–The measure of how much of the total designed capability is currently available.

- **SERT**–Ship's Electronics Readiness Team; the top-level pool of readiness and maintenance expertise, generally the senior technical and operational personnel.

- **TACTICAL READINESS**–The measure of how well the ship's systems, weapons, and people are prepared for tactical employment against specific threats or in specific mission areas.

CSOSS COMPONENTS

CSOSS consists of three separate but interrelated and interdependent sections or subsystems. These are Combat System Operational Preparation (CSOP) procedures, Combat System Operational Casualty Control (CSOCC) procedures, and Support Data.

Combat System Operational Preparation

CSOP is similar to the EOP section of EOSS. (EOP is the Engineering Operational Procedures, used for all plant evolutions not part of casualty control). The CSOP provides a system of procedures and guidance for all combat system evolutions not part of casualty control. CSOP provides:

- Initialization, technical operation and securing of equipment.
- Technically correct procedures, written in standard format, and located at the places of use.
- Methods of collecting, reporting, and recording combat system status using a system of status boards. Centralizing configuration and status information is a basic feature of CSOSS.

- Book-size diagrams and other support data are provided for reference by CSOP procedures.
- Limited tactical support is provided to specific operators with CSOP procedures. They provide standard methods for setting up and maintaining combat system operator stations to required levels of tactical readiness. These are NOT tactical employment procedures, but do assure correct set-up of operational watchstations, especially for watch-to-watch turnovers.

CSOP provides technical operations procedures for:

- Configuration control
- Equipment/systems initialization and securing
- System test operation/checkout as part of initialization
- Restoration of systems under all conditions
- Tactical support (e.g., assume-the-watch checklists).

Combat System Operational Casualty Control

The CSOCC is similar to the EOCC (Engineering Operational Casualty Control) section of EOSS. EOCC is used for all casualty control procedures in the engineering spaces and is supported by EOP procedures. Similarly, CSOCC is used for all casualty control procedures in the combat system spaces and is supported by CSOP. The CSOCC procedures provide guidance for controlling casualties.

The first step in controlling casualty conditions is to limit cascading effects of casualties if possible. The system must then be placed in a safe condition within the limitation of the casualty and/or the tactical situation. Under CSOOW direction, alternate or casualty configurations using available redundancies are used to restore available capabilities. After repairs are completed, the system is restored to its pre-casualty configuration, if possible. Re-initialization of an emergency type may be required in combat conditions. CSOP procedures are used if normal reinitialization is needed, such as following lengthy repairs.

CSOCC procedures are technically correct, written in a standard format, and located in books at the places of use. CSOCC is used for continuous training and actual casualty processing. Status boards are used to plot status in all conditions for rapid readiness assessment by the CSOOW. Autonomous actions by personnel are supported for rapid casualty responses in critical situations.

CSOCC provides technical operations procedures for:

- Control of casualties to systems and equipment
- Control of major emergencies (e.g., fires and magazine problems)
- Emergency reinitialization of systems under combat conditions
- Restoration of systems after casualty repair

Support Data

- Support data provides the following:
- Status boards used by CSOOW, CSRO, and area supervisors
- Book-sized data (tables, notes, diagrams)
- System interface diagrams

As shown by figure 16-12, procedures may cross-reference each other, or refer to support data. Additionally, limited reference may be made to ship's technical and PMS data as a way of accessing technical data not suitable for CSOSS (e.g., ordnance related procedures).

Component Fundamentals

Table 16-2 lists all the standard component types, including identifiers, names, and functional use.

Each page of each CSOSS component contains the functional title and its two-part CSOSS identifier, as shown in figure 16-13. The "SP 2" is the component type "SP" and sequence number "2." Sonar is the literal code for the system covered by this SP.

The sequence number O (e.g., MP O) is reserved for master and system procedures that coordinate or supervise initialization.

Master level coordination procedures such as MCRPs have other procedures related to them to complete the procedure for a specific task. These related procedures (e.g., CRPs) are identified by sub-sequence numbers attached to the parent procedure's sequence number as in the following example:

MCRP 3/GWS–is the parent procedure, held by CSOOW and supervisors.

CRP 3.1/GWS–is the first related procedure located in the action area(s).

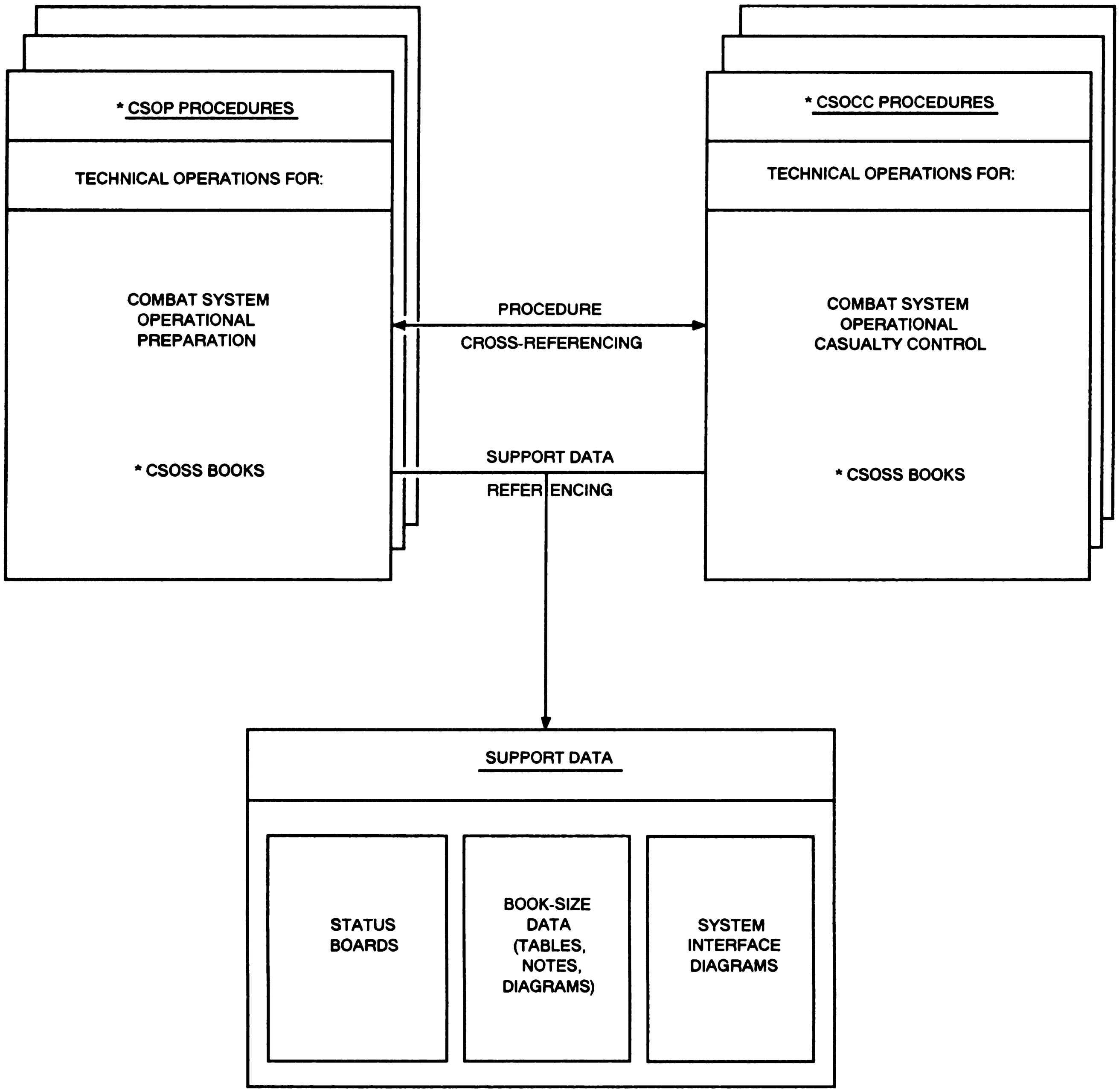


Figure 16-12.–CSOSS procedures and support data.

(component functional title) SONAR DOME CONTROL SYSTEM SETUP	(CSOSS identifier) SP 2/SONAR

Figure 16-13.–Typical CSOSS component designator.

Table 16-2.–Basic CSOSS Components

TYPE/ID	NAME	APPLICATION
CSOP:		
MP	MASTER PROCEDURE	COORDINATE MAJOR NON-CASUALTY EVOLUTIONS AT THE SYSTEM LEVEL.
OP	OPERATIONAL PROCEDURE	SYSTEM AND EQUIPMENT TECHNICAL OPERATIONS AND TACTICAL SUPPORT.
SP	SYSTEM PROCEDURE	END-TO-END EVOLUTION WITHIN A SYSTEM OR EQUIPMENT GROUP; ALSO SUPERVISION
CP	COMPONENT PROCEDURE	BASIC EQUIPMENT-LEVEL TURN ON, TURN OFF, AND TECHNICAL OPERATION STEPS (TEST OPERATION, CONFIGURATION).
CSOCC:		
MESP	MASTER EMERGENCY SYSTEM PROCEDURE	COORDINATE RESPONSES TO MAJOR FIRES, EXPLOSIONS.
MCRP	MASTER CASUALTY RESPONSE PROCEDURE	COORDINATE RESPONSES TO ALL DEFINED CASUALTIES.
MEP	MASTER EMERGENCY PROCEDURE	EMERGENCY CONFIGURATION CHANGES, AND SYSTEM RECOVERY.
CRP	CASUALTY RESPONSE PROCEDURE	DETAILED ACTION AREA STEPS.
SUPPORT DATA:		
SD	SYSTEM DIAGRAM	DIAGRAMS FOR SYSTEM POWER, WATER, AIR, ETC.
SDT	SYSTEM DATA TABLE	TABULATED DATA FOR QUICK REFERENCE.
SN	STANDARD NOTES	GENERAL GUIDANCE INFORMATION FOR TECHNICAL AND ORGANIZATIONAL MATTERS.
SB	STATUS BOARD	VISUAL PLOTS OF STATUS AND CONFIGURATION INFORMATION.
SID	SYSTEM INTERFACE DIAGRAM	INTERCONNECTION AND SIGNAL DISTRIBUTION DIAGRAM.

CRP 3.2/GWS–is the second related procedure located in the action area(s).

TYPICAL CSOSS PROCEDURE CONSTRUCTION

CSOSS procedures provide the correct steps required to perform all required technical operations in support of combat system readiness. Basic step-by-step information is obtained from the specific equipment reference publications, incorporated into the CSOSS procedures in their respective formats as shown in figure 16-14. The cross-referencing area on the first page allows the users to see how each component fits with all the other related procedures.

Should a procedure be longer than one page, a continuation page is used. This is the standard follow-on page format for all CSOP and CSOCC procedures. A similar approach is used for support data items of multiple pages. The title and CSOSS ID information blocks at the top of the pages will be repeated throughout a procedure or other CSOSS component to minimize confusion.

The bottom information blocks are also repeated on each page, although some of the information may differ. The page block will indicate the individual page number and the total number of pages within the procedure.

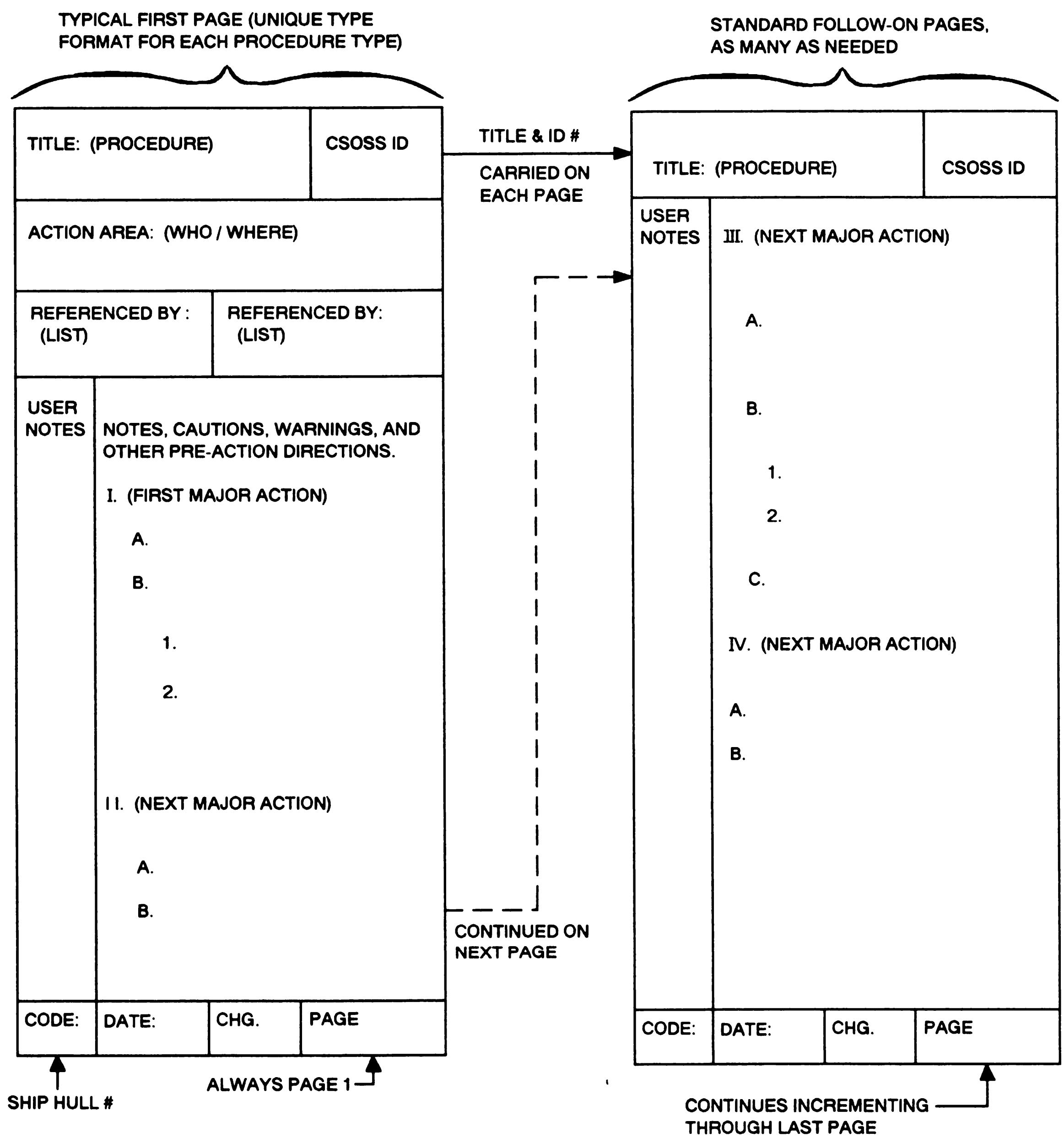


Figure 16-14.–Typical CSOSS procedure construction method.

As shown in figure 16-14, procedural details are organized in a top-down outline format, supplemented by notes, cautions, and warnings as required. Included also are communications requirements to assure personnel coordination and status reporting. References to specific detailed step-by-step information in selected external source publications is also included. References to tables, diagrams, and other procedures are used to construct a full set of materials to support the titled action. Notes, cautions, and warnings are also inserted wherever they are needed. The typical construction details shown here vary by procedure type.

CSOSS PROCEDURE CROSS REFERENCING

Figure 16-15 illustrates the principle of cross-referencing used in the CSOSS procedures. Using the identifiers, all related procedures can be easily determined. The level of cross-referencing provided in the "Referenced By" and "Reference To" blocks present an instant view of how each CSOSS component fits with all other related components. The "Reference To" block on each procedure and some other components contains all references to specific CSOSS components embedded directly in the body of the procedures themselves. In this way, the processing threads that complete all actions for each process are formed. In addition, many components may be incorporated into multiple processes (e.g., an initialization CP for an equipment found in multiple systems), so each reference to each CSOSS component is recorded in the "Referenced by" block.

Using the reference-summary blocks, a technician can "walk" from any procedure to all related components, going in any direction from any component. Starting at the top-level procedure of a specific process (e.g., the MCRP for a system casualty) a total picture of top-down referencing to other

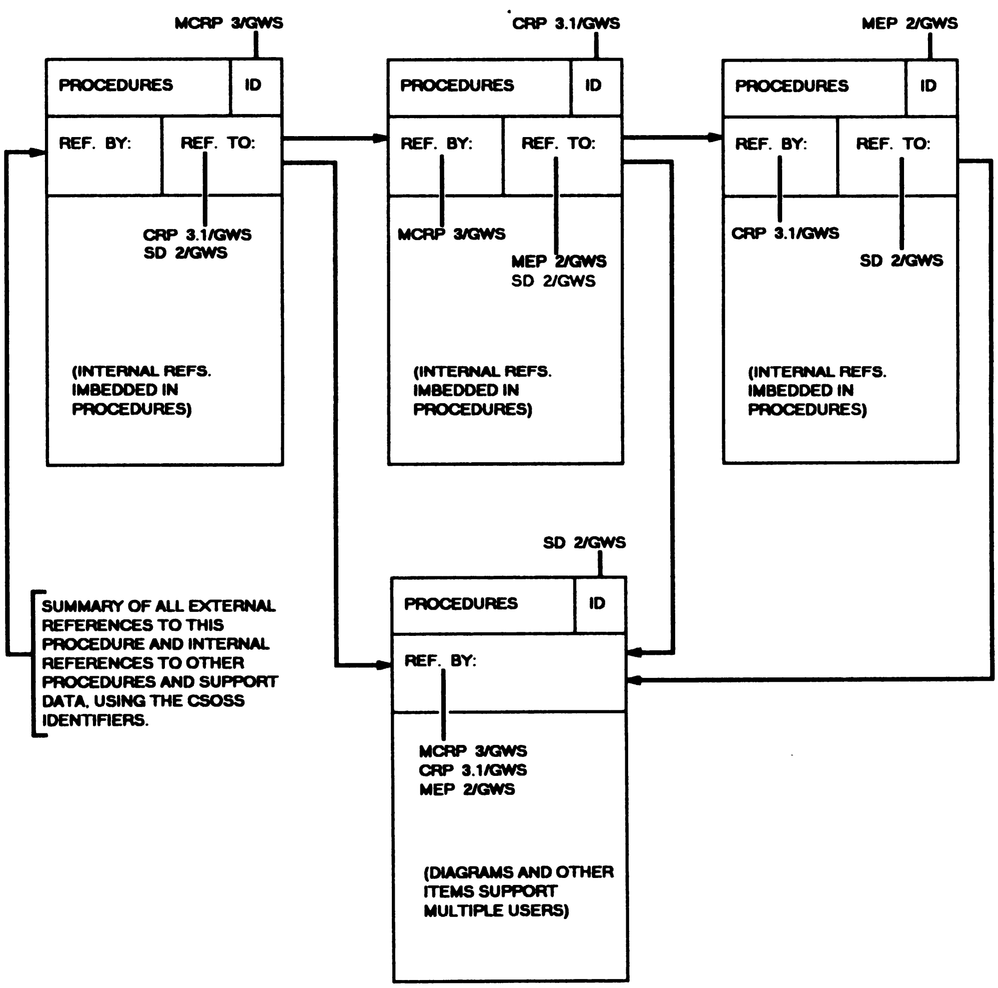


Figure 16-15.–CSOSS cross-referencing principles.

procedures and horizontal referencing to support data can be constructed. This is the fundamental element of the CSOSS building-block approach, in which component CSOSS IDs are used to thread together the set of CSOSS components needed for each specific process.

CSOSS COMPONENT RELATIONSHIPS

CSOSS components provide the configuration management, functional integration, and central coordination of all combat system events. Specific procedures and supporting reference data are provided throughout the combat system to support training and operations. The following paragraphs show the relationships of the various components, how the various levels of coordination and supervision are supported, and in general how the CSOSS building-block approach is implemented.

BASIC CSOP PROCEDURE RELATIONSHIPS AND USES

Figure 16-16 shows the typical relationships or CSOP procedures established by CSOSS and implemented by the cross-referencing system. Support

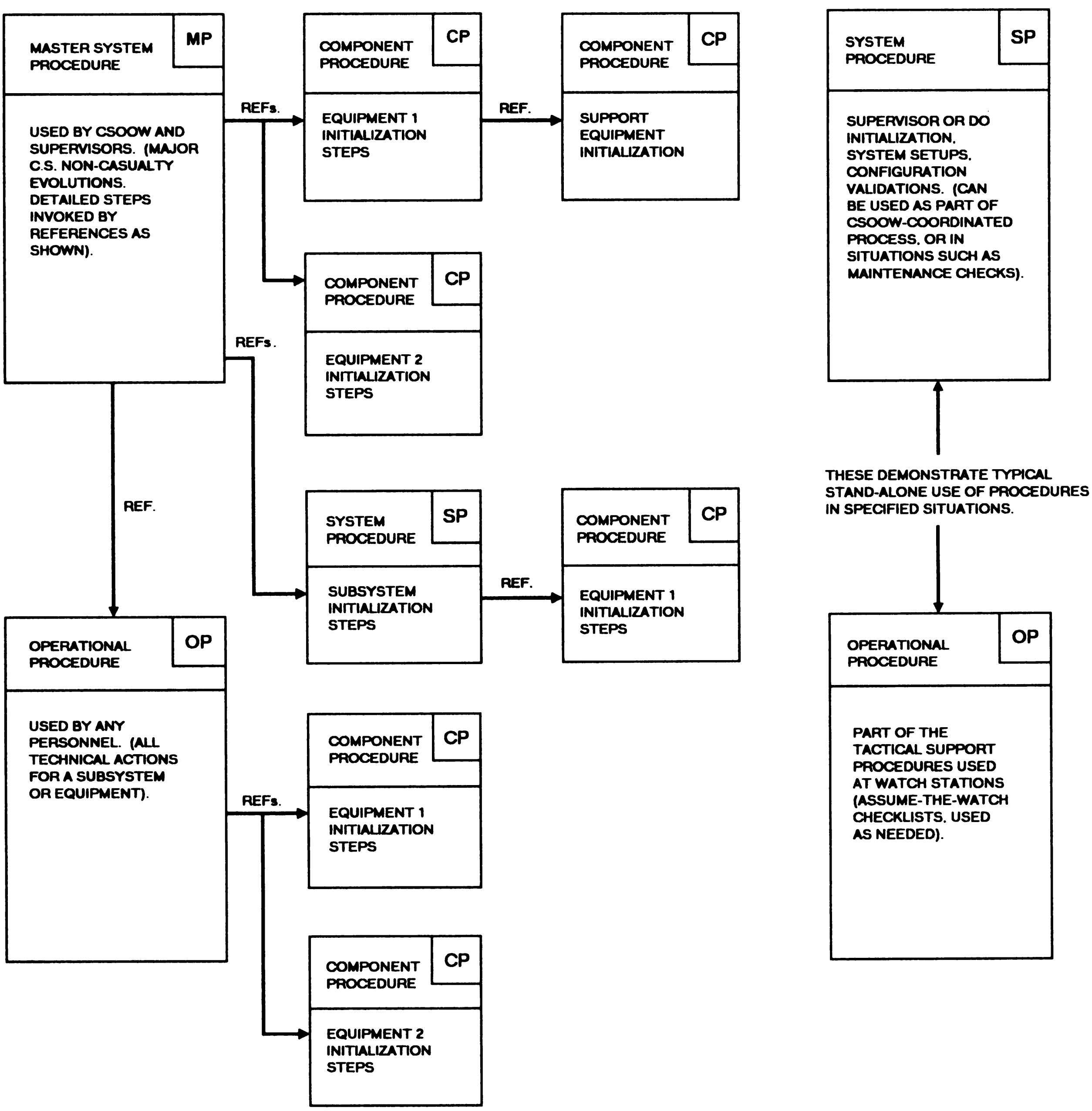


Figure 16-16.–CSOP relationships.

MASTER PROCEDURE COMBAT SYSTEM MASTER LIGHT-OFF CHECKLIST		CSOSS ID MP 0/CS
REFERENCED BY: MP 4/CS, MCRP 1/CS		REFERENCE TO: MP 0/UWS, MP 0/ESS, OP 1/CS THROUGH OP 20/CS, SP 0/AUX, SP 0/CMPRM, SP 1/GYRO, SD 4/CS, SB 1/CS
USER NOTES	NOTES:	

Figure 16-17.–Master procedure header.

data, not shown, can be referenced by any procedure. CSOP cross-referencing rules are flexible, and permit SP, CP, and OP types to be referenced by each other. A brief description of each CSOP type is provided.

Master Procedure (MP)

Figure 16-17 shows the header of the MP, which establishes an overview of major noncasualty evolutions for use by the CSOOW and area supervisors. A master procedure contains all required orders, status reports, interacting events requiring coordination, and the correct sequence of events when applicable. Parallel operations are covered as separate sections in the MP. In general, MPs do not include detailed steps, but can incorporate by reference, any level of detail required.

Operational Procedure (OP)

Figure 16-18 shows the header of an OP, used to provide detailed step-by-step instructions for accomplishing nontactical, noncasualty evolutions. An OP presents data in a "step 1 through step last" format for clarity. All required steps are generally incorporated, with few references to other procedures. OPs are used to provide procedural direction for any kind of event-driven, button-pushing, or start-to-finish operations. Examples are: Relieve the Watch

OPERATIONAL PROCEDURE HARPOON ORDNANCE HANDLING SUPPORT		CSOSS ID OP 1/HWS
ACTION AREA: CIC (CSRO) CSOOW		
REFERENCED BY: MP 1/CS		REFERENCE TO: MP 5/CS
USER NOTES	REFERENCES:	

Figure 16-18.–Operational procedure header.

SYSTEM PROCEDURE SHIPS LAMPS MK III EQUIPMENT INITIALIZATION	CSOSS ID SP 0/LAMPS
ACTION AREA: SONAR ROOM	
REFERENCED BY: MP 1/CS	REFERENCE TO: CP 1/LAMPS CP 2/LAMPS, SD 1/LAMPS, SD2/LAMPS
USER NOTES	NOTES: This procedure directs the initialization of shipboard LAMPS

Fignre 16-19.–System procedure header.

Checklists, and Exercise Firing Procedures. OPs are the primary format for tactical support applications.

System Procedure (SP)

System procedures are used for both supervisory and technical purposes. A supervisory SP provides guidelines at the area or system supervisor level. An SP in general covers a start-to-finish process, such as activating a cooling system or TACAN system. System procedures can refer to other system procedures and to component procedures. Figure 16-19 shows the header for system procedures.

Component Procedure (CP)

Figure 16-20 shows the header for CPs, which are the basic building blocks of the CSOP. Component procedures contain detailed procedures for equipment activation, deactivation, and operate/configuration change evolutions. Step-by-step data is taken from the most authoritative source and incorporated into the CP, along with required communications guidelines for coordination and status reporting. Component procedures are organized into standard major sections, which are identified in the description block. A CP may cover a group of related and interconnected equipment or single equipment. Other CPs, or even SPs, may be referenced, if the complexity requires such referencing.

COMPONENT PROCEDURE AN/SRQ-4 RADIO TERMINAL SET ACTIVATION AND CONTROL	CSOSS ID CP 1/LAMPS
DESCRIPTION: I. PREINITIALIZATION II. ENERGIZE III. DEENERGIZE	
REFERENCED BY: OP 10/LAMPS, SP 0/LAMPS, CRP 1.1/LAPS, CRP 2.1/LAMPS	REFERENCE TO: SD 1/LAMPS
USER NOTES	I. PREINITIALIZATION SET UP

Figure 16-20.–Component procedure header.

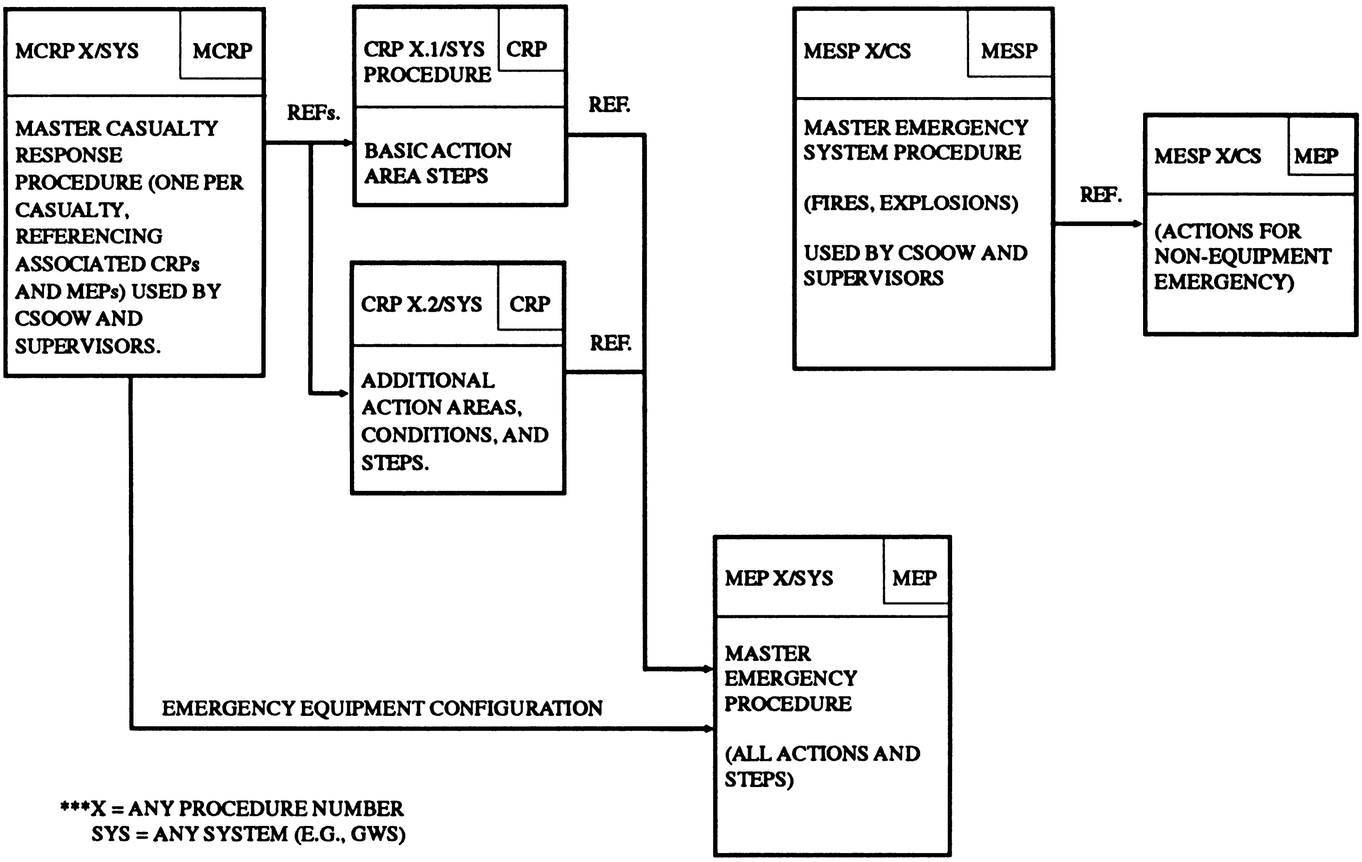


Figure 16-21.–CSOCC relationships.

BASIC CSOCC PROCEDURE RELATIONSHIPS AND USES

Figure 16-21 shows the relationship of CSOCC procedures. Flexible cross-referencing, as used in CSOP, is not permitted because of a fixed method of procedure organization. Support data is referenced by any procedure as required.

Casualty Processing Procedure Set Fundamentals

Figure 16-22 depicts the fixed relationships of a typical MCRP/CRP set. The MCRP (master casualty response procedure) has essential action and coordination requirements, while the CRPs (casualty response procedures) have expanded and detailed steps based on the MCRP's overall requirements for that situation. Figure 16-23 shows the MCRP's first page, formatted in a standard way to describe the overall casualty in terms of detection source; related indicators, indications, or symptoms; possible causes; and possible effects or impact. Figure 16-24 shows the four sections of both the MCRP and the CRP, which provide the actual response requirements for each casualty.

Casualty Response Procedures (CRPs)

Each CRP set contains detailed steps, which amplify actions identified in the four sections of the MCRP. The MCRP provides requirements for each action area and specific situations. A separate CRP is developed for each action area if parallel, multiple actions are required. The full casualty description on the MCRP front page is not repeated in the CRPs. The CRP is the same as the MCRP if there are no variations of the basic casualty. Each major variation of a basic casualty is covered by a CRP. Figure 16-25 shows the header used for CRPs.

Master Emergency System Procedure (MESP)

A MESP is the same as an MCRP, except that it applies to major fires, or ammunition or magazine problems. As in an MCRP, the four standard sections of casualty processing are used in the MESP. An MESP uses a Master Emergency Procedure to provide detailed

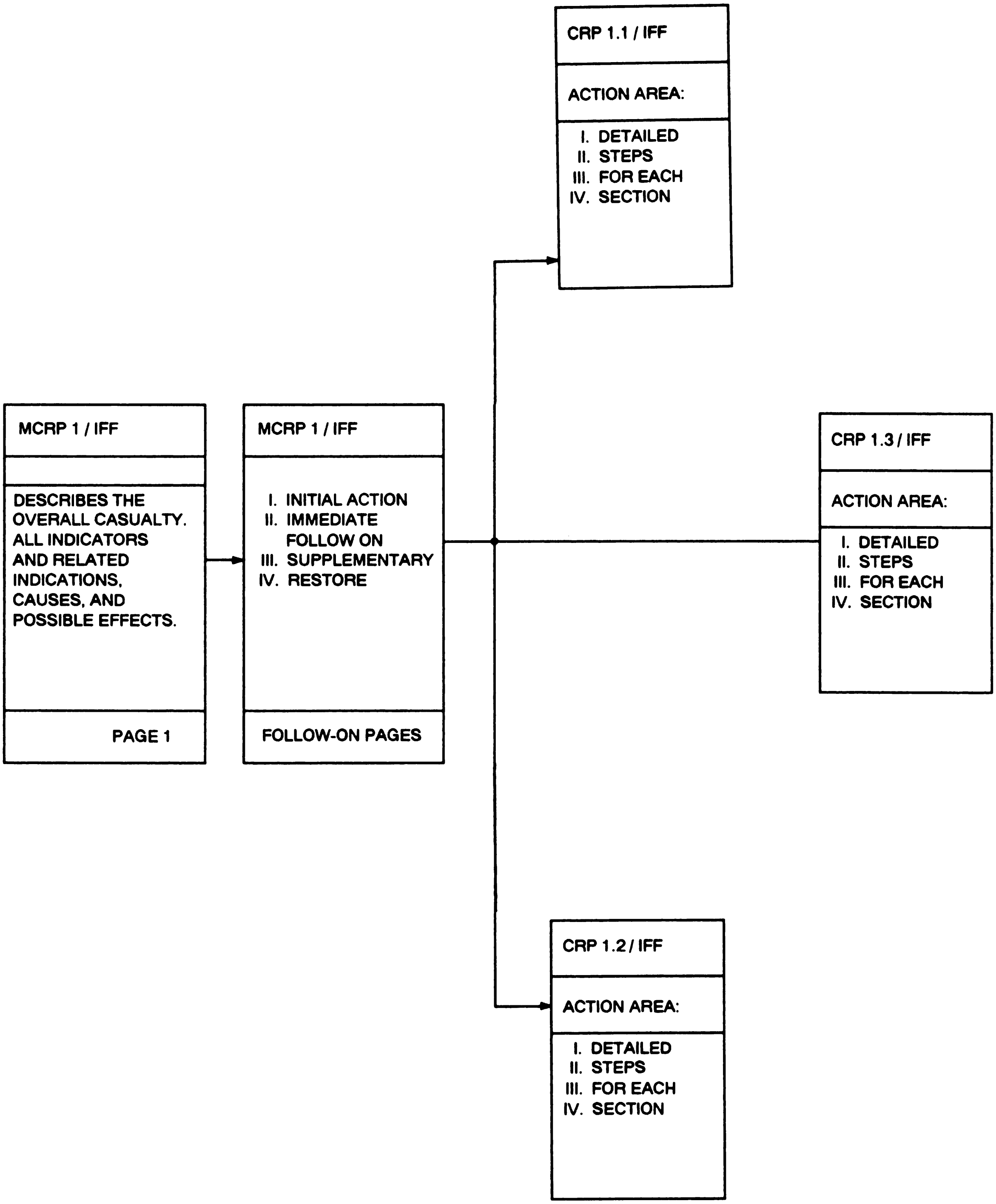


Figure 16-22.–Typical MCRP/CRP set.

MASTER CASUALTY RESPONSE PROCEDURE	CSOSS ID
REFERENCED BY:	REFERENCE TO:

CASUALTY DETECTION (ALERTS/ALARMS/INDICATORS)

1. CONSOLES: (All types)

   Visual indications, hardware and software generated alerts or alarms which appear at various manned consoles (Some C/S problems are presented in non-combat system spaces.)

2. Alarm Switchboards

   Hardwired alarm circuit annunciators, some of which are repeated in several locations.

3. Local Equipment Indicators/Operator's Observation:

   Indicators on individual cabinets, and observations made by individual operators and technicians.

RELATED INDICATORS/INDICATIONS/SYMPTOMS

There are indicators derived from the basic casualty condition, or relation to the unit/signal/system and presented remotely from the casualty source. Used for fault confirmation and fault isolation. Symptoms are any recognizable indications for impending or actual casualties which may be available in addition to alarms above. This data can be accumulated during the ship's operational life.

ALARM DERIVATION/POSSIBLE CAUSES

A brief description of how casualty detection logic is instrumented in hardware and software (what is checked, what determines abnormal state). Description/list of component or system failures which could result in the monitored/tested fault condition or could cause other observable fault conditions.

POSSIBLE EFFECTS/TACTICAL OR MISSION IMPACT

Describes most likely effects on the Combat System of the specific casualty. Includes personnel hazards as known/possible. Provides an initial assessment of the casualty's impact on mission capability.

CODE:	DATE:	CHG:	PAGE 1 OF

Figure 16-23.–MCRP casualty description section.

PROCEDURE NAME	CSOSS ID

USER NOTES		
	I.	INITIAL CONTROLLING ACTIONS Actions to get an abnormal condition (which may be a precursor of a developing hard casualty) under control. May prevent further casualties. Starts fault isolation of abnormal condition. May not be needed for specific well-defined casualties. Proceed to II when time does not permit use of initial actions or casualty has reached its limiting condition
	II.	IMMEDIATE FOLLOW-ON ACTIONS Actions to get an actual casualty under control and put the affected system into a safe (but degraded) state. Initial impact assessment is done or started when possible. Stops cascading effect of major casualties.
	III.	SUPPLEMENTARY CONTROL/RECONFIGURATION/REPAIR ACTIONS Takes the system from the safe condition in II to any available stable alternate configuration. Determines Estimated Time to Repair (Actual repairs will be accomplished as the combat situation and casualty permit). Complete impact assessment and validate mission capabilities provided by the alternate configuration. Repairs are accomplished by methods not covered by CSOSS.
	IV.	RESTORE PRECASUALTY CONFIGURATION Restores the casualty objects (equipment, system, computer programs) to a precasualty on-line condition/configuration as the tactical situation requires and CSOOW directs (may require CSOOW/CSRO/TAO joint decision). Uses the standard and special CSOP procedures to do initialization, configuration change and configuration validation.

CODE:	DATE:	CHG:	PAGE OF

Figure 16-24.–MCRP body.

<table>
<tr><td colspan="2">CASUALTY RESPONSE PROCEDURE

LOSS OF POWER TO OMEGA</td><td>CSOSS ID

CRP 1.1/OMEGA</td></tr>
<tr><td colspan="3">ACTION AREA: CHART ROOM</td></tr>
<tr><td colspan="2">REFERENCED BY: MCRP 1/OMEGA</td><td>REFERENCE TO: SD 1/OMEGA</td></tr>
<tr><td>USER
NOTES</td><td colspan="2">I. <u>INITIAL CONTROLLING ACTIONS</u></td></tr>
</table>

Figure 16-25.–Casualty response procedure header.

response and processing guidance. The MESP header is displayed in figure 16-26.

Master Emergency Procedure (MEP)

The Master Emergency Procedure has two purposes. It can be used to support a MESP or for emergency process reconfiguration or re-initialization in situations of great urgency. MEPs are a complete set of information for direct reference by other procedures. The processing path generally returns to the referencing procedures for completion of the evolution. MEPs are formatted like an OP. Each MEP is a stand-alone component, referenced as needed by its unique ID number.

Figure 16-27 shows the format of a typical MEP header.

BASIC SUPPORT DATA RELATIONSHIPS AND USES

Figure 16-28 demonstrates how three of the five types of support data are incorporated by reference into

<table>
<tr><td>MASTER EMERGENCY SYSTEM PROCEDURE

FIRE IN AMMUNITION MAGAZINE</td><td>CSOSS ID

MESP 1/CS</td></tr>
<tr><td>REFERENCED BY:</td><td>REFERENCE TO: MEP 1/CS, MEP 2/CS,
SDT 2/CS</td></tr>
<tr><td colspan="2"><u>CASUALTY DETECTION (ALERTS/ALARMS/INDICATORS)</u></td></tr>
</table>

Figure 16-26.–Master emergency system procedure header.

MASTER EMERGENCY PROCEDURE CIWS MISFIRE (EXERCISE FIRING)	CSOSS ID MEP 1/CIWS
REFERENCED BY: OP 2/CIWS, MCRP 2/CIWS, CRP 2.1/CIWS	REFERENCE TO:
USER NOTES	REFERENCE:

Figure 16-27.–Master emergency procedure header.

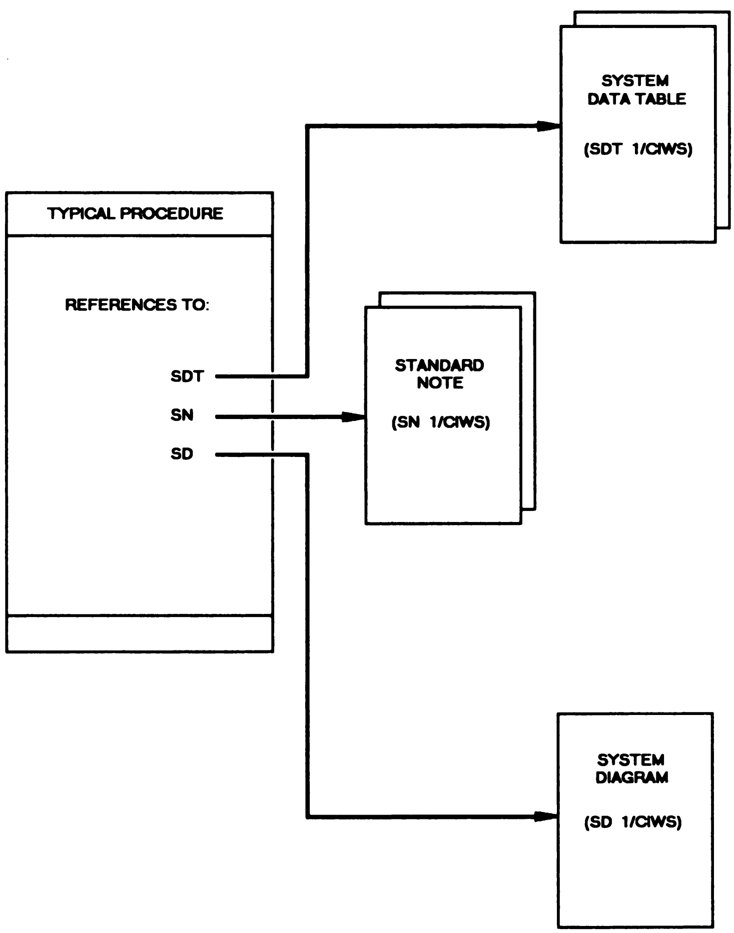


Figure 16-28.–Support data relationships.

STANDARD NOTE ELECTRICAL FIRES (CLASS C)	CSOSS ID SN 1/CS
REFERENCED BY:	

Figure 16-29.–Standard note header.

various procedures. Reference is by the assigned CSOSS component ID (e.g., SD 1/CIWS). The referenced material is used as directed by the referencing procedure, or as needed by the user. Support data can also be used independently for quick reference within the spaces and systems covered. Most CSOSS diagrams are simplified. Therefore, source publications, such as CSTOMS and technical manuals, must also be referenced when detailed information is needed for maintenance and training.

Standard Note (SN)

Figure 16-29 shows the header of the SN form, used to cover information of a general nature on technical and organizational matters. Its content is formatted as best fits the subject matter.

System Data Table (SDT)

Figure 16-30 shows a typical SDT, used to provide tabulated data for quick reference in support of various procedures. It is used when clarity in the body of a procedure is required and is incorporated by reference.

System Diagram (SD)

Figure 16-31 shows a typical SD, used to provide a simplified "snap-shot" view, tailored to specific uses, of more complex diagrams. The SD can be in either horizontal or vertical format, may be multiple pages, and

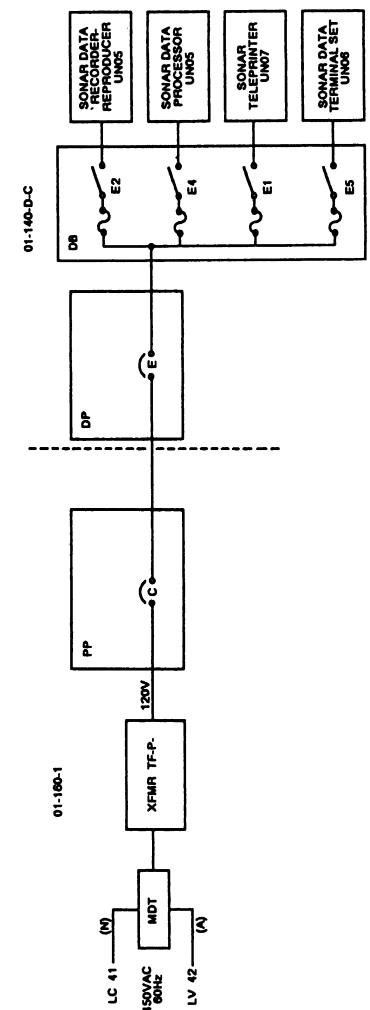
SYSTEM DATA TABLE VALVE SETTINGS FOR DOME PRESSURIZED WITH AIR					CSOSS ID SDT 1/SONAR
REFERENCED BY: SP 1/SONAR, SP 2/SONAR					
LOCATION	VALVE	POSITION	LOCATION	VALVE	POSITION
01 LEVEL 01-28-2 (X)	FM-439	SHUT	DOME RM 4-71-3 (X) 4-71-1 (W) 4-75-1 (W)	ALP-471 ALP-478 ALP-599	SHUT OPEN OPEN
1-58-0-T 1-58-1 (W)	ALP-70	OPEN			

Figure 16-30.–System data table example.

SYSTEM DIAGRAM SIMAS 60 Hz POWER DISTRIBUTION	CSOSS ID SD 1/SIMAS

REFERENCED BY:

SP 1/SIMAS, CRP 1.1/SIMAS



CODE:	DATE: 29 AUG 88	REV: 0	PAGE 1 OF 1

Figure 16-31.–System diagram.

may also be a fold-out. SDs are also used to show any information best presented in diagrammatic form.

System Interface Diagram (SID)

SIDs are special-purpose drawings showing system interconnections, such as computer I/O channel assignments and signal distribution through switchboards.

Status Boards

The system of CSOSS status boards is designed to support readiness processes of all types in all conditions.

Each status board is designed to be a major tool used to manually collect, plot, evaluate, and control combat system status and configuration. The CSOOW has the primary set of status boards, allowing him to collect and plot comprehensive information. Other status boards are provided at key locations such as area supervisor stations and in CIC.

This system of status boards not only supports CSOOW's responsibilities during any readiness condition, but also supports communication of accurate and timely information to all stations. In addition to the CSOOW, department heads and division officers, and the Ship's Electronic Readiness Team (SERT) are also primary users of status information collected by CSOOW. The status boards and included diagrams are also useful as aids in isolation and maintenance management at the system level.

A summary status board in CIC is used by the CSRO in maintaining a current picture of mission capabilities and advising the CO and TAO of problems with tactical impact. This information is condensed and translated from all other status boards by verbal reports to CIC.

Area supervisors are provided with individual status boards to directly support their areas of responsibility under CSOOW's coordination.

The basic organization of status boards is shown in figure 16-32.

LEARNING TO USE CSOSS

All CSOSS users are responsible for studying applicable CSOSS material they will be using. As SEMO, you must memorize the key casualty-control information to assure your ability to take quick action on any applicable casualty. However, you must also use the other information contained in the CSOSS books, since accuracy of action is a major objective. Study the casualty characteristics and effects on the first page of each MCRP and MESP. Memorize the Initial and Immediate actions of each casualty response in which you may participate. Study the remaining Supplementary and Restoration sections so you can correctly take the required actions. MCRPs for your area are located in your area supervisor's book and a complete set for the entire combat system in the CSOOW's book.

CASUALTY CONTROL PROCESS

Figure 16-33 shows the essentials of the casualty-control process, the actions and control of the autonomous response mode, and typical communications points. Figure 16-34 shows the basic methodology of fault and casualty detection and reporting. Once the report is made or symptoms have been seen by trained personnel, casualty processing may be started in an autonomous manner. This means that action is started immediately by the involved personnel, and will proceed until it is either stopped or completed. The concept of autonomous action is that preplanned casualty responses will be done unless they are negated by command. This is possible because the command knows what casualty responses are in use and thus can exercise negation as required. This capability is achieved by planning for, and training in, the use of CSOSS procedures. It is important that you master the assigned CSOSS materials and their related sets of information and action. You should also spend time in

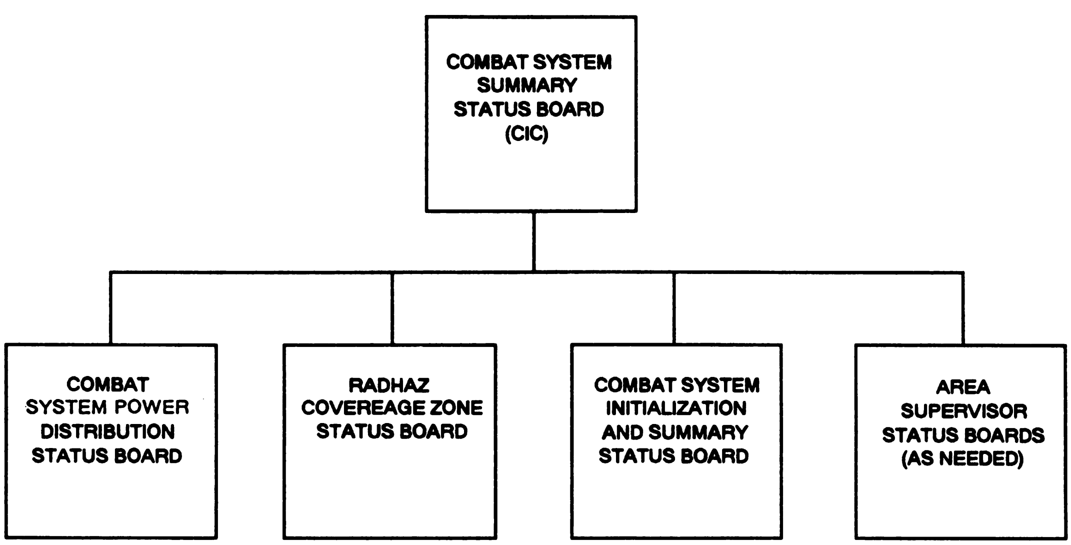


Figure 16-32.–Organization of CSOSS status boards.

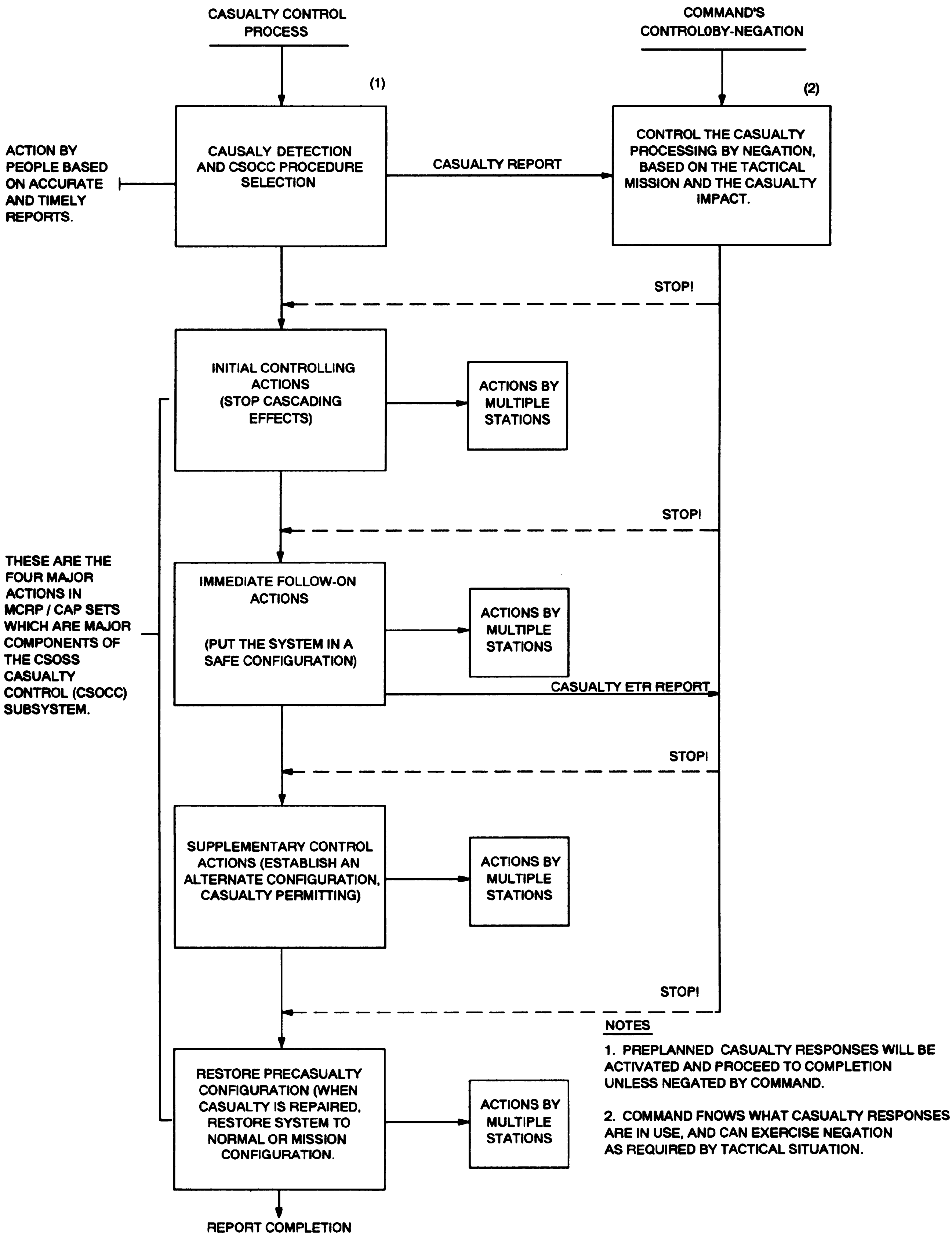


Figure 16-33.–Concept of autonomous action.

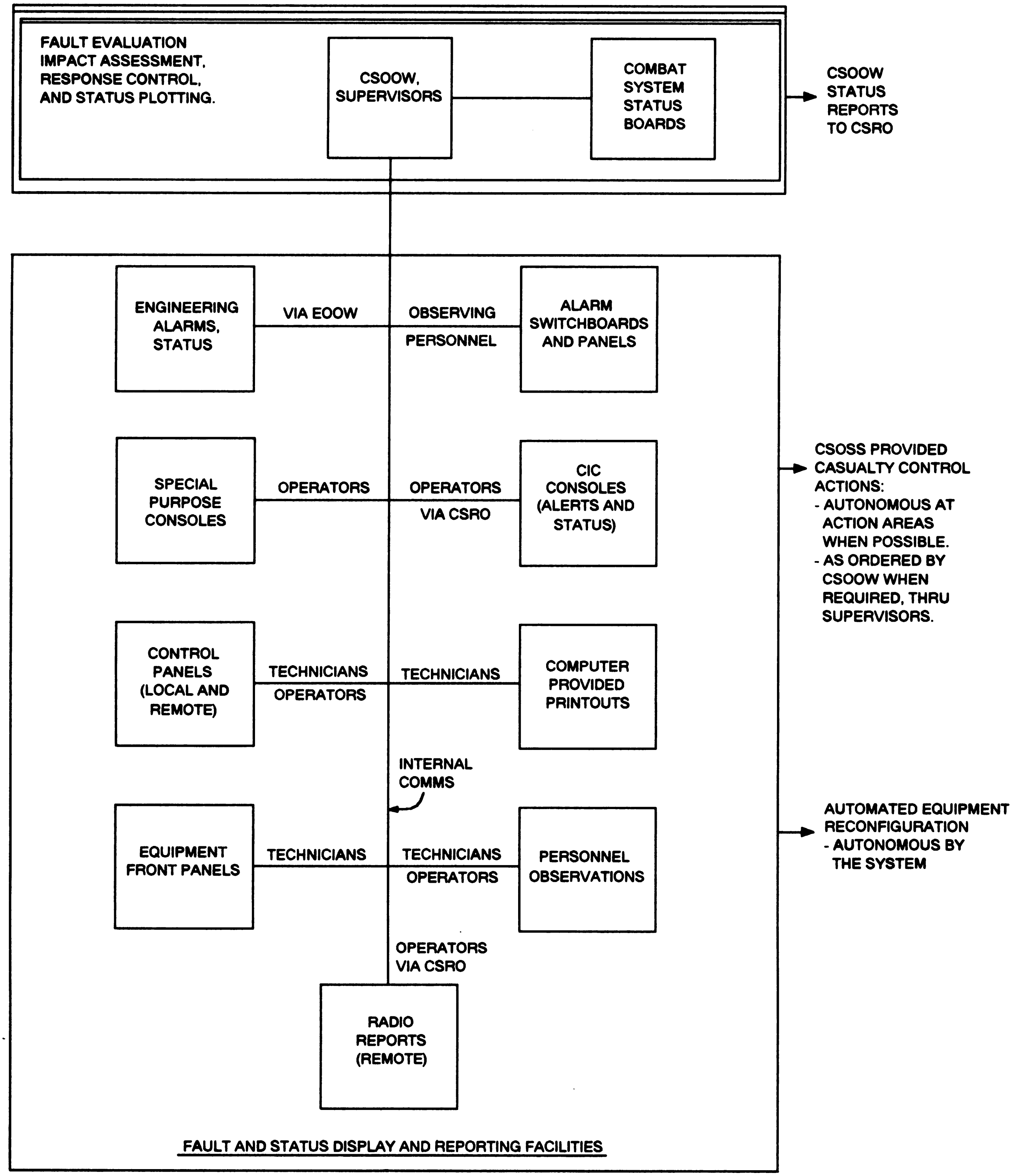


Figure 16-34.–Basics of fault detection and reporting.

the CSOOW's area to become familiar with status boards and coordination procedures.

When you have become familiar with CSOSS in general and your materials in particular, walk through your specific procedures and support data in the actual action areas. Be careful to only sight controls at this step; do not turn anything. Supervisors will conduct talk-throughs with the teams whose members have become familiar with their assigned area and applicable CSOSS. A classroom setting is advised to get each procedure checked out and all questions answered. Then, the process should be repeated with personnel on station and actual communication in use. Each supervisor will determine actual hands-on CSOSS training that can be done by personnel. At this time, exercises with the actual equipment and, possibly, selected drill guides can be conducted.

Casualty control training under the guidance of the CSTT should be used as soon as possible. This leads to integrated team training with the whole ship, which is the environment in which the most challenging training and real world events will occur.

In all situations involving procedural processes, the general rule is to check all actions against the specific CSOSS procedure if any doubt exists about the correct action required. This is a necessary step in developing the ability to act and react correctly and in a standard way, and will be constantly evaluated during drills.

Casualty control, as covered by CSOSS, is the process of detecting and properly identifying the casualty; taking action required by each casualty situation to stop any cascading effects; attempting to correct the situation or developing an alternate configuration; and determining the magnitude of mission-capability degradation. There is also a repair function which is necessary to fully restore affected system capability, but CSOSS assumes that existing maintenance techniques will be used when repair is possible. Remember that restoration of maximum available tactical readiness and capability in minimum time is the real objective of casualty control. This is the reason for the control-by-negation autonomous actions, which permit immediate reaction in combat conditions down to any stage of processing as determined by the CO (or TAO) qualified in all aspects of casualty control.

DETECTION AND REPORTING GUIDELINES

Current methods of combat system monitoring on which fault/casualty detection is based requires the full participation of all personnel as observers.

Properly trained and qualified personnel are essential to observe, evaluate, and report with effectiveness under all conditions. The following are guidelines for effective casualty detection and reporting:

- Most casualties detected by human sensors, or casualty indicators interpreted by human sensors, must be verbally reported to supervisors and the CSOOW.
- To be immediately useful, each report must be accurate, timely, and complete.
- Supervisors and the CSOOW can take action correctly, and record status accurately, only if this level of reporting is consistent throughout the combat system.
- Personnel must develop the skill of casualty symptom recognition and collection of amplifying information in an almost automatic reaction BEFORE making a report.
- Vague reports lead to incorrect action, excessive communication for clarification, and possible multiple and different casualty reports for the same situation.
- Good reports from multiple sources are valuable in localizing casualty causes, and help sort out complex problems.

TRAINING

Earlier in this chapter, the Combat System Training Team (CSTT) was introduced and tied to both SERT and CSOSS. The following section expands that discussion to show how integrated training for the whole ship is achieved. A major training objective is to exercise the ship in controlling potentially cascading casualties, in realistic operational situations, to gain readiness-related expertise using EOSS and CSOSS.

Training to sustain maximum combat system capability under adverse conditions requires the active involvement of the CSTT, supported by the SERT, using timed drill packages. A drill package is a collection of drill guides designed to exercise combat systems casualty control under varied conditions. These conditions range from exercising a specific work center or system to fully integrated casualty control requiring damage control, engineering casualty control, and combat systems casualty control under scenario driven conditions.

The goal is to provide the tactical users with maximum firepower in a timely manner for any given

The package is generated by the CSTT and submitted through the appropriate chain of command for approval.

COMBAT SYSTEMS TACTICAL/CASUALTY CONTROL
DRILL PLAN

DATE__________________ SCENARIO ____________ WATCH TEAM ____________

PURPOSE–To challenge crew familiarity with Casualty Control procedures/communications flow required to restore single equipment level casualties during CONDITION III.

REQUIREMENTS–Commence Scenario 1 at T-0. Operational "N" circuit, simulated LAMPS helo UP, 55 Radar up, LINK 11 up (HF), SATCOM up.

REMARKS–Integrated casualty control. Drills will be imposed at time of loss of power (T+10). Magazine Fire (simulated), repair party response.

TEAM MEMBERS and LOCATION

TAO EVAL (Example)	LCDR JONES	CSOOW EVAL	LT SMITH
____________	____________	____________	____________
____________	____________	____________	____________
____________	____________	____________	____________

CASUALTY CONTROL DRILLS

TIME	DRILL	TITLE	IMPOSER
+10	AUX/09/LPAIR	LOSS OF DRY AIR TO SPS-49	
+10	AUX/10/LPAIR	LOSS OF DRY AIR TO FCS FWD	
+10	CS/09/CDS	LOSS OF CONSOLE GROUP	
+10	GWS/04/LWG	LOSS OF HP AIR TO MT51	
+10	GWS/12/LWG	LOSS OF HYDRAULIC PRESSURE MT51	
+10	HWS/03/WCIP	CLASS "C" FIRE IN WCIP	
+10	CIWS/04/CW	LOSS OF COOLING WATER TO CIWS	

SUBMITTED: ____________ (CSTT LDR)   REVIEWED: ____________ (CSO)   APPROVED: ____________ (CO)

Figure 16-35.–Drill package example.

situation. The effectiveness of the crew is determined by the evaluations of the CSTT using on-station debriefs and post-scenario critiques. Written critiques will provide a basis for future training requirements as well as a history of training.

DRILL PACKAGE

Figure 16-35 is an example of a basic integrated drill package. The entire package will be briefed prior to its conduct and critiqued upon its conclusion. The number of CSTT members required to conduct the drill package will depend on its purpose, requirements, and complexity. The drill package should contain the information contained in figure 16-35.

Purpose

This is the goal of the package. It can vary in complexity, from exercising a single warfare area with no casualties to exercising the entire crew across all departments in a multithreat situation with multiple casualties.

Requirements

These define the scenario and the equipment required to conduct the drill package. The scenario can be generated using available onboard simulation equipment to exercise the tactical users in the various warfare areas. Adding casualties to the scenario at key points tests the reaction of the tactical users to report the problem accurately and to continue "fighting through" using available equipments or casualty reconfiguration of the affected equipment. It also tests the maintenance organization in the exercise of autonomous casualty control and restoration, allowing minimum impact to the tactical users.

Remarks

These outline major events or equipment losses and impact during the conduct of the drill, tactical impact of the overall package, and any safety warnings or cautions.

Team Members

This section defines the responsibilities of the supervisors, operators, or technicians required to participate in the drill and the location(s) of CSTT members during conduct of the drill package. The number of personnel required will vary with the scope of the package.

Casualty Control Drills

These are imposed on a time sequence basis by drill, drill title, and the casualty imposer or evaluator. The timing should be scheduled to coincide with key events and should allow a reasonable time for the imposer or evaluator to fully conduct his assigned tasks. The number of drills will depend on the scope of the package.

DRILL GUIDES

Drill guides (fig. 16-36) define the inserted casualty and the procedures for insertion and response to that casualty in a specific equipment, subsystem, or system. The majority of casualties should be of the type expected from battle damage or near misses, causing a response to a casualty mode of operation or reconfiguration.

The SERT, under the supervision of the STO, is responsible for developing and validating drill guides.

Drill Guide Format

The drill guide is composed of the following sections.

DRILL GUIDE IDENTIFICATION.–Identifies each guide with a two- or three-part code; e.g., EW/05/SLQ32.

Part one will identify the major system with a two or three letter designation. From the above example, Electronic Warfare.

Part two is the number of the drill associated with the system.

Part three will identify the highest level subsystem or component within the system.

EXAMPLES:

UWS/01/MK116–Underwater Weapons System, drill #1, Mk 116.

AUX/02/DWC–Auxiliary Equipment, drill #2, Distilled Water Cooler.

CS/04/CDS–Combat System (used when the casualty involves several systems, such as interface casualties), drill #4, CDS.

DRILL GUIDE
EW/05/SLQ32

TITLE: SLQ-32 Computer Failure

PURPOSE: To train technician(s) to properly respond to SLQ-32 computer failure, and evaluate the Area Supervisor's ability to coordinate and direct casualty response actions.

REFERENCES: NAVELEX EE150-CV-MMO-010

SAFETY PRECAUTIONS:

Forces afloat will comply with Navy safety precautions for Forces Afloat, OPNAVINST 5100 Series.

CAUTIONS:

Potential electrical safety hazard exists.

DESCRIPTION OF PROCEDURES:

Casualty Insertion

In EW equipment room, on top of SLQ-32 Rack 1, set switch 1A7A1A5/A6 to OFF.

– This secures AN/UYK-19 computer.

EXPECTED ACTIONS:

The real time clock will stop.

The SLQ-32 CRT will go blank.

The EW Console Operator report the casualty and try to reload system

The area supervisor coordinate casualty response.

EW technician(s) respond to casualty using applicable procedures.

EXPECTED/POSSIBLE PROBLEMS:

Loss of EW capabilities during drill period.

Figure 16-36.–Drill guide example.

TITLE.–Defines the fault effect desired; for example:

1. Loss of power to an equipment or system, caused by tripped circuit breakers, blown fuses, or engineering casualties, requiring switching to the alternate source or locating the failed component.

2. Loss of interfaces through computer failures and simulated broken cables caused by missile hazards and shock waves.

3. Loss of auxiliary support equipment, cooling water systems and air systems, through ruptured pipes, clogged strainers, failed pumps, power losses, and so on.

4. Loss of a system, subsystem, or equipment.

5. Emergencies–fires, flooding, hot guns, misfires, etc.

6. Equipment switch positions.

Casualties inserted in printed circuit boards, terminal boards, backplanes, and so forth, are NOT recommended because of difficulty in insertion and hazards to personnel and equipment.

PURPOSE.–Explains the purpose of the particular drill; for example, "To train technician(s) to properly respond to ___(drill title)___ and, evaluate the area supervisor's ability to coordinate and direct casualty response actions."

REFERENCES.–Identifies the applicable procedures and other documentation (T/Ms, etc.).

SAFETY PRECAUTIONS.–This section will contain at least the following information:

1. "Forces afloat will comply with Navy Safety Precautions for Forces Afloat, OPNAVINST 5100 Series."

2. Any additional safety precautions required by references, T/Ms, OPs, and so on.

CAUTIONS.–Identifies any special care of concern associated with fault insertion.

Examples:

1. "Ensure GMLS is not in a load cycle."

2. "Ensure transmitter is not in RADIATE."

DESCRIPTION OF PROCEDURES.–This section should identify:

1. Crew watch condition (if applicable).

2. Any special system set-up conditions prior to fault insertion.

3. The specific instructions for actual fault insertion and alternate fault insertion (if identified).

EXPECTED ACTIONS.–Describes:

1. How and where the fault will manifest itself (for example, loss of SPS-55 video to CIC, a light indication, a visual alarm, etc.).

2. How personnel are expected to respond to the casualty, including the procedures and documentation to be used.

EXPECTED/POSSIBLE PROBLEMS.–Contains:

1. Tactical impact during the period of the drill.

2. Any additional corrective action that may be required as a result of the fault insertion (for example, a recalibration or alignment if the inserted fault disturbs proper settings).

Drill Guide Validation

Validation is done in two parts and must be conducted before its use in a drill package.

PART ONE–"Walking through," a process of verifying locations, numbers, materials, and ensuring that the test does not pose a hazard to personnel or equipment.

PART TWO–"Hot Checking," a process of verifying insertion procedures, symptoms, restoration and reconfiguration procedures, and, again, assuring that the test poses, at most, minimal risk to personnel and equipment.

Drill Package Execution

Effective training and training goals are achieved through well organized drill packages, prebriefs, and critiques to identify weak areas. Recognizing weak areas and establishing training requirements to correct them will result in effective combat system operations, and maximum combat system readiness will be the norm. An effective drill package fulfills its purpose, and is prebriefed, executed properly and on time, and critiqued.

PREBRIEF.–Before a drill package is started, a thorough prebrief is required. During the prebrief, provide each participant in the drill with a copy of the drill package and critique sheets. Provide the casualty imposers and observers a copy of the applicable drill guide for review and comment. Brief the tactical situation and equipment status. Resolve conflicts or problems prior to start time (T-O). Establish start time, critique time, and location.

EXECUTION.–Communication between team members is essential to prevent confusion caused by unplanned events, actual equipment losses, scenario generation malfunctions, safety considerations, and so forth. Direction to and from CSTT members on adjustments to the time line, cancellation of drills, and problem freeze and restarts can easily be coordinated. Use of walkie-talkies is the recommended method for those communications.

Correct safety violations and hazardous practices immediately. If necessary, freeze the problem until they are corrected and readjust the time line as necessary.

CRITIQUES.–Conduct on-station critiques with the maintenance technician at the conclusion of each drill while the events are still fresh in his or her mind (time and events permitting; if not, at the conclusion of the drill package).

Critique CIC personnel at the end of the scenario. Some items for discussion include:

- Communications flow
- Casualty recognition and reporting
- Use of available assets
- How well the tactical picture was maintained

Conduct the CSTT debrief beginning with each drill guide and progress through the supervisor level, and warfare areas. Discuss any weak areas, both in the trainees and the training and initiate actions to correct them. Key personnel (for example, TAO, CSOOW, area supervisors) should also attend if possible.

After the drill sessions are over, provide the command written critiques. Written critiques will provide a basis for future training requirements as well as a history of training. They also provide an excellent guide for the debriefs.

Lessons Learned

The major areas that historically, require training emphasis are as discussed in the following paragraphs.

SYSTEM BASELINE.–A valid system baseline is a must for effective combat system operations. Accurate status of combat systems equipment, including power sources, is imperative for proper and timely responses to problems requiring reconfiguration of equipments and effective employment of available weapons.

CASUALTY SYMPTOM RECOGNITION AND REPORTING.–This is the number one cause of excessive restoration and reconfiguration time and communications. "The 49 radar is broke" is not a good report and requires much amplification over an internal tactical circuit before the casualty control organization can take the right course of action. "Lost 49 video, transmitter is down and will not reset" gives the technician an immediate starting point.

INTERNAL COMMUNICATIONS.–Accurate, concise, and brief communications are a must. Inaccurate casualty reports, requests for DC routes naming every DC fitting instead of preplanned routes, lack of attention of the phone talker, and improper phone talking procedures cause mass confusion, inappropriate actions, and lack of confidence in the ship's ability to sustain combat system operations. Correcting this problem requires an aggressive shipboard training program in proper procedures.

CSOSS SUMMARY

Comprehensive and repeated training assures that ship's personnel are fully qualified for all operations, including both casualty control and damage control. Specialized ship's training teams are used in the major areas of tactical operations, combat system casualty control, engineering plant operations (including casualty control), and ship's damage control. Each of these shipboard teams is linked to a Type-Commander Mobile Training Team (MTT), as shown below.

SHIP AREA	SHIP TERM	PROCEDURES	SCRIPTS	MTT
Combat System	CSTT	CSOSS/ORG	DRILL GUIDES /SCENARIOS	CSMTT
Engineering Control	ECETT	EOSS	DRILL GUIDES	ENG MTT
Damage Control	DCETT	REPAIR PARTY MANUAL	DRILL GUIDES	DC MTT

CONDITION I CSOSS ORGANIZATION

Figure 16-37 depicts the proposed Condition I casualty control organization for your ship. In Condition I, this organization is manned for maximum on-station reaction capability. Most personnel are already located in their assigned stations or action areas, which include equipment spaces and some operating stations.

The CSOOW controls and coordinates technical operations from his station in CIC. He reports to the CO or TAO through the CSRO, providing system status and impact-assessment reports, and receiving requirements for the tactical situation. The CSOOW maintains communications with the DCA for required repair party services and the EOOW for control of vital services. Reporting directly to him are three area supervisors, who are responsible for the technicians in their respective areas. The CSOOW is provided with status boards and CSOSS procedures for support. He may be assisted by phone talkers.

COMMUNICATIONS

Figure 16-37 also depicts the proposed communications paths for the casualty control organization. The solid lines indicate communication

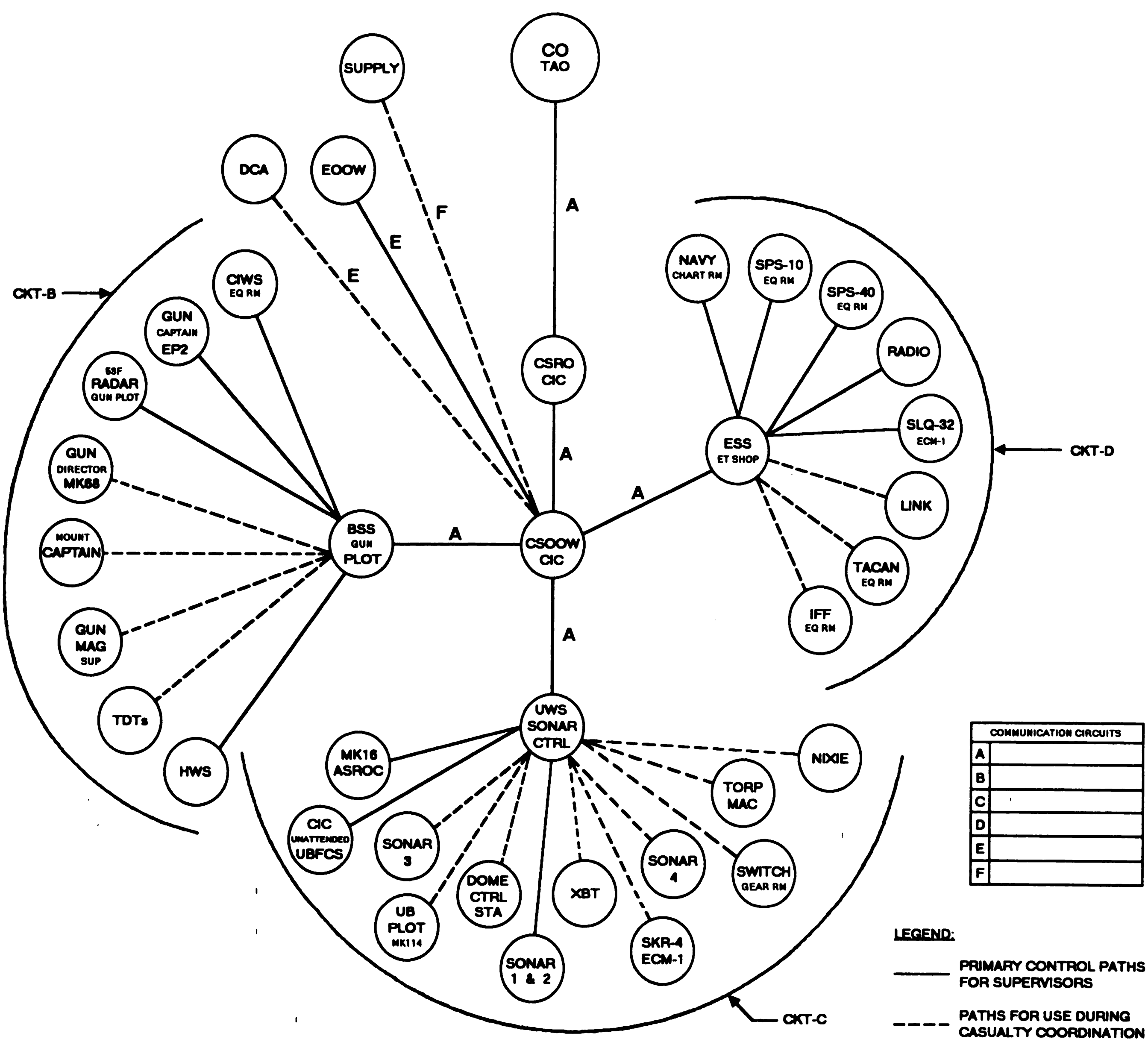


Figure 16-37.–FF CSOSS organization.

Table 16-3.–Summary of CSOOW Duties

RESPONSIBLE TO:	CO/TAO
VIA:	CSRO
DUTIES:	CONTROL AND COORDINATION OF C/S: INITIALIZATION CONFIGURATION CASUALTIES (PROCESSING, IMPACT ASSESSMENT) RECONFIGURATION CORRECTIVE MAINTENANCE RESTORATION EMCON COMPLIANCE RADHAZ CONTROL DESTRUCTION BILL COMPLIANCE QUIET SHIP COMPLIANCE CONTROL C/S DC ROUTES BATTLESHORT MANAGEMENT MAINTAIN TAG-OUT LOG MAINTAIN STATUS BOARDS COORDINATE PMS AND TESTING EVENTS MAINTAIN HISTORICAL RECORD COORDINATE MAN ALOFT
COORDINATES WITH:	EOOW
FOR:	VITAL SUPPORT SERVICES: POWER ELECTRONICS DRY AIR FIREMAIN (COOLING, SONAR DOME PRESSURE) CHILL WATER (COOLING) HP/LP AIR VENTILATION
COORDINATES WITH:	DCA
FOR:	TRADITIONAL DC SERVICES AND ROUTES
COORDINATES WITH:	SUPPLY SUPPORT CENTER
FOR:	REPAIR PARTS
COORDINATES WITH:	AREA SUPERVISORS
FOR:	EQUIPMENT READINESS

and coordination paths in constant use. The dashed or broken lines of communication are only activated during casualty coordination. Communication circuits within this network are for casualty control, communication and coordination, and are exclusive of tactical control circuits. The CSOOW communicates with the area supervisors and the CSRO on the designated sound powered telephone (SPT) circuit for group A, the EOOW and DCA over the designed SPT for group E. The area supervisors communicate with their personnel on the SPT circuits designated for each group. For some paths an SPT circuit is not required because communications are face-to-face within the same space. To complete the communication paths that are depicted in figure 16-37, patches between some SPT circuits may be necessary. These patches allow the supervisors to have direct communications with all their areas of responsibility.

OTHER READINESS CONDITIONS

While figure 16-37 is a maximally manned network for Condition I, the organization may be manned to a lesser degree for other conditions. However, the coordination relationships required in all conditions are identical and the CSOOW remains the single point of contact for technical operations in the combat system. The degree of manning, determined by the commanding officer, in other at sea conditions is based on ship manning, mission or tasking, threat level, and threat warning.

In port, administrative organizations generally take full control of the day-to-day direction of personnel, with CSOOW becoming a central information and coordination point. He is vital as the single point of contact for EOOW, OOD, CSO, and so on, who need immediate responses and information for such things as man aloft authorization, tag-outs, and combat system status. He makes required reports to the CDO, OOD, and Duty CSO. After hours safety, security, and basic casualty response are also maintained. The CSOOW performs his duties in the same manner as the EOOW, on-station during the work day or as required, and on call the remainder of the time.

DUTIES AND RESPONSIBILITIES

The following are basic descriptions of the duties of personnel involved in CSOSS.

CSOOW

The CSOOW's duties involve controlling and coordinating technical operations within the combat system. These duties include initializing the system, changing the configuration, and controlling casualties. Using CSOSS procedures, status boards, and any other required materials, CSOOW directs area supervisors in reconfiguration and restoration to provide maximum tactical capability.

Table 16-3 is a tabulation of CSOOW duties.

CSRO

The CSRO moves about CIC as necessary to evaluate problems and collect system status data. He provides the interface between the operational organization coordinated by the TAO and the technical organization coordinated by CSOOW. CSRO provides the technical-to-tactical interpretation of combat system status for the TAO, as well as impact assessment of combat system casualties.

Table 16-4 is a tabulation of CSRO duties.

Table 16-4.–Summary of CSRO Duties

RESPONSIBLE TO:	CO/TAO
DUTIES:	ADVISE TAO/CO: IMPACT OF C/S CASUALTIES CAPABILITIES LOST/REMAINING
	ADVISE CSOOW: TACTICAL REQUIREMENTS EMCON IMPOSITION OF SHIP'S BILLS
	MAINTAIN C/S SUMMARY STATUS BOARD SUPERVISE CIC CASUALTY ACTIONS ACT AS TEMPORARY BACK-UP FOR CSOOW
COORDINATES WITH:	CSOOW
FOR:	ALL READINESS DUTIES

AREA SUPERVISORS

The Battery Systems Supervisor (BSS), Underwater Weapon Systems Supervisor (UWS), and Electronic Support Systems Supervisor (ESS), are responsible directly to the CSOOW for providing optimum combat system capabilities within their areas. Each supervisor is also responsible for overseeing the initializing and configuring of the equipment in his area and for casualty control, corrective maintenance, and restoration as directed by CSOOW in support of tactical operations.

TECHNICIANS

Technicians assigned to equipment spaces work directly for their respective area supervisor. They advise him of changes in status, and perform initialization, reconfiguration, or corrective maintenance as directed. They may react autonomously to specific casualties and emergencies. Should corrective maintenance be required, they advise their area supervisor of the estimated time of repair (ETR) and the results of those actions.

STATUS BOARDS

The following are brief descriptions of the primary status boards used within CSOSS. The Combat System Summary Status Board, Power Distribution Status Board, RADHAZ/Coverage Zone Status Board, and Combat System Initialization Status Board are located in CIC and are the responsibility of the CSOOW. The Area Supervisor Status Boards are located in Gun Plot, Sonar Control, and the ET Shop. Each area supervisor is responsible for his own status board.

Combat System Summary Status Board

This status board (CSOSS ID: SB 1/CS) is used to provide up-to-date status information on the ship's combat system. The center portion of this board is a block diagram of the combat system and includes representations of combat system elements for detect and engage.

On the right-hand side is an element and warfare matrix to provide an overall assessment of the combat system and support elements. As the status of combat system equipment changes, the effect is charted on this matrix.

On the left-hand side of the board is a matrix for tracking EMCON. The EMCON plan for the day is recorded on this matrix, and as changes in EMCON occur, the matrix is updated. This board must be kept up-to-date so that when Condition III or I is set, this information is available for the CO and the TAO. The matrices on this status board should be updated as changes occur. Color is not required, but when an EMCON condition is set, the appropriate EMCON letter should be circled in a color that stands out. As various radiating elements are secured, they should be marked in red to show they are secured and unavailable. At the same time, the element and warfare area boxes on the right-hand side of the status board should be evaluated and changed as necessary.

As problems occur in the combat system and reports are made, the failed component should be marked with a grease pencil on the center section. A note can be written denoting the problem, ETR, and any other data desired by CSOOW. Area supervisors record more specific information on their status boards. At the same time, the element and warfare area boxes on the right-hand side of the status board should be evaluated and changed as necessary. The following color scheme may be used to keep equipment status:

GREEN–Up or operationally ready

YELLOW–Marginal

RED–Down or not available

GREEN WITH YELLOW CIRCLE–Good, but has loss of redundancy

Power Distribution Status Board

This status board (CSOSS ID: SB 2/CS) shows the distribution of 60- to 400-Hz power from the ship's service generators, switchboards, and main distribution panels to the power panels feeding a space. The outer columns list the major equipments fed by each panel. Casualty power terminals are also depicted on this status board. More detail about how power is distributed within each space to the various elements is provided in the CSOSS system diagrams (SD) in CSOSS. All combat system areas should be highlighted for ease of tracking. Casualty power terminal ties and all bus-transfer switches may be marked with grease pencil to show what equipment is on casualty busses or alternate busses. If the equipment is unmarked, it is assumed to be on a normal bus.

RADHAZ/Coverage Zone Status Board

This status board (CSOSS ID: 3/CS) consists of two parts. The upper portion identifies all antennas, their locations, and designations. The lower portion is divided into boxes, each illustrating the RADHAZ or coverage zone of an antenna or group of antennas. This board is for use by CSOOW in assisting the total RADHAZ management, and complements the RADHAZ master procedure for all phases of RADHAZ management. The top portion is used for identifying antennas to be secured for man aloft situations or to protect ships traveling in company that fall into the RADHAZ areas illustrated on the lower portion of the board. The lower portion is used for quick reference of RADHAZ zones. Distances in feet are listed for each HERP (personnel) RADHAZ zone.

NOTE: This status board is designated CONFIDENTIAL when specific frequency data is filled in by the CSOOW.

Combat System Initialization Status Board

This board (CSOSS ID: 4/CS) provides an initialization time-line and interdependencies for each combat system element. Circles along each line denote initialization procedures required. Initialization interdependencies shown include the order in which procedures must be performed; which element to start with; and what procedures and systems depend on other procedures and systems (i.e., ship's air and water must be provided to CIWS before CIWS can be initialized). At the right side of the board is T-Zero, the time at which the combat system is fully initialized and ready for use. Each time-line backs up in time, showing the time required to initialize and in what order to accomplish specific events. This board is used in conjunction with MP O/CS, the MASTER LIGHT-OFF CHECKLIST (MLOC), to manage the initialization of the combat system. Combat system initialization from cold iron to combat ready for any part of the system can be done using this board. Emergency reinitialization using CSOCC casualty control procedures is NOT tracked on this board because of the many variables involved.

As the combat system is initialized, the CSOOW uses this board to track the progress of each element through its initialization cycle, marking off each procedure with grease pencil as it is completed. He can track progress and interrogate areas that are running behind the timeline, especially those functions and services on which others depend. Color is not mandatory on this board but marking procedures in red that could not be completed can key CSOOW to problems requiring resolution or alternative action.

Area Supervisor Status Boards

These status boards (BSS–Gun Plot, UWS–Sonar Control, and ESS–ET Shop) provide a useful management tool for the area supervisors. They are formatted for recording and tracking equipment status, personnel, space and equipment casualties, repair work, manned and ready reports, and assistance necessary for support. There are also blocks to record DC routes, EMCON and CBR data, and warfare and weapon conditions. Each supervisor uses his status board to maintain close control of the material status of the equipments under his control. Failed or damaged units and interfaces are marked down as reports are received. Details of initial reports to CSOOW, time made, amplification of casualty (personnel, spaces related, equipment related) and ETR, are tracked. This enables the supervisor to maintain a detailed picture of his area. A side benefit is that if the CSOOW is either over extended or disabled, the supervisors can carry on in cooperation with each other until the CSOOW function is restored.

While these status boards are primarily intended for use in Condition I, their use under other conditions is encouraged to maintain a current status plot for equipment in each area.

REFERENCES

Combat Systems Operational Sequencing System (CSOSS) User's Manual; Naval Sea Systems Command, Washington, D.C., 1988.

Combat System Technical Operations Manual (CSTOM) for CG-16 Class, Volume 3, Part 1; S9CGO-AR-CSM-050/(U) CG-16 CLASS, Naval Sea Systems Command, Washington, D.C., 1985.

Standard Organization and Regulations of the U.S. Navy, OPNAVINST 3120.32B, Department of the Navy, Washington, D.C., 1986.

CHAPTER 17

REPORTING ABOARD AS EMO

OVERVIEW

Your time before and just after assuming the EMO responsibilities is very important to you for accountability. This chapter will help you through the relieving process by providing checklists, sample relieving letters, and tips on what to do and what not to do.

OUTLINE

Relieving checklist

Relieving letter

Post-relieving actions

When you report aboard, you may discover that the EMO you are relieving either will be leaving shortly or will have already departed. If he is on board, the former EMO will pass on to you information accumulated over his and his predessors' assignments. If he is not on board, hopefully he will have turned the information over to someone else on board.

When you turn over or relieve a position, you will transfer a large amount of information. Take good notes in a pocket notebook. You will find them indispensable in the days to come.

We have included checklists in this chapter to aid you in the relieving process. They will not solve all the problems you may encounter; but if you use the checklists, you will get some ideas of questions to ask and ways to proceed.

The first step in relieving the EMO is to discuss with him the forum you will use for the relieving process. It is extremely important to agree on how you will go about the turn-over, and how long the whole process will take. Generally, you should limit the turn-over to no more than 2 weeks. Start the relieving process by reviewing previous inspection reports. This will give you some idea of specific areas you may need to look at closely.

Divide your pocket-size notebook into two sections: Equipment and Personnel. Use it for recording information you obtain during the relieving process and then as a reference afterward. Your notebook will serve as a quick reference guide whenever you deal with equipment and personnel matters.

It is extremely important that you tour the spaces during the first few days on board and ask many questions. This will help you get familiar with the current condition of the personnel, equipment, and spaces. Don't get "hung-up" in specific areas. Remember, it will soon be your division and you will have plenty of time to correct discrepancies later.

When you do the equipment inventory, SIGHT EVERYTHING. Take inventory with the officer you are relieving and verify the accuracy of custody cards. DO NOT SIGN FOR ANY EQUIPMENT YOU CANNOT SEE PHYSICALLY!

Here are a few actions you need to take on a daily basis:

1. Observe the routine of the division.

2. Become acquainted with each of the technicians' abilities. Note deficiencies that may require training. Ask and answer questions. As a rule, the technicians will be eager to help you through this period.

3. Determine what records are used and what reports are made. You may find that after a short period of time on board you will want to refine your procedures to meet needs that weren't visible at the time you reported.

4. Maintain a relief notebook containing pertinent sections: bills affecting the electronics section, EMO standing orders and memoranda, personnel charts, captain's and executive officer's standing orders, and

copies of interdepartment memos of concern to the electronics section.

5. Use a tickler file for periodic reports and pending action items. With the many demands of the job, a good tickler system will bring those infrequent reports to your attention, and in a manner for a timely response.

6. Review the division supply log for legibility and completeness. Ensure that parts are on order for each ESL (Equipment Supply Log) entry requiring parts. Requisition numbers for these parts should be included in both the division supply log and the ESL. Any requisitions over 2 weeks old should have a status listed.

7. Check on the completion of field changes for all of your equipment. First, check the list of authorized field changes against field changes actually completed. If outstanding changes exist, order those that can be done by ship's force, and ensure that work requests have been submitted for all others. Next, verify current field change information with the field change identification guide.

8. Review the planned maintenance program for completeness and availability of up-to-date references. You should remain aware of the status of program requirements. Check work center status boards.

9. Review all ship's bills. It is always important to check the Ship's Organization Manual and the Type Commander's Administration Manual. When you conduct any type of review of the ship's bills, ensure that all hands read and initial the bills.

10. Evaluate the existing training programs and check to see that they include the following features:

- "Buddy system" for equipment training (two people present when working on energized equipment). This is the easiest form of OJT.
- Lecture or discussion methods for electronic theory; knowledge and performance.
- Group training for use of test equipment.
- A provision for evaluating the enrollment of your technicians in training courses (self-study and correspondence).
- The installment of Personnel Qualifications Standards (PQS), according to the *PQS Manager's Guide*, NAVEDTRA 43100-1.
- Operator training having technicians serving as instructors.

RELIEVING CHECKLIST

To help ensure that you get a complete transfer of information, we have provided a rather extensive checklist of pertinent questions on information most needed by a new EMO. This checklist is not all inclusive, so tailor it to fit the needs of your command.

GENERAL INFORMATION

In the beginning days of your takeover, you can get some very helpful information by answering the following questions, either by asking another individual or by reading instructions and observing workday activities.

- What is the upcoming operating schedule?
- What are your divisional and collateral duties?
- What divisions are in the department?
- What workcenters are in your division?
- What is the watch standing routine of the electronics division, in port and at sea?
- What are the current divisional collateral duty assignments?
- What shipwide collateral duties are held within the division?
- What routine reports are you required to initiate?
- What departmental officers are you normally most associated with, and what would be the most expeditious manner of reaching them?
- What ship's instructions is the division responsible for maintaining?
- Does the electronics division maintain a tag-out log?
- Is the division officer's notebook current and complete?

ASSIGNMENT OF PERSONNEL

An important consideration for you is having certain information concerning the division's personnel. Find out the following information:

Officers/Chief Petty Officers:

Department Head:________________________

Division Officer:____________

Divisional LCPO/LPO:_________________

Enlisted Distribution:

RATES_____________________________

ALLOWANCE________________________

PRESENTLY ON BOARD_______________

PROJECTED ON BOARD,
6 MONTHS OUT_____________________

WATCH, QUARTER AND STATION BILL

As you study the watch, quarter and station bill, ask yourself the following questions:

- Is it posted and current, and does it follow the Ship's Manpower Document for:

  Condition I manning?

  Condition III manning?

  Abandon ship stations?

  Man overboard stations?

  Emergency destruct stations?

  Are billet numbers being used?

- Are all division personnel assigned to duties in Electronic Casualty Control during CONDITION I?

ELECTRONICS DIVISIONAL DOCTRINE

Questions to ask yourself concerning the electronics divisional doctrine are:

- Was the doctrine reviewed within the last 12 months?
- Is the doctrine approved by the current commanding officer?
- Is the doctrine available and read by all divisional personnel?
- Does the doctrine contain a divisional organization chart and are the duties, responsibilities and, authority of key personnel within the division set forth in written form?
- Does the doctrine contain the mission of the division?
- Does the doctrine assign responsibilities for cleaning and maintenance of all divisional spaces?
- Does the doctrine address inport and underway watches and routines?
- Does the doctrine contain instructions concerning safety and do they cover the following:

  Responsibilities of the EMO/ERO?

  Responsibilities of the leading PO?

  Responsibilities of all divisional personnel?

  General safety?

  Electrical shock?

  Drydock precautions and procedures for usage of electronic equipment?

  Man aloft procedures?

  Work on electronic equipment by authorized personnel?

  Intentional shock?

  Working on energized equipment?

  Measuring voltages in excess of 300 volts?

  Circuit breakers?

  Discharging de-energized circuits?

  Fuses?

  Grounds and ungrounded electrical distribution systems?

  Interlocks and safety devices?

  Protective enclosures on electrical/electronic devices?

  Use of portable cables, plugs, and outlets?

  Tools?

  Warning signs?

  Precautions in the handling of cathode-ray tubes?

  Precautions in the handling and stowage of radioactive substances and first-aid procedures?

  Disposal of radioactive materials?

  Radio frequency radiation hazards?

  Radar radiation hazards by onboard radars?

  Electrical fires?

  Cleaning of electrical/electronic equipment?

Cleaning, preservation, and grounding of antennas?

Batteries?

Electrical safety program?

Shipboard tag-out procedures?

Electrostatic devices (ESDs)?

Handling/stowage/disposal of PCBs?

Loose metal parts or liquids?

- Do the doctrine's written instructions concerning preventive/corrective maintenance include:

Preventive maintenance?

Organization chart (Ship's 3-M chain of command)?

Responsibilities of the technicians in the program?

Responsibilities of the operators in the program?

Corrective maintenance?

Trouble reporting procedures?

In port?

Underway?

Responsibilities for completing and submitting proper MDS forms?

- Does the doctrine contain Emergency Action Plan/Destruction procedures?

- Is there a copy of the effective ship's Emergency Action Plan (EAP), signed by the commanding officer, readily available to all division personnel?

- Do the division EAP/Destruction procedures cover the following requirements:

Procedures for destruction of non-COMSEC equipment and material?

Designation of responsible person by functional title of billet vice name to coordinate the division EAP?

Designation of destruction priorities?

Do destruction cards/sheets state emergency destruction techniques, location of destruction materials, and reporting procedures?

- Do the doctrine's written instructions concerning cold weather operations include:

Moderate and extreme cold weather winterizing methods for antennas and antenna train assemblies for onboard equipment?

Equipment maintenance and de-icing procedures?

Waveguide drainage methods?

Whip antenna base drainage methods?

Procurement of specific special lubricants, batteries, compounds, and other necessary installation items for onboard equipment?

Storage location of suitable canopies or wind screens and necessary space heaters for personnel working in exposed areas?

Special personnel cold weather safety precautions?

- Does the doctrine contain written instructions concerning hot and humid weather operations?

- Does the doctrine contain written instructions applicable to HERO Restrictions?

- Does the doctrine contain written instructions concerning security, including:

Stowage/handling of classified material?

Authorized entry to electronic spaces?

Security of intermittently occupied electronic spaces?

Photographing electronic equipment and classified matter?

TEMPEST inspections?

Prohibitions against unauthorized modifications to cryptographic equipment?

Reporting procedures when discovering classified space/safe/material unguarded?

- Do the doctrine's written instructions concerning Electronic Casualty Control(ECC)/Combat Systems Operational Sequencing System (CSOSS) cover:

Organization of Electronic Casualty Control during General Quarters?

Duties and responsibilities of ECC Central, operators, and technicians during General Quarters?

Equipment/personnel casualty reporting procedures during General Quarters?

Location and use of the casualty control folders and space manuals?

PERSONNEL QUALIFICATIONS STANDARDS (PQS)

Consider the following questions when you observe the use of the personnel qualification standards on board the ship:

- Is PQS established and functioning for those watch stations and systems for which PQS documentation is required?
- Does the division have all the effective PQS materials including, but not limited to, the following?

  3M–NAVEDTRA 43241

  DC–NAVEDTRA 43119-2

  ECC/REPAIR 8–NAVEDTRA 43119-8

- Are all division personnel included in the PQS program?
- Do the PQS records indicate timely completion of PQS?

FORMAL TRAINING

A good checklist concerning formal training would be:

- Does the EMO have a copy of the applicable parts of sections 4, 5, 6, and 8 of the current EDVR?
- Does the EDVR, Section 6, reflect basic allowance of NECs for installed equipments?
- Are all DNEC requirements presently filled and reflected in the EDVR?
- Have the EMO, COMMO, and leading ET and RM trained in visual TEMPEST awareness?
- Have the leading ET and RM attended the antenna maintenance course?

TRAINING PROGRAM

The training program for the ship is an important procedure. Use the following guidelines as you look at the one used aboard your ship:

- Is a divisional training program established and functioning, and does it include:

  Lesson plans/outlines?

  Long-range scheduling?

  Short-range scheduling, including instructor assignments?

- Do records indicate training is being conducted in:

  On-station equipment qualifications?

  Basic first aid?

  Annual cardiopulmonary resuscitation (CPR) qualifications by either an American Heart Association or Red Cross trained instructor?

  General safety precautions?

  Electrical safety precautions (within the last 12 months)?

  Emergency Egress, EEBD, and OBA training (within the last 6 months)?

  Tag-Out Program (all hands) and Equipment Tag-Out Bill (applicable personnel) conducted annually?

  NCO Drills (From FXP-4)

  SERT/CSTT

ELECTRONICS CASUALTY CONTROL

You need to be aware of the following as you consider electronic casualty control:

- Location of primary Electronic Casualty Control
- Location of secondary Electronic Casualty Control

MASTER CASUALTY CONTROL/CSOSS MANUAL

A good check-off list for master casualty control and the CSOSS Manual is as follows:

- Does the Master Casualty Control/CSOSS Manual contain the following information?

  Antenna systems details (block diagram topside, below decks, port/starboard elevations, including cable numbers)?

  Power system details (from source of power to equipment, including cable numbers, fuse size, breaker size, and cut-out switches: for all sources of power–60 Hz, 400 Hz, GYRO, SYNCHRO, and so on)?

Radar data transmission systems details (path of triggers and video, including cable numbers)?

IFF data transmission systems details (path of enabling voltages and video, including cable numbers)?

Transmitter and receiver patching details (including cable numbers)?

TTY (teletype) patching details (including cable numbers)?

Audio patching details (including cable numbers)?

All means of communications?

Repair equipment location (test equipment and tool boxes)?

Specific location of CO_2/dry chemical extinguishers in electronic spaces including back-up?

Procedures to obtain routes to all electronic casualty control spaces during General Quarters?

Procedures to obtain spare parts during General Quarters?

Electronic emergency access routes?

Dry air systems flow paths including cut-out valves external to the space?

Cooling water systems flow paths including cut-out valves external to the space?

Location of vent switches and controllers for all spaces?

Listing of all classified fittings by space? (CCOL)

First-aid equipment location (nearest, if not in the space)?

Emergency destruction equipment location (nearest, if not in the space)?

Technical manual location and index?

If the manual is part of or in an Electronic Casualty Control space, it should contain the following information, as appropriate:

EW systems details

Fire Control systems details

Sonar systems details

Data systems details

SUPPLY

Questions concerning supply that you should consider are:

- Is there a division budget and, if so, what portion has been expended to date?
- What has it cost in the past, per quarter, to operate the division?
- What is the correct procedure for requisitioning material?
- Who is authorized to sign requisitions for the head of the department?
- What equipment are you required to sign for?
- Do you have sub-custodians for all material for which you are signed?
- Where are electronics repair parts stored?
- Is the electronics division authorized to maintain pre-expended bins?
- What equipment or material is awaiting survey? Have survey documents been prepared and submitted?
- What is the shipboard procedure for surveying material?
- Is all onboard equipment supported by COSAL?
- Does the division maintain current copies of applicable APLs/AELs?
- Is the division on the distribution list for microfiche?

SHIP CONFIGURATION LOGISTICS SUPPORT INFORMATION SYSTEM (SCLSIS)

Questions to ask concerning SCLSIS are as follows:

- Has the ship's SECAS program been converted to the SCLSIS program? If not, are copies of the old SECAS reports being maintained properly?
- Has the ship received either a hard copy of the SCLSIS Report or magnetic tape for SNAP II augmentation?

- Does the ship's Weapon Systems File represent actual electronic equipment installations?
- Are configuration change reports (OPNAV 4790.CK) submitted and tracked as required?

TECHNICAL PUBLICATIONS

Ask the following questions about the technical publications that you should have available in your division:

- Are the following OPNAV instructions or publications on board for ready reference?

  Ships' 3-M Manual, OPNAVINST 4790.4B

  Information Security Program Regulations, OPNAVINST 5510.1H

  NAVOSH Program Forces Afloat, OPNAV-INST 5100.19B Vols. 1 & 2

- Are the appropriate type commander instructions on board for ready reference? For example:

  Mobile Technical Unit (MOTU) publications

  Type Commander Maintenance Manual

  Combat System Readiness Review (CSRR)

  Type Commander Combat Systems Officer Manual

- Are the following training and installation publications on board for ready reference?

  Bonding and Grounding, MIL-STD-1310(E)

  CANTRAC (Catalog of Navy Training Courses), Parts 1 and 2

  Combat Systems Technical Operating Manual (where applicable)

  CSOSS Manuals (if applicable)

  EMO's Guide to Shipboard Electromagnetic Interference Control, SDT 407-5287556

  Installation Criteria for Shipboard Secure Information Processing, MIL-STD-1680B

  Navy rate training manuals

  NEETS training series

  Operational Reports, NWP 10-1-10

  Ship's Exercises, FXP-4

  Tube and Transistor Cross Reference/Specification Guides(s)

  Wiring Plans and Blueprints

- Are the following GPETE/2M management publications on board for ready reference?

  Electronics Test Equipment Calibration Indoctrination Program, NAVMAT P-9491

  Metrology Automated Systems for Uniform Recall and Reporting (MEASURE) User's Manual, OPNAV 43P6, Ch. 2

  Metrology Requirements List (METRL)

  Miniature/Microminiature (2M) Electronic Repair Program, Volumes 1-3, w/chg A-B, TE000-AA-HBK-010/2M

  Portable Test Equipment Stowage Guide, ST-000-AB-GYD-010/GPETE

  Test Equipment Index, ST000-AA-IDX-010/PEETE

- Are the following hardware instructions or publications on board for ready reference?

  Electromagnetic Radiation Hazards: to Personnel, Fuel and other Flammable Materials, (Vol. I), OP3565

  Electromagnetic Radiation Hazards: to Ordnance (Vol II), OP3565

  Electronics Installation and Maintenance Books (EIMB)

  Engineering Information Bulletins (EIB) (845 and up)

  Shipboard Antenna Systems, Vol. 1, Communications Antenna Fundamentals, NAVSHIPS 0967-LP-177-3010

  Shipboard Antenna Systems, Vol. 3, Antenna Couplers, Communications Antenna Systems, NAVSHIPS 0967-LP-177-3030

  Shipboard Antenna Systems, Vol. 4, Testing and Maintenance, Communications Antenna Systems, NAVSHIPS 0967-LP-177-3040

  Shipboard Antenna Systems, Vol. 5, Antenna Data Sheets, NAVSHIPS 0967-LP-177-3050

  Technical manuals for all installed and portable electronic equipment

- Are all publications, directives, instructions, and notices containing pertinent electronic information being promptly routed to the technicians?

Equipment Maintenance

Know all you can about the maintenance of the equipment in your division. Ask some of the following questions:

- Is the commanding officer's permission required before technicians begin working on energized electronic equipment?
- What new equipment is expected? Have necessary materials for installation been requisitioned or otherwise provided?
- Is the CSMP up to date, showing work to be done during the next overhaul or upkeep availability?
- Have work requests been submitted for the next availability or overhaul?
- What alterations are outstanding?
- Has preventive maintenance coverage been requested for newly installed equipment?
- What is the general condition of the ship's antennas, and who is responsible for their maintenance?
- Are there any regularly authorized shutdown periods of equipment during operational periods to allow technical checks and adjustments to be made?
- What type and how many air pressure systems for waveguides and transmission lines are on board? What is their operating condition?
- What type and how many liquid cooling systems for electronics equipment are installed on board? What is their operating condition?
- Who has maintenance responsibility (corrective and preventive) for electronic equipment support systems?
- What is the operating condition of all equipment?
- Is the latest SFR implemented in the work center and appropriate work center manuals?
- Are the Cycle, Quarterly, and Weekly PMS status boards up to date and properly maintained?
- Is the CSMP being properly maintained for each work center?
- Are the proper MDS forms (2K, 2L, CK) being submitted as required?
- Is the WCWL/JSN log properly maintained?
- Do records indicate PMS SPOT CHECKS have been made by:

  Department Head? (3 per week plus 1 DC)

  Division Officer? (1 per work center per week plus 1 DC)

Emergency Equipment

Since safety is utmost on any ship and in any division, ask the following questions about the emergency equipment:

- What are the emergency sources of power to the equipment?
- How is emergency power obtained, and how long can the plant be operated to provide that power?
- When were the emergency power circuits and cables last tested?
- When were the emergency transmitters last tested?

INSPECTION OF SPACES

When you inspect spaces, check for the following conditions:

Violations of safety precautions

Use of correct operating techniques

Safety precaution signs and devices (rubber gloves, shorting probes, and so forth)

Necessary fire-fighting equipment and damage-control fittings (compartment checkoff lists, hull reports)

Destruction tools

Operating instructions posted near each equipment

Condition of equipment, mounting, and cables

Reports on the last official inspection of the electronics section

Cleanliness and preservation of spaces

SAFETY, DAMAGE, AND CASUALTY CONTROL MATERIAL STATUS

Questions to ask yourself regarding safety, damage, and casualty control are:

- Are the following signs posted where required?

  High Voltage

  Electronic safety precautions

  Workbench signs

  Operating instructions

  Stack gas hazards

  RF radiation hazards

  RADHAZ warning circle

  Radar circuit disablement sign

  EMCON signs/Status Board

  Multiple source tags

  Rotating antenna warning sign

- Are rubber gloves properly maintained and readily available in spaces containing electronic equipment?
- Are approved shorting probes available in spaces containing electronic equipment?
- Are climber safety rails properly maintained IAW PMS standards (MIP H-313 or 6231)? Were they grounded IAW MIL-STD-1310(E)?
- Are the parachute-type harnesses, safety lanyards, working lanyards, and climber safety devices available for working aloft?
- Is rubber matting installed in all spaces containing electronic equipment, and was it properly installed and of the correct type?
- Are portable (CO_2) fire extinguishers available in all spaces containing electronic equipment and were they properly weighed, sealed, and tagged?
- Are all spaces containing electronic equipment clear of unauthorized stowage and fire hazards?
- Is there a communication system between all electronics spaces for the exclusive use of ECC? Is the communication system operational from all stations?
- Are all portable test equipment and power tools equipped with an approved power plug?
- Are electrical safety checks being performed?
- Is emergency lighting adequate in all spaces containing electronic equipment?
- Are radioactive tubes properly identified and stowed?
- Is there at least one radioactive tube clean-up kit, and does it contain the following materials?

  An air-tight metal container; recommend a 30/50 caliber ammo box or a 3-pound coffee can with a plastic lid

  Radioactive clean-up gloves or surgical latex gloves (two pairs are required)

  Forceps, hemostats, or 5-inch tweezers

  4-inch square gauze, one package (50 or more)

  Approximately 8 ounces of water in an unbreakable container

  Masking tape, 2-inch roll (1.5 inches min/3 inches max)

  Radioactive material stickers

  Dust mask

  Two 12-inch plastic ziplock-type bags

  Clean-up instructions

  Rope, with hazard signs

  Talcum powder

  Two 12-inch x 12-inch cloths

- Does each piece of equipment have a bulkhead-mounted switch located in the space for disconnecting it from all sources of power, including 60 Hz, 400 Hz, 120 vac, GYRO, SYNCHRO, and so on?
- Do all electronic workbenches meet minimum safety requirements?
- Have provisions been made to stow all test equipment properly?
- Is all installed electronic equipment grounded to prevent shock hazards?
- Is the air conditioning and ventilation system operating correctly?
- Are there a casualty control status board and a master casualty control folder available in primary and secondary casualty control, and do they meet existing standards?
- Are space-tailored casualty control folders available in each space containing electronic equipment, and are they complete IAW FXP-4?

- Are provisions made for investigator battle damage repair kits, and do they include: rubber gloves with leather shells, tape, flashlight, shorting probe, Phillips and flathead screwdrivers, pliers, and fuse pullers?

EQUIPMENT STATUS

You should know the status of the equipment you and your personnel will be concerned about. Find out from the appropriate personnel the answers to some of the following questions:

- Is a full tool allowance on board?
- Does the ship have the following certificates, and are they current?

  FCA package? Date of last certification _____

  2M station? Date of last certification _____

  TACAN system? Date of last certification ____

- What major equipment is currently out of commission or has a reduced capability?
- IAW the latest 310/350 format, what percentage of test equipment is out of commission? ____ This percentage should include equipment awaiting both repair and calibration.
- Are all required pieces of test equipment on board and IAW the ship's SPETERL?
- What is the status of test equipment that is missing, on order, awaiting survey, and so forth?

RELIEVING LETTER

When you have finished your turn-over inventory and inspection, see that a relieving letter is written to the commanding officer. As a minimum, it should include a paragraph identifying the discrepancies you noted during the turn over. Furnish a copy of the letter to the department head (operations or weapons, depending on the configuration).

A relieving letter is used for two purposes. First, it serves as official notification to command that an official position in the shipboard organization has been assumed by a specific individual and that this individual assumes sole responsibility for his assigned job. Second, it informs command of the conditions the assuming individual noted within the organization during the turnover process.

Because the relieving letter is an official document and because it becomes part of the service record of both the relieving officer and the officer being relieved, the information it contains must be complete and must reflect the true condition of the electronics organization at the time the relief occurs. A properly prepared relieving letter can direct the efforts of the new incumbent toward those areas of his job that will need the most attention, as well as provide a baseline upon which to evaluate his own performance. It may also serve as a check-off list to ensure that all areas of importance are investigated before the new person assumes the job. Although the relieving letter must be complete, it must also be limited to those areas of prime importance. Its purpose is NOT to place the person being relieved on report (although it may in fact tend to do so), but is to advise command as to the readiness of the ship. Submission of numerous trivial comments or readily corrected problems may tend to obscure the purpose of the letter as well as generate a personality clash among the parties involved in the relief.

The relieving letter is normally prepared by the officer being relieved, endorsed by the relieving officer, the department head, and the executive officer, and then submitted to the commanding officer. It may be initiated by the relieving officer if the previous incumbent is not available for contact relief, or if the incumbent refuses to originate a letter. If the incumbent refuses to originate the letter, the relieving officer should send it via the incumbent for the first endorsement to allow him to comment on the conditions noted in the basic letter.

Figures 17-1, 17-2, and 17-3 are examples of relieving letters:

7 Feb 1992

From: CHELECTECH (W-3) Frederick S. Stone, USN, 123-45-6789/7181
To: Commanding Officer, USS ATSEA (DD-901)
Via: (1) ENSIGN Willis M. Wright, USN, 987-65-4321/1100
(2) Operations Officer
(3) Executive Officer

Subj: RELIEF OF DUTIES AS ELECTRONICS MATERIAL OFFICER

1. The records, material, and spaces under the cognizance of the Electronics Material Officer have been jointly inspected by CWO Stone and ENS Wright. The following conditions are noted:

a. The administrative records of the division are essentially complete and accurate with the exception of the Ship Configuration Logistic Support Information System (SCLSIS) documents. A SCLSIS validation aid package has been requested from the Configuration Data Manager (CDM). These records will be updated upon receipt.

b. The divisional personnel records do not reflect the necessary NECs to maintain the existing installed equipment. The following changes to the manpower allowance, OPNAV Form 1000/2, are required:

DEFICIENT		REMARKS
1428	CP-967	Not listed on manpower
1453	N/WSC-3	Not listed on manpower authorization.
1471	N/SRN-9	Not listed on manpower authorization.
1516	AN/SPS-40C	Not listed on manpower authorization.
1572	AIMS (IFF)	Not listed on manpower authorization.
EXCESS		
1421	AN/WRT-2	Equipment no longer on board.
1514	AN/SPS-40	Equipment no longer on board.

c. Under the Navy Manning Plan (NMP), a total of 5 technicians are allowed and 7 are currently on board. Despite this excess of personnel, the distribution of NECs and upcoming personnel losses preclude effective maintenance of the electronic installation on board.

d. The following equipment CASREPs are outstanding:

75-014 AN/SPS-40C	Unable to rotate antenna system at high speed. Awaiting ROH.
75-027 AN/SRN-9	Power supply parts on order.
76-003 AN/SRC-20	Frequency synthesizer on order for serial numbers 1434 and 1438.

Figure 17-1.–Relieving letter–first example.

e. The CSMP reflects the status of other material discrepancies.

f. Maintenance responsibilities for the electronic cooling water systems have not been defined. No PMS has been scheduled or performed on these systems.

g. The following items of test equipment are unaccounted for; survey documents are being prepared.

ITEM	SERIAL	DESCRIPTION
AN/PSM-40	1477	Multimeter
CSV-260	None	Multimeter
AN/USM-140	4214	Oscilloscope

h. Comparison of the test equipment allowance; SPETERL, with the current equipment on board indicates a shortage of 42 items and 17 excess items. Requisition/turn-in documentation is being prepared for all verified deficiencies and excesses.

i. The material condition of all electronics spaces is outstanding.

2. Effective this date, I have been relieved of all duties as Electronics Material Officer and OE Division Officer by ENS Wright.

FREDERICK S. STONE

FIRST ENDORSEMENT on CHELECTECH (W-3) Frederick S. Stone, USN,
123-45-6789/7181, letter of relief

From: ENSIGN Willis M. Wright, USN, 987-65-4321/1100
To: Commanding Officer, USS ATSEA (DD-901)
Via: (1) Operations Officer
(2) Executive Officer

Subj: RELIEF OF DUTIES AS ELECTRONICS MATERIAL OFFICER

1. Forwarded.
2. Conditions are as stated in the basic letter.
3. Discrepancies: None.

Figure 17-1.–Relieving letter–first example–Continued.

7 Feb 1992

From: ENSIGN Cleveland Hill, USN, 123-45-6789/1100
To: Commanding Officer, USS ATSEA (DD-901)
Via: (1) ENSIGN Willis M. Wright, USN, 987-65-4321/1100
(2) Operations Officer
(3) Executive Officer

Subj: RELIEF OF DUTIES AS ELECTRONICS MATERIAL OFFICER

1. As of this date, I have been relieved of all duties as Electronics Material Officer and OE Division Officer by ENS Wright.

2. A comprehensive review of all records, reports, and files maintained by the division has been completed and those items turned over to ENS Wright.

3. All classified material held by the division has been properly accounted for by inventory and custody signatures have been transferred.

4. All equipage has been inventoried and equipment custody cards have been signed.

5. The electronics division is currently at 40% of manning level.

CLEVELAND HILL

FIRST ENDORSEMENT on ENSIGN Cleveland Hill, USN,
123-45-6789/1100, letter of relief

From: ENSIGN Willis M. Wright, USN, 987-65-4321/1100
To: Commanding Officer, USS ATSEA (DD-901)
Via: (1) Operations Officer
(2) Executive Officer

Subj: RELIEF OF DUTIES AS ELECTRONICS MATERIAL OFFICER

1. As of this date I have assumed the duties of Electronics Material Officer and OE Division Officer.

2. During the review of records, reports, and files maintained by the electronics division, it was noted that the Ship Configuration Logistics Support Information System (SCLSIS) records are incomplete and out of date. A SCLSIS validation aid package has been requested from the CDM and these records will be updated upon its receipt.

Figure 17-2.–Relieving letter–second example.

3. The divisional personnel records do not reflect the necessary NECs to maintain the existing installed equipment. The following changes to the Manpower Authorization (MPA) OPNAV Form 1000/2 are required:

DEFICIENT		REMARKS
1428	CP-967	Not listed on MPA.
1453	AN/WSC-3	Not listed on MPA.
1471	AN/SRN-9	Not listed on MPA.
1516	AN/SPS-40C	Not updated, equipment change.
1572	AIMS (IFF)	Not listed on MPA.
EXCESS		
1421	AN/WRT-2	Equipment no longer on board.
1514	AN/SPS-40	Equipment no longer on board.

4. Under the Navy Manning Plan (NMP), a total of 5 technicians are allowed and 7 are currently on board. Despite this excess of personnel, the distribution of NECs and upcoming personnel excesses preclude effective maintenance of the electronic installation on board.

5. Custody cards were signed on all equipage sighted; survey documentation will be prepared for the following missing items of test equipment:

MODEL	SERIAL
AN/PSN-4D	1477
CSV-260	None
AN/USM-140	4214

6. Upon completion of a TECRR visit, the test equipment allowance will be compared with onboard items to determine excesses and deficiencies.

WILLIS M. WRIGHT

Figure 17-2.–Relieving letter–second example–Continued.

7 Feb 1992

From: ENSIGN Willis M. Wright, USN, 987-65-4321/1100
To: Commanding Officer, USS ATSEA (DD-901)
Via: (1) Operations Officer
(2) Executive Officer
(3) Operations Officer

Subj: ASSUMPTION OF DUTIES AS ELECTRONICS MATERIAL OFFICER

1. Having assumed the duties of Electronics Material Officer and OE Division Officer without contact relief, I have noted the following conditions:

a. The administrative records of the division are essentially complete and accurate with the exception of the Ship Configuration Logistics Support Information System (SCLSIS) documents. A SCLSIS validation aid package has been requested from NAVSEA and these records will be updated upon its receipt.

b. The divisional personnel records do not reflect the necessary NECs to maintain the existing installed equipment. The following changes to the Manpower Authorization (MPA), OPNAV Form 1000/2, are required:

DEFICIENT		REMARKS
1428	CP-967	Not listed on MPA.
1453	AN/WSC-3	Not listed on MPA.
1471	AN/SRN-9	Not listed on MPA.
1516	AN/SPS-40C	Not updated, equipment change.
1572	AIMS (IFF)	Not listed on MPA.
EXCESS		
1421	AN/WRT-2	Equipment no longer on board.
1514	AN/SPS-40	Equipment no longer on board.

c. The onboard test equipment has been inventoried using the existing SCLSIS documentation. The following items cannot be accounted for:

MODEL	SERIAL
AN/PSM-4D	1477
CSV-260	None
AN/USM-140	4214

Survey documentation is being prepared.

d. The equipment condition is considered satisfactory. The CSMP has been updated to reflect the current status.

e. Maintenance responsibilities for the electronic cooling water systems have not been defined. No PMS has been scheduled or performed on these systems.

2. I acknowledge responsibility for all duties as Electronics Material Officer and OE Division Officer.

WILLIS M. WRIGHT

Figure 17-3.–Relieving letter–third example.

THINGS TO DO AFTER RELIEVING THE DEPARTING EMO

1. Don't pass the buck. You have the job now and if something is bad, you are now responsible for correcting it.
2. Follow the basic routine listed below during the first few weeks.
   a. Keep your eyes and ears open. Don't fall on your sword!
   b. Make no important commitments.
   c. Ask questions.
   d. Observe the Electronics Division, noting:
      (1) Work routine
      (2) ETs' abilities
      (3) Good and bad practices
   e. Make no change in existing policies unless safety or an equally important factor is affected.
3. When you have the overall picture, establish your own policies.
4. Initiate steps to correct all discrepancies you noted in the relieving letter.
5. Maintain a tickler file for periodic reports.
6. Maintain a useful NSN file.
7. Establish or update all necessary bills including:
   a. Watch, Quarter, and Station Bill
   b. Safety Bill
   c. Training Bill
   d. Emergency Destruction Bill
   e. Other bills required by:
      (1) Ship's Organization Manual
      (2) Type commander
8. Check the COSAL
   a. Is it up-to-date?
   b. Are any tools or test equipment missing? If so, order them as prescribed by current directives.
9. Inaugurate the use of Electronics Repair Service Reports. These reports are:
   a. Submitted by the equipment operator or technician
   b. Completed by the technician
   c. Checked for completeness by the leading ET

Be sure a file copy is kept.

10. Maintain an equipment file. Include copies of:
    a. Completed Electronics Repair Service Reports
    b. Reports made by MOTU or other outside technical sources
    c. Repair requests
    d. OPNAV 4790/2K Work Requests and Deferred Actions
    e. Block diagram of the complete system
    f. NAVSEA letters
11. Ensure that the 3-M Systems has been properly implemented. Establish a procedure of personally monitoring PMS on a random basis.
12. Check the completeness of the blueprint file and order missing blueprints.
13. Inventory publications.
    a. Order all missing technical manuals. Order all outstanding changes to the manuals. Use SCLSIS to determine the requirements.
    b. Order all necessary professional references. Use the FTG and TYCOM pubs lists.
    c. Check stowage, filing, and security.
    d. Assign a classified publications custodian.
    e. Ensure that the EIB file is complete.
    f. Establish an index of applicable EIB articles.
    g. Establish a system to ensure that appropriate action is taken on all EIB articles that apply to your equipment.
14. Ensure that all applicable APLs and CIDs are on board and up to date.
15. Ensure that all authorized field changes are installed and recorded on Field Change Record Plates and SCLSIS reports. Order all outstanding field changes that can be done by ship's force.
16. Initiate action to correct all discrepancies noted by previous electronics inspections. Especially

note those concerning safety of personnel and equipment.

17. Tour all assigned spaces regularly, preferably on a daily basis. Check for:
    a. Cleanliness and upkeep
    b. Necessary safety precautions, safety signs, and devices
    c. Necessary fire fighting equipment, destruction equipment and damage control fittings. Use compartment check-off lists or hull reports.
    d. Posted operating instructions.
    e. Condition of equipment and hardware.
    f. Evidence that PMS is being done on time.
    g. Violations of safety precautions.
    h. Proper marking on power and control panels and on switches and outlets.
18. When you've gotten your feet wet and if the ET assignments listed below are not already in effect, assign them.
    a. Blueprint Petty Officer.
    b. Supply Petty Officer.
    c. Damage Control Petty Officer (DCPO). He or she should be a graduate of DCPO school, be an E-5 or work center supervisor, and have completed DCPO PQS.
    d. Technical Manual and Publications Petty Officer.
    e. Test Equipment Petty Officer.
19. If the technicians have problems keeping up with their tools, you may want to institute a program of standard tool issue, with each technician signing for and held responsible for his or her own tools.
20. Determine the routing of all applicable electronics directives, instructions, and notices. Is it adequate?
21. Locate all directives that apply specifically to electronics, electronics maintenance, electronics supply, and 3-M and have them handy or establish your own binder.
22. Ensure that safety tag-out procedures follow current directives and that personnel are adhering to them.

REFERENCE MATERIAL INDEX

The following is a list of publications from various commands that you should review.

OPNAV INSTRUCTIONS AND MANUALS

1. 3120.32B
2. 4790.4B
3. 5100.19B
4. 5100.20C
5. 5510.1H
6. MANUAL 43P6A
7. OP3565

CINCLANTFLTINST

1. 3541.1D

COMNAVSURFLANTINSTS

1. 2241.1D
2. 3500.2E, JUN 88; CH-1, APR 89; ADV CH 1/2, AUG 89
3. 3500.9E
4. 3541.1B
5. 3560.2B
6. 5040.2B, AUG 86; CH-1, MAR 88; ACN 1/2
7. 5100.4, SEP 87; chg 1, NOV 88
8. 5510 series
9. 9000.1C, CH-1 JUN 89
10. 9093.3, APR 86; ACN 1/1 - 4/1, MAR 89
11. 9400.1B
12. 9900.1B

COMTRALANTINST

1. OPORD 2000, CHG 5

MISCELLANEOUS

1. ATP-17A
2. CMS-4L
3. NAVAIR DWG 63-A-114 series
4. CSP-1A

5. DOD-STD-1686/DOD-HDBK-263
6. EIBs
7. EIMBs
8. FXP 4
9. GEN SPECS FOR US NAVY SHIPS
10. MIL-E-24269
11. MIL-STD-1310E
12. MIL-STD 1680B
13. NAVEDTRA 10061-AS
14. NAVEDTRA 43100-1B
15. NAVMED P5055
16. NAVSEA ST000-AB-GYD-010/GPETE
17. NAVMILPERSCOMINST 1080.1D
18. NAVSHIPS DWG 04-1640412
19. NSTMs
20. SHIPS' SAFETY BULLETIN

APPENDIX I

ELECTRONICS ADMINISTRATION PUBLICATIONS AND INSTRUCTIONS

REFERENCE LIST

The following reference list contains publications and instructions that will assist you in your electronics administration duties. Notes at the end of the appendix explain the ordering symbols used throughout the list.

Afloat Shopping Guide	NAVSUP 4400	
Section 1	20XX-49XX	0588-LP-460-1100
Section 2	51XX-56XX	0588-LP-460-1200
Section 3	59XX	0588-LP-460-1300
Section 4	61XX-73XX	0588-LP-460-1400
Section 5	75XX-84XX	0588-LP-460-1500
Section 6	91XX-99XX	0588-LP-460-1600
Afloat Supply Procedures	NAVSUPPUB P-485	0530-LP-485-0074
AIMS MK XII Shipboard Newsletters	NAVSEA	(X)
AN/SPS-40 Series Newsletters	NAVSEA	(X)
Application Guide for MUF/LUF	NOSEC TN 333	(X)
AN/SRN-12 Information Bulletin Number 5	NAVELEX 14203-12804	(X)
Antenna Maintenance Guide	MOTU TWO	(X)
Atlantic Fleet Mobile Technical Units (MOTUs)	COMNAVSURFLANTINST 9400.1C	(X)
Avionics Cleaning and Corrosion Prevention/Control	NAVAIR 16-1-540	0816-LP-312-6030
Bibliography for Advancement Examination Study	NAVEDTRA 12052	0502-LP-050-2690
Call Sign Book for Ships	ACP-113	(X)
CANTRAC–Catalog of Navy Training Courses, Vol. 1, Introductory, General Information	NAVEDTRA 10500	0502-LP-214-4200
CANTRAC–Catalog of Navy Training Courses, Vol. 2, Course Descriptions; and Vol. 3, Skills Profiles	NAVEDTRA 10500	NETPMSA

Catalog of Courses Available at Atlantic Fleet Shore Based Training Activities	COMTRALANTINST 1540.1	(X)
Catalog of SURFLANT IMA Maintenance Routines	COMNAVSURFLANTINST 9000.2	(X)
Central Dry Air Systems, Surface Ships	NAVSEA	0949-LP-056-8010
CINCLANTFLT OPORD 2000, Annex K	CINCLANTFLT 2000	(X)
Classified Electronic Communication Security (COMSEC) Material in the Navy Supply System		(X)
Coast Guard Cutter Training and Qualification Manual	CMODTINST M3502.4	(X)
Coast Guard Cutter Training Manual Vols. 1-7	CMODTINST M3502.3	(X)
Codes for Instrument Manufacturers (CIM)	NAVSEA TNOOO-AB-IDX-010	(1)
Combat Systems Technical Operations Manuals	See NAVSUP 2002 for complete information and FSNs	
Combat Systems Test and Evaluation Program (CSTEP)	COMNAVSURFLANTINST 9010.3	(X)
Combat Systems Training Requirements Manual (CSTRM)	COMNAVSURFLANTINST 1543.(XXXX) Series number is different for each ship class	
Combat Systems Troubled Equipment Action Program (CSTEAP)	COMNAVSURFLANTINST 9050.1	(X)
Combat Systems Readiness Review (CSRR)	COMNAVSURFLANTINST 9093.1	(X)
Combat Systems Ship Qualification Trials (CSSQT)	NAVSEAINST 9093.1A	0693-LP-054-1200
Communications Handbook EIMB	NAVSEAINST SE000-00-EIM-010	0967-LP-000-0010
COMNAVAIRLANT Master Job Catalog	COMNAVAIRLANTINST 9000.3	(X)
COMNAVAIRLANT Quality Assurance Manual	COMNAVAIRLANTINST 9090.1	(X)
COMSUBLANT Maintenance Manual	COMSUBLANTINST C4790.8	(X)
COMNAVSURFLANT Combat Systems Officers Manual	COMNAVSURFLANTINST 9093.3	(X)

Consolidated Afloat Requisitioning Guide Overseas	NAVSUP 0641A 4998	(X)
Consolidated Subject Index	NAVPUBNOTE 5215	(X)
Consolidated Index of Instructions/Directives	CINCLANTFLTINST 5215	(X)
Consolidated Index of Instructions/Directives	COMDTNOTE 5600	(X)
Consolidated Index of Instructions/Directives	COMNAVAIRLANTINST 5215	(X)
Consolidated Index of Instructions/Directives	COMNAVSURFLANTINST 5215	(X)
Consolidated Index of Instructions/Directives	SPCCINST 5215.10	
CONTACT Magazine	SURFLANT Periodical	(X)
Coordinated Shipboard Allowance List (COSAL)	SPCC Mechanicsburg, Pa., (Ship Tailored)	DSN 430-2256/2785
COSAL Use and Maintenance Manual	SPCCINST 4441.170	(X)
Countermeasures EIMB	NAVSEA SE000-00-EIM-070	0967-LP-000-0070
Cryptographic Equipment Guide/Manual	NAVTELCOM NTP-7	(X)
Cryptographic Security Policy and Procedures	CSP-1	(X)
Deckplate	NAVSEASYSCOM Periodical	(X)
DOD Index of Specifications and Standards	Microfiche Edition	(X)
Equipment Identification Code Master Index	NAMSOINST 4790.E2579	(X)
Equipment Identification Code Master Index	NAMSOINST 4790.E2579 (FFG Addendum)	(X)
Electric Shock, Its Causes and Prevention	NAVSEA 250-660-42	0900-LP-007-9010
Electronic Circuits Handbook EIMB	NAVSEA SE000-00-EIM-120	0967-LP-000-0120
Electronic Equipments and applicable publications (microfiche listing)	E STEPS REPORT 102E	(X)
Electronics Liquid Cooling Systems PQS	NAVEDTRA 43376	(X)
Electronics Safety Handbook	NAVELEX E0410-AA-HBK-101	(X)

Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies and Equipment	DOD-HDBK-263	(X)
EMI Reduction EIMB	NAVSEA SE000-00-EIM-150	0967-LP-000-0150
EMO's Guide to Shipboard Electromagnetic Interference Control (SEMCIP)	STD-407-5287556	Comm 804-486-5895 DSN 564-7811
Engineering Information Bulletin (Electronics)	NAVSEA S0111-84-EIB-EXX	(1)
Engineering Management Manual	COMNAVSURFLANTINST 3540.5	(X)
Enlisted Distribution and Verification Report (EDVR)	NAVMILPERSCOMINST 1080.1	(1)
Enlisted Performance Evaluation Manual	NAVMILPERSCOMINST 1616.1	(X)
Enlisted Transfer Manual	NAVPERS 15909	(X)
FATHOM (Surface Ship and Submarine Safety Review)	NAVSAFECEN Periodical	(X)
FCA METRL	NAVELEX	0969-LP-133-2020
FCIG Microfiche EIMB	NAVSEA SEOOO-OO-EIM-170	0969-LP-000-170
Fitting-Out Management Information System	NAVSEAINST 4441.10	(1)
Fitting-Out Management Information System, General Requirements	MIL-STD-1626	(X)
Federal Supply Code		
Groups and Classes, Part 1	DOD HDBK-1	0581-LP-002-1075
Numeric Index to Classes, Part 2	DOD HDBK-2	0581-LP-002-2080
Federal Supply Code for Manufacturers (FSCM) (Microfiche)	DOD H4 - 1 & 2 (U.S & Canada) DOD H4 - 3 (all others)	0581-LP-003-2080 0581-LP-004-3075
Field Change Installations	NAVSEAINST 4790.12	(X)
Fleet Modernization Program	OPNAVINST 4790.2	(X)
Fleet Modernization Program	NAVSEA SL720-AA-MAN-010	0910-LP-037-4300
Fleet Repairables Assistance Agent (FRAA) Program	NAVSUPINST 4420.33	(X)

General EIMB	NAVSEA SE000-00-EIM-100	0967-LP-000-0100
General Maintenance EIMB	NAVSEA SE000-00-EIM-160	0967-LP-000-0160
General Specifications for Navy Ships	NAVSEA S9AAO-AA-SPN-010	0910-LP-007-4100
GSA Supply Catalog GSA Supply Catalog Guide, Tools Catalog, Office Products Catalog, Industr. Products Catalog, and Furniture Catalog	Mailing Guide List OSSC - 0001	FTS Ph. No. 234-4195 Gen. Services Admin (8BRC), Bldg. 41 Denver, CO 80225
Guide for Preparation of Articles for Publication in the Engineering Information Bulletins (EIB), Revision of	NAVELEXINST 5600.6	(X)
Guide for User Maintenance of NAVSEA Technical Manuals	NAVSEA S0005-AA-GYD-030	0910-LP-007-4000
Handbook for Shipboard Surveillance Radars	NAVSEA SE200-AA-HBK-010	0910-LP-048-8100
Hazards to Ordnance	OP 3565 Vol. 2	0631-LP-530-6190
Hazards to Classified Ordnance	OP 3565 Vol. 3	(X)
Information and Personnel Security Program Regulations	OPNAVINST 5510.1	(X)
Index of Specifications and Standards	DODISS Part I & II	(X)
Index of Technical Publications	No specific number-depends on ship class	NSDSA Pt. Hueneme, CA DSN 360-5172 (Per EIB 082)
Installation Control Drawing Index for Electronic Equipment (for shipboard systems)	NAVSEA 0967-LP-034-4010	0967-LP-034-4010
Inspections Required for Forces Afloat	OPNAVNOTE 5040	(X)
Installation Criteria for Secure Processing Systems	MIL-STD-1680	(X)
Installation Standards EIMB	NAVSEA SE000-00-EIM-110	0967-LP-0110
INSURV Inspectors' Catalog of Recurring INSURV Deficiencies (RIDCAT)	INSURVINST 4730.19	(X)
Integrated Logistics Overhaul (ILO) Vols. 1-7	SL105-AA-PRO-XX	(X)
Introduction to Federal Supply Catalogs and Related Publications	NAVSUPPUB 4000	(1)

Joint Electronics Type Designations System	MIL-STD-196	(X)
Joint Pub 1-02		(X)
Job Performance Aid	COMSECONDFLT JPA	(X)
Level of Equipment Maintenance in the Naval Electronics Systems Command; Policy Governing	NAVELEXINST 4700.10	(X)
Life Cycle Management of Portable Test, Measuring and Diagnostic Equipment (TMDE): Policy and Responsibilities for	NAVSEAINST 9082	(X)
LIFELINE (The Navy Safety Journal)	NAVSAFCEN	DSN 564-1561
LINK (Enlisted Personnel Distribution Bulletin)	NAVPERS	(X)
Liquid Cooling Systems, Radar Set AN SPS-40	NAVSEA	0948-LP-115-5010
LIRSH (List of Items Requiring Special Handling)	NAVSUPPUB 4105	0588-LP-005-0035
List of Recurring Reports	COMNAVAIRLANTINST 5214.1	(X)
List of Recurring Reports	COMNAVSURFLANTINST 5214.1	(X)
Listing of Recurring Reports	OPNAVNOTE 5214	(X)
List of Training Manuals and Correspondence	NAVEDTRA 12061	(1)
Maintenance of Ships	OPNAVINST 4700.7	(1)
Management List - Navy (MLN)	NAVSUPPUB 4100	(X)
Manpower Authorization (MPA)	OPNAVINST 1000/2	(X)
Manual of Navy Total Force Manpower	OPNAVINST 1000.16	(X)
Manufacturers' Designation Symbols (MDS)	NAVELEX 0967-LP-190-4010	0967-LP-190-4010
MARK and MOD Nomenclature System	MIL-STD-1661	(X)
Master Cross Reference List (MCRL)		
Part 1	MCRL - N-1	0588-LP-002-1000
Part 2	MCRL - N-2	0588-LP-002-1500
Master Index of Allowance Parts List (MIAPL)	SPCC, Mechanicsburg, Pa.	DSN 430-4140/3588
Master Repairable Items List (MRIL)	NAVSUPPUB 4107	0588-LP-410-2600
Master Training Plan (MTP)	COMNAVSURFLANTINST C3500.2	(X)

Metrology Requirements List METRL METRL, FCA		0969-LP-133-2010 0969-LP-133 2020
Microwaves and Waveguides	NAVELEX 0367-LP-024-0010	0367-LP-024-0010
MILSTRIP/MILSTRAP Desk Guide	NAVSUPPUB 409	0530-LP-409-0010
Naval Arctic Manual	OPNAV ATP-17	(X)
Naval Command Inspection Program within NAVSURFLANT; Assist Visits Available to NAVSURFLANT Units	COMNAVSURFLANTINST 5040.2	(X)
Naval Warfare Mission Areas	OPNAVINST C3501.2	(X)
NAVELEXSYSCOM Metrology and Calibration Program	NAVELEXINST 9690.3	(X)
NAVELEX TAMS Newsletters		DSN 564-7814
NAVSHIPS Technical Manuals	S9086 STM.CH	0901-LP-XXX XXXX (See NAVSUP 2002 for complete FSN and ordering procedures
NAVSURFLANT Maintenance Manual	COMNAVSURFLANTINST 9000.1	(X)
NAVSURFLANT Quality Assurance Manual	COMNAVSURFLANTINST 9090.1	(X)
Navy Calibration Activity List (NCA)	NA-17-35NCA 1	(X)
Navy Calibration Equipment List	NA-17-35NCE 1	(X)
Navy Enlisted Manpower and Personnel Classification and Occupational Standards Section I, Occupational Standards Section II, Navy Enlisted Classification (NEC)	 NAVPERS 18068 NAVPERS 18068	 0500-LP-453-0076 0500-LP-453-0112
Navy Hazardous Material Control Program	NAVSUPINST 5100.27	(X)
Navy Occupational Safety and Health (NAVOSH) Program Manual	OPNAVINST 5100.23	(X)
United States Naval Regulations 1990		0584-LP-180-8800
Navy Stock List of Publications and Forms	NAVSUPPUB 2002 (Microfiche)	0535-LP-004-0100

Nomenclature Assigned to Naval Electronic Equipment: Vol. 1 Vol. 2		0967-LP-311-9010 0967-LP-311-9020
Officer Distribution Control Report (ODCR)	NAVMILPERSCOMINST 1301.2	(X)
Operational Reports	OPNAV NWP-10	(NICN not assigned, see NWP Custodian)
Personnel Advancement Requirements (PARs)	NAVPERS 1414/4	(X)
Personnel Qualifications Standards	COMNAVSURFLANTINST 3500.9	(X)
Portable Test Equipment Stowage Guide	NAVSEA ST000-AB-GYD-010	0910-LP-051-8000
PQS Manager's Guide	NAVEDTRA 43100.1	0501-LP-221-0012
Preparation of Deficiency Forms	INSURVINST 4730.11	(X)
Principles of Modems	NAVSHIPS 0967-LP-291-6010	0967-LP-291-6010
Principles of Single-Sideband	NAVSHIPS 93271	(X)
Principles of Telegraphy	NAVSHIPS 0967-LP-255-0010	0967-LP-255-0010
Procedures for Submission of Application for Approval of Non-Standard General-Purpose Electronic Test Equipment (GPETE)	MIL-STD-1387	(1)
Protection of Items Susceptible to Damage from Electrostatic Discharge	NAVSUPINST 4030.46	(X)
Radar EIMB	NAVSEA 0967-LP-000-0020	0967-LP-000-0020
Radar Electronic Fundamentals	NAVSHIPS 900.016	(X)
Radar Systems Fundamentals	NAVSHIPS 900.017	(X)
Radiac EIMB	NAVSEA SE000-00-EIM-050	0967-LP-000-0050
Reference Data EIMB	NAVSEA SE000-00-EIM-140	0967-LP-0140
Repair Party Manual	COMNAVSURFLANTINST 3541.1	(X)

Report of Fitness of Officers	NAVMILPERSCOMINST 1611.1	
Reporting of Defective Materials Obtained through the Supply System	NAVSUPINST 4440.120	
RF Transmission Lines	BUSHIPS 0967-LP-108-3010	0967-LP-108-3010
Safety Precautions Afloat	OPNAVINST 5100.19	(1)
Safety Precautions Ashore	NAVMAT P5100	0518-LP-099-5004
Satellite Communications	NTP-2, SEC II	(X)
SCLSIS Program Manuals		(X)
Security Classification and Cognizant Activity	MIL-HDBK-140	(X)
Ship Alteration Record (SAR)	CV600058/CVN600059	(X)
Shipboard Antenna Systems	NAVSEA	0967-LP-177-3010
Vol. 1	Fundamentals	0967-LP-177-3020
Vol. 2	Installation	0967-LP-177-3030
Vol. 3	Communications and	0967-LP-177-3040
	Couplers	0967-LP-177-305
Vol. 4	Testing and Maintenance	
Vol. 5	Data Sheets	
Shipboard Bonding, Grounding, and Other Techniques for Electromagnetic Compatibility and Safety	MIL-STD-1310	(1)
Shipboard DC Training Program	CINCLANTFLTINST 3541.1	(X)
Shipboard Electromagnetic Compatibility Improvement Program	NAVSEA STD-407-5287556	(1)
Shipboard Hazardous Material/Hazardous Waste Management Plan	NAVSEA S9593-A7-PLN-010	(1)
Shipboard Installations and Modifications Performed by Alteration Teams; Centralized Control of	NAVSEAINST 4720.11 NAVELEXINST 4720.4	(1) (X)
Ship Dry Air Systems	NAVSEA 0949-LP-056-8010	0949-LP-056-8010
Ship Exercises	OPNAV FXP-3	0411-LP-102-5147
Ship Information Book (SIB), Vol. 4, Electronics	(Ship tailored, may be referred to as GIB, General)	See NAVSUPPUB 2002 for ordering information

Ship Maintenance Manual	COMNAVAIRLANTINST 9000.2	(X)
Ship Manpower Document (SMD) Program	OPNAVINST 5310.19	(X)
NAVSUPPUB 2002 Ship Safety Bulletins (Periodical)	NAVSAFCEN	DSN 564-1561
Ships' Portable Electrical/Electronic Test Equipment Requirements List (SPETERL)	NAVSEA Code 06C12	DSN 222-2599/7747
Ships' Technical Publications Systems (STEPS) Policies and Distribution List	NAVSEAINST 4160.1	(X)
Ships' 3-M Manual	OPNAVINST 4790.4	(1)
Ships' Training Readiness Manual	COMNAVAIRLANTINST C3500.24	(X)
Single Sideband Fundamentals	NAVELEX	0967-LP-222-2010
Sixth Fleet Logistics Manual	COMSERVFORSIXTHFLTINST 4000.1	(X)
Sonar EIMB	NAVSEA SE000000-EIM-030	0967-LP-000-0030
Special HERO EMCON Request	COMNAVBASENORVA 5400.1	(X)
Standard General Purpose Electronic Test Equipment (GPETE)	MIL-STD-1364	(1)
Standardization of Communications Patch Panels, Switchboards, and Various Control Units	NAVELEX 0967-LP-615-0010	0967-LP-615-0010
Standard PMS Material Identification Guide (SPMIG)	NAVSEA	(X)
Standard Organization and Regulations of the U.S. Navy (SORM)	OPNAVINST 3120.32	(1)
Standard Subject Identification Codes (SSIC)	SECNAVINST 5210.11	(1)
STEEP Catalog	NAVSEA ST820-AA-CAT-01E	(X)
Surface Force Supply Procedures (SURFSUP)	COMNAVSURFLANTINST 4400.1	(X)
SURFLANT Master Job Catalog	COMNAVSURFLANTINST 9000.2	(X)
Synchro, Servo, Gyro Fundamentals	NAVPERS 10105	(X)
Synchros	MIL-HDBK-225AS	(X)

TACAN Flight Inspection Manual	NAVELEX EE172-FA-GYD-O10/E120	(X)
TEMMAD and School Quotas	COMNAVSURFLANTINST 1320.1	(X)
Technical Manual Identification Numbering System	NAVSEA S000-000-IDX-000	(X)
Technical Manual Identification Numbering System (TMINS), Description and Application Guide	NAVSEA M0000-00-IDX-000	(X)
Technical Repair Standards	NAVSEA T04551-086-600	(X)
TEMPEST Instruction	COMNAVSURFLANTINST C2241.1	(X)
Test Equipment Calibration Program	NAVMAT P-949119-7000	(1)
Test Equipment EIMB	NAVSEA ST000-00-EIM-040	0967-LP-000-0040
Test Equipment Index	NAVSEA ST000-AA-IDX-010/PEETE	0910-LP-018-0000
Test Methods and Practices EIMB	NAVSEA SE000000-EIM-130	0967-LP-000-0130
Title "D" and "F" SHIPALT Installation Authorization Letter; Discontinuation of	COMNAVSURFLANT LTR SER N432/7734, 21SEP82	(X)
3-M Inspection Policies, Procedures, and Criteria	CINCLANTFLTINST 4790.2	(X)
3-M (Maintenance, Material, Management Reports)	NAMSOINST 4790.2	DSN 430-2043
Training Appraisal Program	OPNAVINST 1540.50	(1)
Trials and Inspections of Surface Ships	INSURVINST 9080.2	(X)
Unauthorized Alterations of Navy Ships	OPNAVINST 4720.93	(1)
Uniform Material Movement Issue Priority System (UMMIPS)	COMNAVAIRLANTINST 4614.4	(X)
Uniform Regulations	NAVPERS 1566	(X)
UNITREP and CASREP Readiness Ratings	COMNAVSURFLANTINST 3500.7	(X)
U.S. Navy Emissions and Bandwidth Handbook	NAVSHIPS	0967-LP-308-0010
U.S. Navy Synchros	NAVORD OP1303	(X)

Notes: Key for right-hand column
X–obtain from your technical library or order from the issuing activity or originator.
1–order from NAVPUBFORCEN, Philadelphia, Pa.

APPENDIX II

LIST OF ACRONYMS

AAW	antiair warfare
ACED	anticompromising emergency destruction
ACLS	Automatic Carrier Landing System
ACN	advance change notice
ACR	allowance change request
AER	alteration equivalent to repair
AFC	automatic frequency control
AFTS	audio frequency tone shift
AIC	air intercept control
AIMS	Air Traffic Control Radar Beacon Identification Friend or Foe Mark XII System
ALC	antilog circuit
ASAC	antisubmarine air controller
ASAS	automated single audio system
ASG	Afloat Shopping Guide
ASM	antiship missile
ASMD	antiship missile defense
ASR	automatic send receive
ASUW	antisurface warfare
ASW	antisubmarine warfare
ATC	air traffic control
AUTOSEVOCOM	automatic secure voice communications
BBN	broadband noise
BER	beyond economical repair
BIT	built-in test
BITE	built-in test equipment
BSS	battery systems supervisor
CAGE	commercial and government entity
CANTRAC	Catalog of Navy Training Courses
CASREP	casualty report
CATCC	carrier air traffic control center
CCC	Central Computer System
CDM	configuration data manager
CEIL	controlled equipage item list
CLF	combat logistics force
CNO	Chief of Naval Operations

COBOL	Common Business Oriented Language (computer programming)
COSAL	coordinated shipboard allowance list
COSBOL	coordinated shore based allowance list
CP	component procedure
CSDB	class standard data base
CSFMP	combat systems frequency management program
CSLC	coherent side lobe canceler
CSOCC	Combat Systems Operational Casualty Control
CSOSS	Combat Systems Operational Sequencing System
CSRR	combat systems readiness review
CSTOM	Combat Systems Technical Operation Manual
CSTT	combat systems training team
CW	continuous wave
CW	chilled water
DAMA	demand assigned multiple access
DLR	depot level repairable
DMINS	AN/WSN-1 dual mini system
DMTI	digital moving target indicator
DOD	Department of Defense
DOP	designated overhaul points
DW	distilled water
ECM	electronic countermeasures
EDVR	Enlisted Distribution Verification Report
EIMB	Electronics Installation and Maintenance Book
EMC	electromagnetic compatibility
EMCON	emission control
EMO	electronics material officer
EOH-EOA	end of overhaul/availability
ESS	electronics support systems supervisor
FAD	force activity designation
FCFBRS	Fleet COSAL Feedback Reporting System
FCIG	field change information guide
FDM	frequency division multiplexing
FLTSATCOM	fleet satellite communications
FMP	fleet modernization program
FOT	frequency optimum de travail (optimum working frequency)
FOUO	for official use only
FSK	frequency shift keying

FTC	fast time constant
GPETE	general-purpose electronic test equipment
HERO	hazardous electromagnetic radiation to ordnance
HMIS	Hazardous Material Information System
I/P	identification of position
ICP	inventory control point
IEMC	industrial electromagnetic compatibility
IFF	identification friend or foe
ILO	integrated logistics overview
ILR	integrated logistics review
IMD	intermodulation distortion
IMI	intermodulation interference
IS	interference suppression
ISL	integrated stock list
ISLS	interrogation side lobe suppression
ITP	index of technical publications
JETDS	Joint Electronics Type Designation System
KAM/KAO	cryptographic operating manuals
KSR	keyboard send receive
LED	light-emitting diode
LIRSH	list of items requiring special handling
LORAN	Long Range Aid to Navigation
LUF	lowest usable frequency
MAM	maintenance assist module
MBS	main bang suppression
MCRL	master repairable item list
MDS	Maintenance Data System
MEP	master emergency procedure
MESP	master emergency system procedure
MIP	maintenance index page
MJC	master job catalog
MK/MOD	mark/modification
MLN	Management List Navy
MLS	mobile logistics support
MLSR	missing-lost-stolen report
MP	master procedure
MSAS	Manual Single Audio System
MUF	maximum usable frequency
NAVCOMPARS	Nnaval communication processing and routing station

NAVMACS	Navy Modular Automated Communications System
NAVSEA	Naval Sea Systems Command
NAVSTAR GPS	Satellite Global Positioning System
NAVSUP	naval supply
NCTAMS	naval communications transmission and monitoring station
NEOF	no evidence of failure
NESTOR	uhf secure voice
NMLS	Navy Model Letter System
NNSS	Navy Navigation Satellite System
NOFORN	Not Releasable to Foreign Nationals (special handling required)
NST	Navy standard teleprinter
NSTM	Naval Ships Technical Manual
NTU	new threat upgrade
NWP	Naval Warfare Publication
OCA	original classification authority
OCCSTD	occupational standard
OCSOT	overall combat systems operational test
OP	operational procedure
OPNAVINST	Office of the Chief of Naval Operations instruction
OPORDER	operations order
OPPLAN	operations plan
OPREP	operational report
OPTAR	operating target (funding)
OTC	officer in tactical command
OTCIXS	officer in tactical command information exchange subsystem
OUTBOARD	classified information processing system
PACE	program for afloat college education
PARKHILL	hf secure voice
PBFT	planning board for training
PCS	permanent change of station
PEP	peak envelope power
PLSO	phonetic letter spelled out
PM	phase modulation
PMS	Preventive Maintenance System
POE	projected operational environment
POFA	programmed operational and functional appraisal
PPEE	personal portable electrical/ electronic equipment

PQS	personnel qualification standard
PRF	pulse repetition frequency
PSK	phase shift keying
QA	quality assurance
R & D	research and development
RADHAZ	radiation hazard
RATT	radio actuated tty
RDD	required delivery date
RHI	range height indicator
ROC	record of changes
ROH-COH	regular overhaul
RPU	remote phone unit
SAS	single audio system
SCLSIS	Ship Configuration Logistics Support Information System
SD	system diagram
SDT	system data table
SECAS	Ship Equipment Configuration Accounting System
SEM	standard electronics module
SEMCIP	Shipboard Electromagnetic Compatibility Improvement Program
SERT	Shipboard Electronics Readiness Team
SFWP	ship's force work package
SHIPALT	ship alteration
SHM	ship's head marker
SID	system interface diagram
SID	sudden ionospheric disturbance
SIF	selective identification feature
SINS	Ship's Inertial Navigation System
SMS	system management subsystem
SN	standard note
SNAP 2	Shipboard Nontactical Automatic Data Processing System
SNSL	stock-number sequence list
SOP	standard operating procedures
SORM	standard organization regulation manual
SP	system procedure
SPAWARS	Naval Space and Warfare Systems Command
SPETERL	shipboard portable electrical/ electronic test equipment requirements list
SR	sector radiate
SSBN	nuclear ballistic submarine
SSES	Special Signals Exploitation System

SSIXS	Submarine Satellite Information Exchange System
SSTX	solid-state transmitter
STAN	SEMCIP technical assist network
STC	sensitivity time control
SW	seawater
TACAN	tactical air navigation
TACINTEL	Tactical Intelligence Information Exchange System
TADIXS	Tactical Data Information Exchange Subsystem
TAM	test and monitoring
TEMPEST	control of compromising emanations (ce)
TIP	technical information/ improvement plan
TMDERS	technical manual deficiency evaluation report
TMINS	technical manual identification and numbering system (NAVELEX)
TRANSMAN	Enlisted Transfer Manual
TRE	training readiness evaluation
TSEC	telecommunications security system
TYCOM	type commander
UMMIPS	Uniform Material Movement and Issue Priority System
UND	urgency of need
UWS	underwater systems supervisor
VCS	video clutter suppression
VGC	video gain control
VINSON	uhf secure voice
VSWR	voltage standing wave ratio
WCAP	waterfront corrective action program
WPI	word processing instruction
WQS	watch quarter and station
WSF	weapons systems file

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