RADIOMAN 3 & 2

NAVAL TRAINING COMMAND

RATE TRAINING MANUAL NAVTRA 10228-F

PREFACE

This book is written for enlisted personnel of the U.S. Navy and Naval Reserve who are studying for advancement to the rates of Radioman 3 and Radioman 2. Combined with the necessary practical experience and study of the publications in the reading list, the information in this course will assist the Radioman in preparing for Navywide examinations for advancement in rate.

Those who work in communications know how fast procedures and equipment change. Between revisions of this training course some obsolescence may be unavoidable. For this reason, it is suggested that the student with access to official communication publications use them as much as possible in his study.

As one of the Rate Training Manuals, Radioman 3 & 2 was prepared for the Naval Training Support Command by the Training Publications Division of the Naval Personnel Program Support Activity, Washington, D.C. It was reviewed by the Office of the Assistant Chief of Naval Operations (Communications)/Director, Naval Communications; Naval Examining Center, Naval Training Center, Great Lakes, Ill.; U.S. Naval Schools, Radioman, Class A, at Bainbridge, Md. and San Diego, Calif., and Commander Cruiser Destroyer Force, U.S. Pacific Fleet, San Diego, Calif.

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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 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.

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CHAPTER 1
YOUR CAREER AS A RADIOMAN

A naval force is only as good as the men who man the ships. Even with the most modern equipment, a naval force is almost powerless without competent men to operate and maintain that equipment. Good men are plentiful, but their capability depends chiefly upon their training. "Communications is the voice of Command." The radioman, in the performance of his duties, is a direct representative of his commanding officer. He provides his commanding officer with the capability of exchanging message information—accurately, rapidly, and securely—with his seniors, juniors, and fellow commanders, wherever they may be located.

The Radioman contributes directly to the reputation and effectiveness of his command. A command (ship or shore) is often regarded as being effective and reliable if its communications are effective and reliable.

As a Radioman you will be a member of a team that provides round-the-clock communications.

As a part of the Navy's training program, this self-study rate training manual is written for the purpose of aiding you in your preparation for advancement. It is designed to help you meet the professional (technical) qualifications for advancement to Radioman 3 and Radioman 2.

This rate training manual consists of 15 chapters. The first chapter is nontechnical in nature and introduces you to the course. Remaining chapters deal with the technical aspects of your rating. The remainder of this introductory chapter gives information on the enlisted rating structure, the Radioman rating, requirements and procedures for advancement, and references that will help you in working for advancement and also in performing your duties as Radioman. Study this chapter before beginning intensive study of the remaining chapters of this manual.

ENLISTED RATING STRUCTURE

The two main types of rating in the present enlisted rating structure are general ratings and service ratings.

General ratings identify broad occupational fields of related duties and functions, such as Radioman. Some general ratings include service ratings; others do not.

Example: ET (Electronics Technician)—General Rating.
ETR (Electronics Technician) Radar)—Service Rating.

Both regular Navy and Naval Reserve personnel may hold general ratings.

Service ratings identify subdivisions or specialties within a general rating as outlined in the previous example. Although service ratings can exist at any petty officer level, they are most common at the PO3 and PO2 levels. Both regular Navy and Naval Reserve personnel may hold service ratings.

RADIOMAN RATING

Within the enlisted rating structure, ratings are divided into a total of 12 groups, with ratings in each particular group related occupationally. Group I is called the deck group which includes: BMs, QMs, RDs, STs...etc. The Radioman is a general rating in group V, commonly called the administrative and clerical group which includes: RMs, CTs, YNs, PNs, JOs...etc.

Your responsibilities as a petty officer in the Radioman rating break down into two types of duties: professional duties and military duties.

Professional duties as a Radioman third or second class may vary slightly depending upon the activity to which you are assigned.

The Radioman is primarily an operator. As such, you will be required to fulfill certain qualifications that require you to know what makes your equipment work, as well as how to operate it. You will also become involved in the maintenance of your equipment by developing special skills which will be discussed later in this chapter.

As a Radioman you will be a "jack of all trades" in the communication business. Ashore, you will generally be assigned to a communication center. Here, you will be concerned with getting message to and receiving them from ships of the fleet, and with monitoring other circuits. Additionally, you may be operating teletype or facsimile equipment.

Afloat assignments include a wide variety of responsibilities. You may have the opportunity to:

(1) Operate radiotelephone circuits.
(2) Maintain communications that use on-line cryptographic systems.
(3) Maintain communication publications, files, and cipher devices.
(4) Process your ship's message traffic.
(5) Learn the nomenclature and operation of communications equipment used throughout the navy.

Now that you have a general idea of your professional duties as a Radioman, let's discuss some of your military duties as a petty officer.

MILITARY DUTIES

Often, the difference between a "good" petty officer and a "bad" petty officer is leadership. The guide for leadership in the Navy is General Order 21, which states, in part: "The strength of our nation and of our services depends upon courageous, highly motivated, and responsible individuals." Each command has a training program that provides instruction in leadership principles and practices. The man who wants to move ahead takes advantage of this instruction. He applies its principles and practices in his every dealing with the men around him—especially those who look to him for an example of leadership.

Many books have been written on the subject of leadership, and many traits have been listed as a necessary part of the makeup of a leader. Whether you are a successful leader is decided by the success with which you stimulate others to work willingly under your supervision—not by compiled lists of desirable traits.

Self-confidence is one of the keys to leadership, but it must be backed up by enthusiasm, understanding of others, and especially by knowledge. For example, you not only must be able to supervise and teach lower rated men in their communication duties, but (as necessary) you also must be ready to pitch in and help do the job. Your men will respect you as a man who has demonstrated his knowledge and skill.

A cooperative attitude is another requirement of leadership. Do not let your experience in the RM rating make you unreasonable and overbearing with lower rated men whom you may have to instruct. Your attitudes will have a definite effect upon the attitudes and the actions of these men.

When you become a petty officer, you become a link in the chain of command between your officers and your men. Your responsibilities are more than merely giving orders and seeing that work is done. You likewise have a responsibility for sharing your knowledge with others. When the Navy promotes you, it expects you to train others.

The opportunity to acquire knowledge and to master new skills was given to you for your own benefit and for the benefit of the Navy as a whole. As new types of communication equipment become available or changes in communications procedures evolve, you should be the first to learn about them. Be ready to pass on this information and training to others.

A petty officer's working relationship with others is of great importance to the success of his work and the mission of his activity. Your day-to-day working relationships will be most successful as you cooperate with others, both within and outside your own division. Ability to get along is, at times, just as necessary as proficiency in performing your technical skills. Ability to work with others is a definite skill. This skill can be developed in much the same manner that you develop a technical skill. The many different skills you need may each be studied and developed. Some of these skills are understanding another man's job, his problems, and his abilities. Others are instructing, leading, and (in some instances) inspiring the men with whom you work. Detailed information to help you develop these skills is given in effective editions of the training courses Basic Military Requirements, NavPers 10054, and Military Requirements for Petty Officer 3 & 2, NavPers 10056. You should be familiar with the entire contents of both training courses before taking the Navywide examination for advancement.

ADVANCEMENT

Some of the rewards of advancement are easy to see. You get more pay. Your job assignments become more interesting and more challenging. You are regarded with greater respect by officers and enlisted personnel. You enjoy the satisfaction of getting ahead in your chosen Navy career.

The Navy also profits from your advancement. Highly trained personnel are essential to the functioning of the Navy. By each advancement you increase your value to the Navy in two ways. First, you become more valuable as a specialist in your own rating. And second, you become more valuable as a person who can train others and thus make far-reaching contributions to the entire Navy.

HOW TO QUALIFY FOR ADVANCEMENT

What must you do to qualify for advancement? The requirements may change from time to time, but usually you must:

1. Have a certain amount of time in your present grade.
2. Complete the required military and occupational training courses.
3. Demonstrate your ability to perform all the PRACTICAL requirements for advancement by completing the Record of Practical Factors, NavPers 1414/1. In some cases the Record of Practical Factors may contain the old form number, NavPers 760.
4. Be recommended by your commanding officer, after the petty officers and officers supervising your work have indicated that they consider you capable of performing the duties of the next higher rate.
5. Demonstrate your KNOWLEDGE by passing written examinations on (a) military/leadership requirements and (b) occupational qualifications.

Some of these general requirements may be modified in certain ways. Figure 1-1 gives a more detailed view of the requirements for advancement of active duty personnel; figure 1-2 gives this information for inactive duty personnel.

Remember that the requirements for advancement can change. Check with your division officer or training officer to be sure that you know the most recent requirements.

FACTORS AFFECTING ADVANCEMENT

As Radiomen advance or leave the Naval service vacancies occur at all levels of the rating. The number of persons advanced in each pay grade is determined by the vacancies that occur and the present manning level of the Navy.

Often there are more persons competing for advancement than there are billets to be filled. The selected personnel are separated from the non-selectees by a system which uses two factors to select the ones most qualified to assume the responsibility of the next higher pay grade:

WRITTEN EXAMINATION

A candidate selected for advancement has acquired a combined multiple score high enough to be above the cut-off level established by the Navy for his particular rating. The written examination which is administered locally but prepared for all rates by the Naval Examining Center can provide a maximum of 80 points towards the candidates combined multiple. The score on the written examination is determined (after processing) by the Naval Examining Center.

IN-SERVICE MULTIPLE

The second factor in determining the candidate's combined multiple is the computation of his in-service multiple. The in-service multiple is computated by the addition of several scores.

1. Performance Evaluations. A maximum of 50 points can be acquired by a candidate from his semi-annual evaluations. Assuming a potential candidate has marks of 4.0, in all categories, on his semi-annual evaluations he would be credited with 50 points. The candidates semi-annual marks are averaged to establish a general level of performance and he is then allowed points, up to 50, for his in-service performance.
2. Time in Service. The candidate is given one multiple point for each year of active Naval service up to a maximum of 20 points.
3. Time in Grade. The candidate is given two points multiple for each year in grade up to a maximum of 20 points.
4. Medals and Awards. A maximum of 15 points are given for awards and medals. The amount of points for each award or medal varies with the type.

The Naval Examining Center will combine all candidates in-service and examination

REQUIREMENTS *	E1 to E2	E2 to E3	#† E3 to E4	#E4 to E5	† E5 to E6	† E6 to E7	† E7 to E8	† E8 to E9
SERVICE	4 mos. service—or completion of	6 mos. as E-2.	6 mos. as E-3	12 mos. as E-4	24 mos. as E-5.	36 mos. as E-6. 8 years total enlisted service.	36 mos as E-7. 8 of 11 years total service must be enlisted.	24 mos. as E-8. 10 of 13 years total service must be enlisted.
SCHOOL	Recruit Training.		Class A for PR3, DT3, PT3, AME 3, HM 3, PN 3, FTB 3, MT 3.			Class B for AGC MUC, MNC. ††		
PRACTICAL FACTORS	Locally prepared check-offs.	Record of Practical Factors, NavPers 1414/1, must be completed for E-3 and all PO advancements.						
PERFORMANCE TEST			Specified ratings must complete applicable performance tests before taking examinations.					
ENLISTED PERFORMANCE EVALUATION	As used by CO when approving advancement.		Counts toward performance factor credit in advancement multiple.					
EXAMINATIONS **	Locally prepared tests.	See below.	Navy-wide examinations required for all PO advancements.				Navy-wide, selection board.	
RATE TRAINING MANUAL (INCLUDING MILITARY REQUIREMENTS)		Required for E-3 and all PO advancements unless waived because of school completion, but need not be repeated if identical course has already been completed. See NavPers 10052 (current edition).					Correspondence courses and recommended reading. See NavPers 10052 (current edition).	
AUTHORIZATION	Commanding Officer		Naval Examining Center					

* All advancements require commanding officer's recommendation.

† 1 year obligated service required for E-5 and E-6; 2 years for E-7, E-8 and E-9.

Military leadership exam required for E-4 and E-5.

** For E-2 to E-3, NAVEXAMCEN exams or locally prepared tests may be used.

†† Waived for qualified EOD personnel.

Figure 1-1—Active duty advancement requirements.

REQUIREMENTS *	E1 to E2	E2 to E3	E3 to E4	E4 to E5	E5 to E6	E6 to E7	E8	E9
TOTAL TIME IN GRADE	4 mos.	6 mos.	6 mos.	12 mos.	24 mos.	36 mos. with total 8 yrs service	36 mos. with total 11 yrs service	24 mos. with total 13 yrs service
TOTAL TRAINING DUTY IN GRADE †	14 days	14 days	14 days	14 days	28 days	42 days	42 days	28 days
PERFORMANCE TESTS			Specified ratings must complete applicable performance tests before taking examination.					
DRILL PARTICIPATION	Satisfactory participation as a member of a drill unit in accordance with BUPERSINST 5400.42 series.							
PRACTICAL FACTORS (INCLUDING MILITARY REQUIREMENTS)	Record of Practical Factors, NavPers 1414/1, must be completed for all advancements.							
RATE TRAINING MANUAL (INCLUDING MILITARY REQUIRE MENTS)	Completion of applicable course or courses must be entered in service record.							
EXAMINATION	Standard Exam		Standard Exam required for all PO Advancements. Also pass Military Leadership Exam for E-4 and E-5.				Standard Exam, Selection Board.	
AUTHORIZATION	Commanding Officer		Naval Examining Center					

* Recommendation by commanding officer required for all advancements.
† Active duty periods may be substituted for training duty.

Figure 1-2—Inactive duty advancement requirements.

scores to arrive at the combined multiple. The candidates that are selected for advancement to the next higher pay grade are those who have compiled the highest combined multiple.

The Manual for Advancement, NavPers 15989 will keep you up to date on the latest requirements for advancement.

HOW TO PREPARE FOR ADVANCEMENT

What must you do to prepare for advancement? You must study the qualifications for advancement, work on practical factors, study the required rate training manuals and other required material. You will need to be familiar with (1) the Quals Manual, (2) the Record of Practical Factors, NavPers 1414/1, and (3) a NavPers publication called Bibliography for Advancement Study, NavPers 10052. The following sections describe them and give you some practical suggestions on how to use them in preparing for advancement.

The Quals Manual

The Manual of Qualifications for Advancement, NavPers 18068 (with changes), gives the minimum requirements for advancement to each rate within each rating. This manual is usually called the "Quals Manual," and the qualifications themselves are often called "quals." The qualifications are of two general types: (1) military requirements, and (2) occupational qualifications.

MILITARY REQUIREMENTS apply to all ratings rather than to any one particular rating. Military requirements for advancement to third class and second class petty officer rates deal with military conduct, naval organization, military justice, security, watch standing, and other subjects which are required of petty officers in all ratings.

OCCUPATIONAL QUALIFICATIONS are requirements that are directly related to the work of each rating.

Both the military requirements and the occupational qualifications are divided into subject matter groups; then, within each subject matter group, they are divided into PRACTICAL FACTORS and KNOWLEDGE FACTORS. Practical factors are things you must be able to DO. Knowledge factors are things you must KNOW in order to perform the duties of your rating.

In most subject matter areas, you will find both practical factor and knowledge factor qualifications. In some subject matter areas, you may find only practical factors or knowledge factors. It is important to remember that there are some knowledge aspects to all practical factors, and some practical aspects to most knowledge factors. Therefore, even if the Quals Manual indicates that there are no knowledge factors for a given subject matter area, you may still expect to find examination questions dealing with the knowledge aspects of the practical factors listed in that subject matter area.

The written examination for advancement may contain questions relating to the practical factors and to the knowledge factors of both the military requirements and the professional qualifications. If you are working for advancement to second class, remember that you may be examined on third class qualifications as well as on second class qualifications.

You are required to pass a Navy-wide military/leadership examination for E-4 or E-5, as appropriate, before participating in the occupational examinations. The military/leadership examinations for both levels are given quarterly. Candidates are required to pass the applicable military/leadership examination only once. Each of these examinations consists of 100 questions based on information identified in the Manual of Qualifications for Advancement, NavPers 18068 and Bibliography for Advancement Study, NavPers 10052.

The Navy-wide occupational examinations for pay grades E-4 and E-5 contains 150 questions related to occupational areas of your rating.

The Quals Manual is kept current by means of changes. The occupational qualifications for your rating which are covered in this rate training manual were current at the time the course was printed. By the time you are studying this course, however, the quals for your rating may have been changed. Never trust any set of quals until you have checked it against an UP-TO-DATE copy in the Quals Manual.

Record of Practical Factors

Before you can take the servicewide examination for advancement, there must be an entry in your service record to show that you have qualified in the practical factors of both the military requirements and the occupational qualifications. A special form known as the RECORD OF PRACTICAL FACTORS, NavPers 1414/1 is used to keep a record of your practical factor qualifications. This form is available for each rating. The form lists all practical factors, both military and occupational. As you demonstrate your ability to perform each practical factor, appropriate entries are made in the DATE and INITIALS columns.

Changes are made periodically to the Manual of Qualifications for Advancement, and revised forms of NavPers 1414/1 are provided when necessary. Extra space is allowed on the Record of Practical Factors for entering additional practical factor as they are published in changes to the Quals Manual. The Record of Practical Factors also provides space for recording demonstrated proficiency in skills which are within the general scope of the rating but which are not identified as minimum qualifications for advancement.

If you are transferred before you qualify in all practical factors, the NavPers 1414/1 form should be forwarded with your service record to your next duty station. You can save yourself a lot of trouble by making sure that this form is actually inserted in your service record before you are transferred. If the form is not in your service record, you may be required to start all over again and requalify in the practical factors which have already been checked off.

NavPers 10052

Bibliography for Advancement Study, NavPers 10052 (revised), is a very important publication for anyone preparing for advancement. This bibliography lists required and recommended rate training manuals, correspondence courses, and other reference material to be used by personnel working for advancement. NavPers 10052 is revised and issued once each year by the Bureau of Naval Personnel. Each revised edition is identified by a letter following the NavPers number. When using this publication, be SURE that you have the most recent edition.

If extensive changes in qualifications occur in any rating between the annual revisions of NavPers 10052, a supplementary list of study material may be issued in the form of a BuPers Notice. When you are preparing for advancement, check to see whether changes have been made in the qualifications for your rating. If changes have been made, see if a BuPers Notice has been issued to supplement NavPers 10052 for your rating.

The required and recommended references are listed by rate level in NavPers 10052. If you are working for advancement to third class, study the material that is listed for third class. If you are working for advancement to second class, study the material that is listed for second class; but remember that you are also responsible for the references listed at the third class level.

In using NavPers 10052, you will notice that some courses are marked with an asterisk (*). Any course marked in this way is MANDATORY—that is, you must complete it at the indicated rate level before you can be eligible to take the servicewide examination for advancement. Each mandatory course may be complete by (1) passing the appropriate enlisted correspondence course that is based on the mandatory rate training manuals; (2) passing locally prepared tests based on the information given in the course; or (3) in some cases, successfully completing an appropriate Class A course.

Do not overlook the section of NavPers 10052 that lists the required and recommended references relating to the military requirements for advancement. Personnel of ALL ratings must complete the mandatory military requirements course for the appropriate rate level before they can be eligible to advance in rating.

The references in NavPers 10052 which are recommended but not mandatory should also be studied carefully. ALL references listed in NavPers 10052 may be used as source material for the written examination, at the appropriate rate levels.

Rate Training Manuals

There are two general types of Rate Training Manuals. RATING COURSES (such as this one) are prepared for most enlisted ratings. A rating training course gives information that is directly related to the occupational qualifications of ONE rating. SUBJECT MATTER COURSES or BASIC COURSES give information that applies to more than one rating, for example, Basic Electricity.

Rate Training Manuals are revised from time to time to keep them up to date technically. The revision of a Rate Training Manual is identified by a letter following the NavPers number. You can tell whether any particular copy of a training manual is the latest edition by checking the NavPers number and the letter following this number in the most recent edition of List of Training Manuals and Correspondence Courses, NavPers 10061. (NavPers 10061 is actually a catalog that lists all current training manual and correspondence courses; you will find this catalog useful in planning your study program.)

Rate Training Manuals are designed to help you prepare for advancement. The following suggestions may help you to make the best use of this course and other Navy training publications when you are preparing for advancement.

1. Study the military requirements and the occupational qualifications for your rating before you study the training manual and refer to the quals frequently as you study. Remember, you are studying in order to meet these quals so you can do your job.

2. Set up a regular study plan. It will probably be easier for you to stick to a schedule if you can plan to study at the same time each day. If possible, schedule your studying for a time of day when you will not have too many interruptions or distractions.

3. Before you begin to study any part of the training manual intensively, become familiar with the entire book. Read the preface and the table of contents. Check through the index. Look at the appendixes. Thumb through the book and look at the illustrations and reading bits here and there as you see things that interest you.

4. Look at the training manual in more detail, to see how it is organized. Look at the table of contents again. Then, chapter by chapter, read the introduction, the headings, and the subheadings. This will give you a pretty clear picture of the scope and content of the book. As you look through the book in this way, ask yourself some questions:

What do I need to learn about this?
What do I already know about this?
How is this information related to information given in other chapters?
How is this information related to the qualifications for advancement?

5. When you have a general idea of what is in the manual and how it is organized, fill in the details by intensive study. In each study period, try to cover a complete unit—it may be a chapter, a section of a chapter, or a subsection. The amount of material that you can cover at one time will vary. If you know the subject well, or if the material is easy, you can cover quite a lot at one time. Difficult or unfamiliar material will require more study time.

6. In studying any one unit—chapter, section, or subsection—write down the questions that occur to you. Many people find it helpful to make a written outline of the unit as they study, or at least to write down the most important ideas.

7. As you study, relate the information in the manual to the knowledge you already have. When you read about a process, a skill or a situation, try to see how this information ties in with your own past experience.

8. When you have finished studying a unit, take time out to see what you have learned. Look back over your notes and questions. Maybe some of your questions have been answered, but perhaps you still have some that are not answered. Without looking at the training course, write down the main ideas that you have gotten from studying this unit. Don't just quote the book. If you can't give these ideas in your own words, the chances are that you have not really mastered the information.

9. Use Enlisted Correspondence Courses whenever you can. The correspondence courses are based on Rate Training Manuals or on other appropriate texts. As mentioned before, completion of a mandatory course can be accomplished by passing an Enlisted Correspondence Course based on the Rate Training Manual. You will probably find it helpful to take other correspondence courses, as well as those based on mandatory training courses. Taking a correspondence course helps you to master the information given in the training course, and also helps you see how much you have learned.

10. Think of your future as you study. You are working for advancement to third class or second class right now, but someday you will be working toward higher rates. Anything extra that you can learn now will help you both now and later.

SOURCES OF INFORMATION

As you refer to your quals, you probably will discover certain areas in which you need more basic study. Consequently, you will need to obtain additional books. The most useful books for this purpose are those listed in the reading list in the front of this manual. These training courses serve three purposes: They give you much of the background you need to prepare for a technical rating; they offer a handy refresher course in subjects you may have forgotten; and they are useful throughout your Navy career as a handy reference library. The training courses are organized in such manner that they may be used with a minimum of supervision.

ENLISTED CLASSIFICATION CODES

As discussed earlier in this chapter, you may be required to perform some maintenance. Other than routine maintenance that is required on the job there are special skills in the Navy which are assigned a Navy Enlisted Classification (NEC) code. Depending upon the mission of your command, you may be called upon, or desire, to perform duties that require these specialized skills. Usually these skills are acquired by attending a Navy training school and followed by on-the-job qualification. Primary NEC's within the Radioman rating include:

Communications Systems
  Manager RM-2313
Communication System Technical
  Operator RM-2318
Communication System Technical
  Supervisor RM-2319
Cryptographic Machines
  Repairman RM-2314
Cryptographic Machines (Automatic Off-Line Equipment)
  Repairman RM-2315
Enlisted Frequency Manager RM-2301
High Speed Radio Operator RM-2303
Intermediate Radio Operator RM-2304
Low-Level Keying Teletype
  Repairman RM-2346
Radio Equipment (Submarine)
  Maintenanceman RM-2333
Radio Maintenanceman RM-2312
Satellite Communication Terminal
  Operator RM-2305
Special Fixed Communication
  System Operator RM-2393
Teletype Repairmen 2342-2345
    (AN/UGC-20/25) Repairman . . RM-2345
    Teletype (Mod 28, UGC-6 and
      UGC-20) Repairman RM-2342
Tropo-Scatter Equipment
  Operator RM-2393

A complete listing and explanation of all NECs is given in the Manual of Enlisted Classification, NavPers 15105 (series), which is updated semiannually.

No attempt is made in this training manual to discuss extensively any special skills that are covered by NECs.

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CHAPTER 2

NAVAL COMMUNICATIONS

Many of the skills you will develop as a Radioman require a thorough understanding of communication organization. The organization of Naval Communications is presented in this chapter as the foundation upon which your further study may build.

EARLY HISTORY

In the old days, before the wireless, or radio, poor communications often made naval warfare a matter of guesswork. The commander of a fleet could have trouble trying to figure out not only what the enemy was up to, but also where his own ships were and what they were doing.

Consider what happened when a French fleet slipped through a British blockading squadron off Toulon in 1798. Although the French were discovered and followed by two British observation frigates, Admiral Nelson did not receive news of the French escape until 8 weeks later. He then spent 30 days trying to find the enemy who, meanwhile, had put back into Toulon.

In the American Navy, one of the earliest records of a signal system was a set of simple maneuver and recognition signs issued in 1778. An improved system was worked out by Captain Thomas Truxtun in 1797. His system was based on 10 numeral flags from 0 to 9. Orders were relayed by numbers and combinations of numbers having meanings that could be looked up in a decode book.

During the Civil War, because many Federal officers joined the Confederate forces, Union signals had to be revised completely. The Bureau of Navigation, which took charge of naval communications in 1862, decided that the Navy should adopt the Army signal system. As a result, Army-style communications dominated Navy signaling until as late as 1892.

Semaphore came into the Navy in 1861, with a system of hand semaphoric signals somewhat similar to the present ones, but with a limited number of characters.

In 1864 two forerunners of the present-day flashing light system made their appearance. Under one system a lantern, ball, or similar object was exposed, or a flag was lowered and raised, in dit-dah patterns. In fog or mist, the same code could be used for a trumpet blown in long or short blasts. Under the other system a canvas cylinder, with a lantern inside, was secured to the rigging in a manner permitting the light to be exposed or screened by the pulling or releasing of a line attached to the cylinder.

Electricity came into naval communications in 1875, when experiments with electric lights were conducted. In 3 years the range of these lights increased from 6 miles to a distance of nearly 17 miles.

It was not until the "wireless" came along about 1895 that naval communications could begin to approach the rapidity and long range it has today. By 1903 radio equipment was operational throughout the United States Fleet. The state of the art has improved so rapidly in radio that it now is just as easy to send a message to fleets all over the world as it once was to pass the word to a single ship only a shout's range away.

The modern fleet or naval striking force travels faster, is distributed over much greater areas of ocean, and hits harder than any seagoing force in the past. This increased speed of operation by submarines, surface warships, and aircraft requires better and faster means of communications. To meet new requirements, the Navy's communication equipment and methods are changing as rapidly and radically as budgetary limits and operational commitments allow.

No matter how deep into hostile waters a force may penetrate, it never is out of touch with its base of operations. In support is a complex global organization of communication stations with hundreds of radio and landline circuits. Within the force itself are all types of visual and electronic communication facilities. Orders and information that affect the successful outcome of the force's mission are exchanged swiftly and accurately throughout every level of command. The effect is a tightly directed fighting unit—the direct result of reliable communications.

MISSION OF NAVAL COMMUNICATIONS

The mission of naval communications is to provide and maintain reliable, secure, and rapid communications, based on war requirements, in order to: meet the needs of naval command; facilitate naval administration; satisfy the Joint Chiefs of Staff (JCS) approved requirements in the Defense Communication System (DCS), as assigned, as well as the requirements of the National Communication System (NCS). FOR PRESIDENT & FED. GOV'T.

POLICY OF NAVAL COMMUNICATIONS

The policy of naval communications is to:

1. Establish and maintain effective communications within the Department of the Navy.
2. Encourage at all levels of command an effort to improve techniques, procedures, and efficiency.
3. Cooperate with the military services Defense Communication Agency (DCA), and other departments and agencies of the U.S. Government and Allied nations.
4. Encourage development of the amateur and commercial communication activities of the U.S. to enhance their military value and to safeguard the interest of the nation.
5. Maintain facilities for adequate communications with the U.S. Merchant Marine, aircraft over the sea, and appropriate U.S. and foreign communication stations, in order to promote the safety of life at sea and in the air.

COMMUNICATION PRINCIPLES

Naval communications must always be ready to meet wartime requirements. Its peacetime organization, methods, procedures, facilities, and training must be adequate and capable of shifting to an emergency or war status with a minimum of changes.

Through the years naval communications has been guided by certain principles that have been proved under war conditions. Foremost among these principles are reliability, security, and speed.

Reliability of communications is always the first requirement. A message must say exactly what the originator means it to say; it must be sent by the best method of communications available; and it must be complete and accurate in every way when finally placed in the hands of the addressee. Reliability cannot be sacrificed to meet conflicting demands of security and speed, or for more convenience. A variable relationship between security and speed exists, however. Modern operating procedures permit security with speed, but sometimes one must be stressed more than the other. In the planning stages of an operation, secrecy must be preserved at all costs, hence security is more important than speed. During a critical moment in combat, however, very urgent messages may be sent in plain language, by command authorities instead of being delayed for encryption and decryption. Here, security is sacrificed for speed, although security may never be disregarded entirely.

TELECOMMUNICATIONS

The word telecommunications refers to communications over a distance. Several methods of telecommunications are used by the Navy. Of these methods at least two teletype and radiotelephone concern the Radiomen as operators. In message handling duties afloat and ashore you also will work with traffic sent by other methods, as listed here.

1. Electrical communications:
   a. Radiotelegraph
   b. Teletype (wire or radio)
   c. Radiotelephone
2. Visual communications
   a. Flaghoist
   b. Flashing light
   c. Semaphore
3. Sound Communications
   a. Whistles, sirens, and bells
   b. Sonar

ELECTRICAL COMMUNICATIONS

Of the various means of transmitting messages, electrical communications is by far the most important to the communicator. A brief description of the listed methods of electrical communications follows.

Radiotelegraph

Radiotelegraph (often referred to as CW for "Continuous-wave" telegraphy) is a system for transmitting messages by radio waves. In this system an operator separates a radio wave into dits and dahs of Morse code by opening and closing a hand key. Radiotelegraph, despite development of faster and more convenient methods of electronic communications, is still in use today; however, its use has been reduced to the point that the Navy no longer trains all Radiomen to be proficient in it. Only those trainees that have high aptitude and show personal interest are trained as CW operators. After the CW operators are trained they are designated as having a special skill with limited requirements and are assigned NEC 2304 to identify them for assignment purposes. Since CW operation is no longer a requirement of all Radiomen, this book will not discuss it further.

Teletype

The mental and manual actions performed by an operator in converting letters to Morse code (and vice versa) are replaced in teletype by electrical and mechanical actions. To transmit a message, the operator types on a keyboard similar to that on a typewriter. As each key is pressed, a sequence of signals are fed into receiving machines that type the message automatically.

Teletype signals may be sent either by landline (wire) or by radio. Teletype communication is used both by the military services and by commercial communication companies such as Western Union.

Today the primary shipboard use of radioteletype (RATT) is for receiving fleet broadcast schedules, for which it is well suited. Radioteletype can clear traffic on many channels at a rate of 100 wpm (words per minute) as compared to the 17 to 29 wpm speed of CW fleet broadcasts. Because a shipboard operator is freed from manual copying, and hundreds of ships may be receiving a single broadcast, the total saving in trained manpower is great.

Other shipboard uses of RATT are for communications between ships and between ships and shore communication stations.

SINGLE SIDEBAND TRANSMISSION

Single-sideband (SSB) transmission is the most common communications link used today. It is being applied to many voice circuits that previously operated on amplitude modulation. Many UHF circuits are expected to utilize SSB in the near future.

SSB Voice Circuits

The high command net (HICOM) uses SSB as a means of communication between fleet commanders, and fleet commanders use it for communication with their subordinates and adjacent commands.

Whenever special voice circuits are necessary, either between shore activities or ships and shore activities, SSB is selected because it is less susceptible to atmospheric interference than is amplitude modulation. Often, SSB is used for voice order-wire circuits between NAVCOMMSTAS.

SSB Teletype Circuits

With few exceptions, SSB is used on all existing long-haul (great distance) teletype circuits. It is also used on ship-shore circuits, as well as on ship-ship teletype circuits. Most of these systems are now covered circuits; that is, an electronic cryptodevice on both ends of the circuit automatically encrypts and decrypts message traffic. These devices are used on point-to-point, ship-shore, ship-ship, and broadcast circuits.

SHIP-SHIP SSB TELETYPE CIRCUITS

Ship-to-ship SSB teletype circuits are in wide use today. Their main application is with task force or task group nets or several ships in company. By using this type of net, ships can send their outgoing messages to a guardship from which traffic can be relayed ashore. This procedure saves manpower, and circuit time, prevents individual ships from overcrowding ship-shore circuits, and conserves the frequency spectrum. Depending on the number and types of ships in company, the guard can be shifted to other ships from time to time. A major advantage of these circuits is that electronic cryptodevices can be used to send classified messages without the need for manual encryption. These circuits are used for incoming as well as outgoing traffic, and they can use either HF (high frequency) or UHF (ultra high frequency) signals.

SHIP-SHORE SSB TELETYPE CIRCUITS

Many ships handle enough message traffic to justify ship-shore teletype circuits. Depending on traffic load, these circuits can be from one to four teletype channels on one SSB circuit. If the traffic load warrants more than one teletype channel, usually time division multiplex or frequency division multiplex (MUX) equipment is used. This equipment handles up to four incoming and four outgoing channels. One channel normally is used as an order-wire circuit for handling operator-to-operator service messages and for making frequency changes when necessary. Three remaining channels are available for handling official message traffic.

POINT-TO-POINT TELETYPE CIRCUITS

Most point-to-point long-haul circuits between naval communication stations need more channels than SSB can provide. To compensate for the deficiency, independent sideband (ISB) transmission is used. It is similar to SSB. But where SSB suppresses the carrier and filters out a sideband, in ISB only the carrier is suppressed. Both sidebands are used, and are split into two 3-kHz audio channels, as shown in figure 2-1. Each audio channel may carry different intelligence.

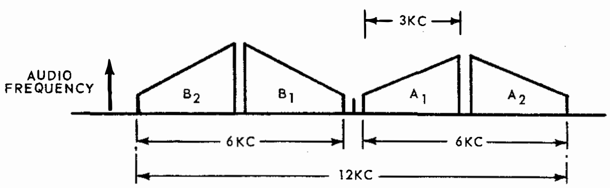

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Figure 2-1.—ISB channel and frequency bandwidth.

The use of frequency division multiplex equipment permits 16 teletype channels to be put into each of the 3-kHz audio channels, giving a possible total of 64 teletype channels on one ISB circuit. Usually, only one or two audio channels are used for teletype. Other channels are available for voice and/or facsimile, depending on the needs of participating stations.

Radiotelephone

Radiotelephone is one of the most useful military communication methods. Because of its directness, convenience, and ease of operation, radiotelephone is used by ships, aircraft, and shore stations for ship-to-shore, shore-to-ship, ship-to-ship, air-to-ship, ship-to-air, and air-to-ground communications. The single sideband (SSB) mode of operation makes it possible to communicate half way around the world by radiotelephone. One of the most important uses of radiotelephone is short-range tactical communications. Its capability of transmitting voice signals enables a conning officer to talk directly with the officer in tactical command (OTC) and with other ships. Little delay results while a message is prepared for transmission, and acknowledgments can be returned instantly. Radiotelephone equipment for tactical use usually is operated on frequencies that are high enough to have line-of-sight characteristics; that is the waves do not follow the curvature of the earth. These characteristics limit the usual range of radiotelephone from 20 to 25 miles. Radiotelephone procedure can be learned easily by persons with no other training in communications.

Radiotelephone also has disadvantages. Transmissions may be unreadable because of static, enemy interference, or high local noise level caused by shouts, gunfire, and bomb or shell bursts. Wave propagation characteristics of radiotelephone frequencies sometimes are freakish, and transmissions may be heard from great distances. Most radiotelephone messages are in plain language, and if information is to be kept from the enemy, users must keep their messages short, stick to proper procedures, and be careful of what they say.

MICROWAVE TRANSMISSION

Microwave is a line-of-sight radio transmission system. Line-of-sight systems are made up of one or more links having a clear path between antennas at the ends of a link. Usually frequencies used are above 900 mHz. In the Naval Communication System, the FRC-37 and the UQ equipments have been replaced with the FRC-84. The FRC-84 operates on the frequency division method with a normal capacity of 120 channels; up to 600 channels can be provided with proper system alignment.

At frequencies above 900 mHz, wavelengths become short, and propagation of the r-f energy becomes remarkably similar to that of light energy. It thus is practicable at microwave frequencies to use high-gain antennas that resemble reflectors used in searchlights. These antennas concentrate energy into a narrow beam in the same manner as light energy. With the beam directed in the desired direction, a much larger signal arrives at the receiving antenna than would come from a nondirectional antenna. Figure 10-3 depicts a parabolic antenna that is used for transmission and reception of microwave electromagnetic energy.

Terrain determines the length of a single link. In actual practice, transmit and receive antennas can be separated by a slightly greater distance than the actual horizon-to-horizon line-of-sight distance due to refraction of the microwave beam by the atmosphere. Most systems are composed of links of 30 miles or less, except where especially favorable sites can be found. Repeater stations may be used to connect one link to another to form long chains, thereby setting up long paths for many voice channels where needed. Chains of more than 40 links, for example, cross the United States carrying voice, teletype, and television signals.

Microwave links are often used for carrying signals from a portion of a Naval Communication Station to another, for example, from and to the transmitter and receiver sites to the main station.

Microwave radio link systems have the advantage of great flexibility, economy of operation, and almost complete independence over weather conditions. They have excellent reliability (over 99 percent), extremely wide information-carrying bandwidth, good resistance to interference, and low power requirements. Limitations are that they require a relatively large portion of the frequency spectrum and are effective at only a short range.

Usually microwave radio is used where large channel capacity is required, links are relatively short, and where it is difficult or costly to install cable.

SCATTER TRANSMISSION

In scatter transmission, a signal is beamed at the ionosphere where it is scattered in a forward direction. A receiving antenna is beamed at the same point in space to receive the signal. Because of its limited bandwidth, relatively high-power requirements, and crowded HF spectrum, this system is not used extensively.

Two types of scatter systems that have been used are ionospheric and tropospheric. Because of greater capacity and reliability, only the tropospheric system is now being used.

Forward propagation scatter transmission is a point-to-point method of HF or UHF radio communications. It permits reliable multichannel telephone, teletype, and data transmission to a range of 400 miles.

Forward Propagation Tropospheric Scatter (FPTS)

Numerous communication networks now in operation, extending for thousands of miles, utilize tropospheric terminals for hops of 300 miles or more. These relay hops are accomplished by the use of both transmitting and receiving equipment at each terminal. At the initial transmitting point, many separate telephone conversations and teletype circuits are combined into a single radio signal. A feedhorn on a tower beams the signal out toward the horizon; it is similar to a huge, precisely aimed searchlight. A minute reflected portion of the signal is picked up by a parabolic receiving antenna well over the horizon. There it is reamplified and sent on its way again, if necessary, for another leap over the horizon toward its destination at the other end of the circuit.

FPTS has many advantages over other methods of long-distance communications. Besides greater economy in areas where construction and maintenance present problems, it is relatively free of atmospheric interferences that affect other transmission methods.

Tropospheric scatter transmission operates in the UHF band, using f-m (frequency-modulated) transmission. The troposphere is the lowest area of the atmosphere, extending from the ground to a height of approximately 6 miles. Above this area are the stratosphere and the ionosphere.

Almost all weather phenomena occur in the tropospheric area. The troposphere itself is made of various layers similar to the entire atmosphere. The layers within the troposphere are sharply defined; they differ in temperature and moisture content. Because these layers are shifting constantly, the refractive index for any one area of the troposphere changes. Boundaries between layers act as reflecting surfaces. The present theory is that the phenomenon of refraction and reflection within the troposphere makes possible the scatter system of transmission. Part of a radio signal beamed upward through the troposphere goes through a complex series of partial refractionand reflection, causing most of the energy to be scattered in all directions and become partially diffused. Figure 2-2 shows how this refraction/reflection change might take place.

A receiving antenna, beamed at the same point in the troposphere as the transmitting antenna, picks up enough transmitted energy to make it useful. For any particular transmitter power and a given antenna size, the average strength of the signal received depends on beam (scatter) angle, distance between stations, frequency used, and weather conditions at the midpoint of the radio path. See figure 10-13.

For optimum results, high-power transmitters are used; antennas range in size from 8 feet in diameter for mobile use to 120 feet for fixed installations. Output power, size of antenna, and frequency used depend on the type of circuit desired.

Scatter angle influences the amount of received signal. Better reception is obtained when scatter angle is kept to a minimum. The takeoff angle of transmitter and receiver antennas is made as low as permissible by local terrain and general geographical location.

The received signal of scattered energy varies extensively, causing conditions of fast and slow fading. Fast fading, caused by multipath transmission, exists for short intervals. Slow fading usually extends over several hours and is brought about by changes in refractive properties of the troposphere. Seasonal variation in signal strength also is experienced. Received signal level is lower during the worst month of the winter season, and higher during the best month of the summer season. Communication paths in tropical or temperate zones are somewhat better in yearly average signal level than are paths in higher latitudes.

To obtain a steady signal, energy combined from a number of fluctuating signals is used in a diversity system. Some or all of the following methods are used to obtain a steady signal over different paths that fade and vary independently.

- Space diversity: Several receiving antennas are used. They are separated by 50 wavelengths or more at the signal frequency. (Usually a separation of 200-feet is sufficient.)

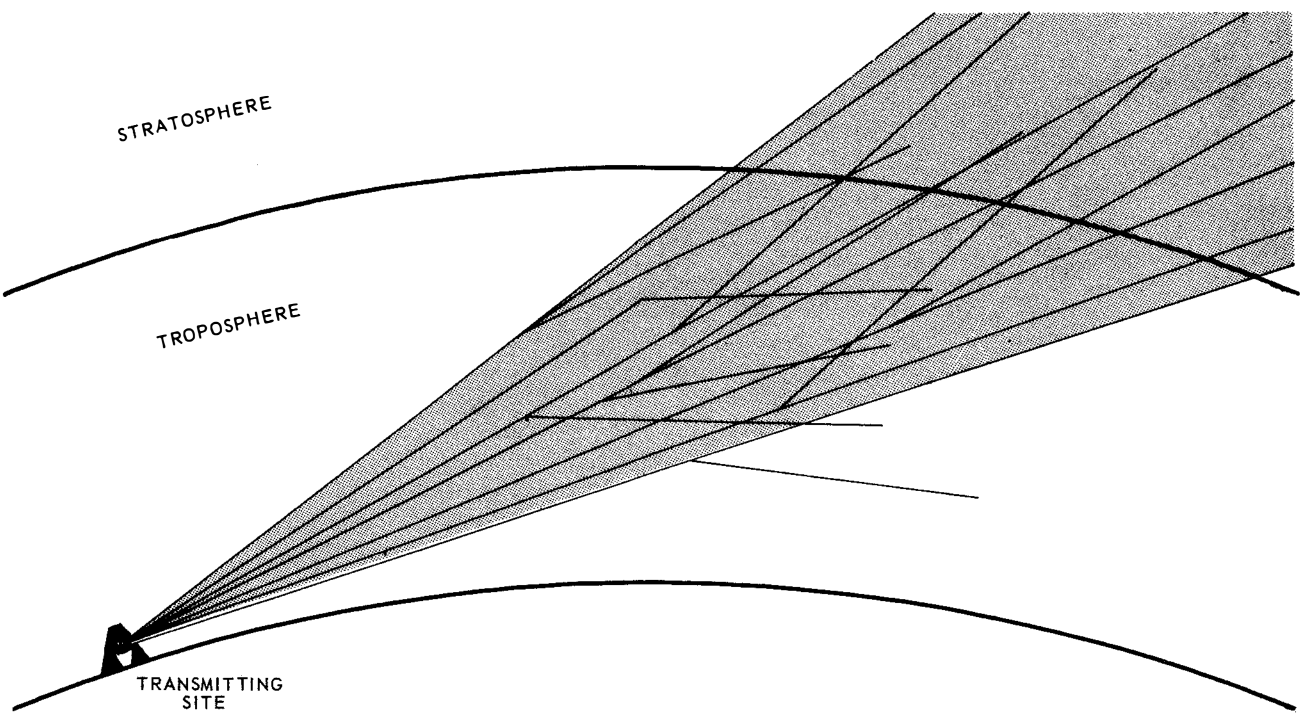

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Figure 2-2.—Scattered radio signal-shaded area is a beamed signal. Lines within the beam show a simplified idea of how the signal is partially refracted and reflected.

- Frequency diversity: Transmission on different frequencies fades independently, even when transmitted and received through the same antennas.
- Angle diversity: Two feedhorns produce two beams from the same reflector at slightly different angles. This arrangement results in two paths based on illuminating different scatter volumes in the troposphere.

The number of channels that can be transmitted over a given link depends on the degree of distortion the particular circuit can accept. For links that are part of long-haul telephone systems, distortion must be held to a minimum. Typical tropospheric scatter link capacities are given in the accompanying list.

Distance	No. voice channels
0-100 miles	to 252
100-200 miles	to 132
200-300 miles	to 72
over 300 miles	12-24 (quality usually limited)

VISUAL COMMUNICATIONS

Visual communication systems have been in use since the beginning of the Navy, and still are widely used for communicating at short range. In reliability and convenience, they are the equal of radio and more secure.

The types of visual systems are flaghoist, flashing light, and semaphore.

Flaghoist

Flaghoist is a method whereby various combinations of brightly colored flags and pennants are hoisted to send messages. It is the principal means for transmitting brief tactical and informational signals to surface units. Signals are repeated by addressees, thus providing a sure check on accuracy of reception. Texts of messages that may be sent usually are limited to those contained in signal books.

Flashing Light

Flashing light is a visual telegraphic system that utilizes either visible or infrared (Nancy) light beams, and it may be directional or nondirectional.

Directional flashing light may be pointed and trained so as to be visible only from the viewpoint of the recipient. It makes use of signal searchlights on which an operator opens and closes the shutter to form dots and dashes of Morse code. Smaller portable lights, in which the source of light is switched on and off to form code characters, are used also.

Nondirectional flashing light is sent out from lamps located on a yardarm. An operator forms dots and dashes with a telegraph key that switches the lamps on and off. Because the light is visible in every direction away from the ship, this method is well suited for messages destined for several addressees.

In wartime, flashing light communication that must be carried on after dark is usually conducted by means of infrared beams (Nancy). These beams are not visible unless viewed through a special receiver. Infrared is the most secure means of visual communications, and transmissions may be either directional or nondirectional. Directional infrared utilizes standard signal searchlights fitted with special filters. Infrared yardarm blinker lamps are used for nondirectional signaling.

Semaphore

Semaphore is a communication medium by which an operator signals with two hand flags, moving his arms through various positions to represent letters, numerals, and other special signs. Because of its speed, it is still widely used at short range during daylight. It is not readable much farther than 2 miles, even on a clear day.

SOUND COMMUNICATIONS

Sound systems include whistles, sirens, bells, and sonar. The first three devices are used by ships for transmitting emergency warning signals such as air raid alerts, for navigational signals prescribed by the Rules of the Road, and, in wartime, for communication between ships in convoy.

Ships equipped with sonar (underwater sound) apparatus may communicate with other ships by this method, although passing of messages is not the chief purpose of sonar. At times underwater sound is used for coordinating exercises between surface vessels and submarines.

Generally the underwater sound system "Gertrude" is used for morse code and voice communications while the main sonar can be used as a backup for morse code.

Sound systems normally have the same range limitation as visual methods but are considered less secure.

ELEMENTS OF NAVAL COMMUNICATIONS

Naval communications is comprised of three major elements which coordinate the operating elements. The three major elements are:

1. Office of Naval Communications—Assistant Chief of Naval Operations, Communications and Cryptology.
2. Commander, Naval Communications Command (COMNAVCOMM).
3. Commander, Naval Security Group Command, two are discussed here.

ASSISTANT CHIEF OF NAVAL OPERATIONS (COMMUNICATIONS AND CRYPTOLOGY)

The Commander, Naval Communications Command (COMNAVCOM), assists the Chief of Naval Operations (CNO) in matters pertaining to communications by filling the billet of Assistant Chief of Naval Operations, Communications and Cryptology.

Supporting the Commander, Naval Communications Command in the exercise of his authority and in the discharge of his various duties, is the Headquarters, Naval Communications Command. The headquarters is organized into various functional departments. Each department is headed by an Assistant Commander. In addition, Special Assistants are under the direct supervision of the Deputy Assistant Commander and Deputy Commander. The COMNAVCOMM Headquarters organization is shown in figure 2-3.

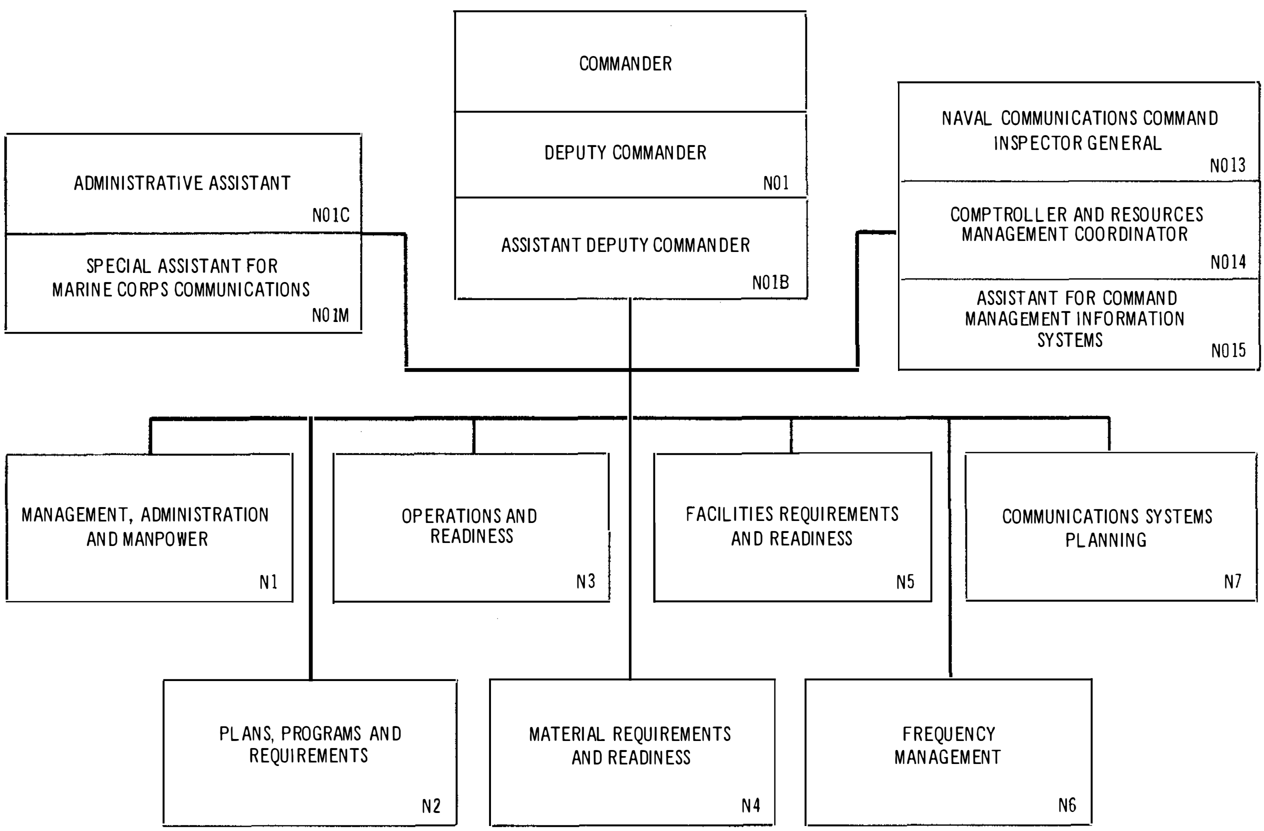

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Figure 2-3.—COMNAVCOM Headquarters Organization.

Mission

The mission of the Commander Naval Communications Command is to:

- Exercise authority over the readiness, operating efficiency, and security of naval communications throughout the Department of the Navy;
- Provide, operate, and maintain adequate and secure naval communications;
- Approve requirements for the use of existing communication capabilities and resources;
- Coordinate the execution of approved communication programs;
- Administer and coordinate radio frequency matters;
- Exercise command authority over, and be responsible for the primary support of, the field activities of the Naval Communication System, and such other activities and resources as may be assigned.

THE NAVAL COMMUNICATIONS COMMAND HEADQUARTERS

The tasks and functions of the Naval Communications Command Headquarters are many and varied. The Headquarters acts as advisor and assistant to the Commander Naval Communications Command in all areas of Naval Communications. Some of the assigned tasks and functions are as follows:

1. Participate in joint action matters in support of CNO. Review concepts, policy, doctrine, methods, procedures, standardization, and compatibility of Joint and Combined agreements on communications and radio frequency spectrum matters, and recommend provisions to obtain maximum effectiveness of forces.
2. Develop, implement, and provide for the procurement, distribution, and installation of communications systems and equipments to ensure that Fleet units and shore activities are capable of satisfying validated communications operating requirements.
3. Provide for the procurement, protection, and assignment of radio frequencies required for all electronic devices of the Department of the Navy, and ensure maximum feasible compatibility of these devices within the Department of the Navy and with other users of the radio frequency spectrum.
4. Plan for and determine the current and future (including long-range) requirements of Naval Communications for manpower, material, facilities, and services, including the quantities, characteristics, times, places, and priorities of need.
5. Provide information to and keep COMNAVSECGRU (Commander, Naval Security Group Command) advised of the cryptographic equipment requirements for all Naval activities) less Cryptologic activities).
6. Advise COMNAVSECGRU, when appropriate, of the operational acceptability of communications security measures which substantially impact on Naval Communications.
7. Provide for the continuous review of concepts; methods, and procedures, standards, compatibility, and security aspects of intra-Navy, Joint, and Combined doctrine and policy on communications and radio frequency matters.
8. Provide for the continuous review, analysis, and promulgation of radio call signs and address groups in conjunction with the other military services.
9. Provide for the continuous monitor, review, and analysis of allowance, printing, and distribution of such communications publications as may be assigned U.S. Navy cognizance in whole or in part by the Navy Department and/or JCS (Joint Chiefs of Staff).
10. Plan, coordinate, and conduct command inspections and investigations of shore (field) activities of the Naval Communications Command to assess the readiness level of the ability of each activity to accomplish its mission and perform its assigned tasks and functions.
11. Program and provide communications support to satisfy the communications operating requirements (less tactical/mobile) of MARCORPS shore (field) activities and major Fleet Marine Force Commands based ashore as are designated by Commandant, Marine Corps.
12. Provide assistance to Fleet Commander in Chiefs, commands bureaus and offices of the Department of the Navy, and other commands and activities as appropriate in matters relating to communications service and support to the Operating Forces and the Shore Establishment.
13. Sponsor, organize, administer, and support the Naval Reserve Naval Communications System program.
14. Plan and provide for wartime communications needs of the U.S. Merchant Marine, Allied, MSTS-operated shipping and other

friendly forces in accordance with approved plans and agreements.

15. Furnish aids to mariners by arranging for the transmission of time signals, meteorological reports, destructive storm warnings, hydrographic and oceanographic forecasts and chart information, sudden ionospheric disturbance warnings, and other environmental scientific information; provide for the handling of commercial communications which are authorized by law or treaty.

16. Provide advice and assistance to the Chief of Naval Personnel (Navy Training Authority) in matters pertaining to communications training programs. Advise as to the adequacy of communications training and corrective actions required in the areas of concept, scope, procedures, curricula, training media, training plans, and preparation for the introduction of new communications equipment into the Navy, afloat and ashore.

NAVAL OPERATING ELEMENTS

1. Communication departments of shore (field) activities
2. Communication organizations of operating forces
3. Naval Communication System

COMMUNICATION DEPARTMENTS OF SHORE ESTABLISHMENT ACTIVITIES

Communication departments of shore establishment activities are components of the station or activity they serve. Their mission differs from that of NAVCOMMSTAs and other activities of the Naval Communication System in that, primarily, they furnish local support to the shore station mission. They disseminate information and convey reports and similar data to their own local command, although they may (and often do) work into or connect with the worldwide network of the Defense Communication System (DCS).

Normally, the communication department of a shore activity has a small communication center consisting of a message center and cryptocenter. It may also provide other facilities, depending on the mission of the command it supports. Where radio transmitting and receiving facilities are required, small communication centers usually use equipment installed at radio transmitting and receiving sites of a NAVCOMMSTA and remotely control them from the communication center.

In the interest of economy and effective utilization of resources, communication departments ashore are consolidated under the naval communication station wherever feasible.

COMMUNICATION ORGANIZATIONS OF OPERATING FORCES

In the operating forces, communications is the "voice of command." The communication organization aboard ship is under the direct and positive control of the commanding officer. It provides communication services needed to control and employ fleet units. These services include sending and receiving orders, instructions, reports, and various other forms of intelligence. Facilities are provided for rapid ship-shore and air-surface communications as well as for communications between ships.

NAVAL COMMUNICATION SYSTEM

The Naval Communication System, as part of the Defense Communications System (DCS), may be described as the backbone of naval communications. It is a fixed, integrated communication network, which forms the worldwide framework of naval communications. It provides the means for transmission of CNO directives and instructions; broadcast to the fleet of weather, general messages, orders, and similar message traffic; and for reception of essential intelligence from fleet commanders.

ORGANIZATION COMPONENTS

Three major types of activities make up the Naval Communication System. These activities are NACOMMSTAs, NAVRADSTAs, and NAVCOMMUs. Organizational components of the Naval Communication System—as activities of the system—manage, operate, and maintain the facilities, systems, equipment, and devices necessary to provide communications for the command, operational control, and administration of the Navy.

Naval Communication Station

As its name implies, a naval communication station (NAVCOMMSTA) is a naval station that has a primary responsibility for communications. It includes all communication facilities and equipment required to provide essential fleet support and fixed communication services for a specific area.

U.S. Naval Radio Station

A naval radio station (NAVRADSTA) ordinarily is a component of a NAVCOMMSTA but may be located physically some distance from the NAVCOMMSTA. It is classified as either a transmitting station or a receiving station, depending upon the function performed, and is so designated by letter T or R added in parentheses. For example, NAVRADSTA (T) Lualualei, Oahu, is a component of NAVCOMMSTA Honolulu, Hawaii, but is located approximately 15 miles from the NAVCOMMSTA.

U.S. Naval Communication Unit

Naval communication units (NAVCOMMUs) are assigned limited or specialised missions, which may include some but not all missions assigned a NAVCOMMSTA. For this reason, a NAVCOMMU is much smaller in terms of personnel and facilities than is a NAVCOMMSTA. The NAVCOMMUs are identified by geographical location; e.g., NAVCOMMU LONDON.

Follow-The-Fleet Concept

The follow-the-fleet concept was organized so that fleet and force commanders will have optimum communications no matter where they operate. Within this concept the commander will have complete control over his forces even when operational and tactical situations are continually changing.

Stations within a given geographical area are organized to operate on a closely coordinated basis under direction of a master station. An area served collectively by each group of stations is known as a Naval Communication Area (NAVCOMMAREA). The master station exercises coordination control of all Naval Communication System fleet broadcast, ship-shore, air-ground, and other tactical circuits within the NAVCOMMAREA. It is known as the Naval Communication Area Master Station (NAVCAMS). Other stations within a NAVCOMMAREA are called Naval Communication Area Local Stations (NAVCALS). They coordinate control of communications under direction of the NAVCAMS.

Operational Components

Facilities provided by the NAVCOMMSTA, transmitting, and receiving stations are operated by a communication center (COMMCEN). The COMMCEN controls the use of these facilities by connecting them to various circuits used by Naval Communications and provides a connecting link for users of these circuits. It ensures a continuous path by constantly monitoring the circuits and provides for alternate paths when necessary. Normally each COMMCEN consists of several components.

TECHNICAL CONTROL FACILITY.—Essentially the control facility is the master switchboard and monitoring station. All equipment of the communication center is wired through switchboards and patching panels of the control center. From the control center landlines branch out to other communication spaces. Landline or radio links lead to remotely located transmitting and receiving stations serving the communication center. Technical control facility personnel connect radio and landline circuits to appropriate equipment in other spaces of the COMMCEN. The technical control facility contains control and terminal equipment and built-in monitoring and test equipment. It ties together, electronically, all spaces of the communication center, and is the electrical outlet from that communication center to other communication centers.

CRYPTOCENTER.—A cryptocenter provides the following services: (1) receives and off-line encrypts messages and routes to message center for rapid transmission, or transmits to relay center directly; (2) receives and off-line decrypts messages and makes delivery to addressees; (3) receives and transmits messages on circuits authorized for on-line transmission of Top Secret messages without previous off-line encryption; and (4) operates the Top Secret message processing area.

FLEET CENTER.—A fleet center exercises keying control of all circuits to and from forces afloat. It is the point of interface between naval operating forces afloat and ashore served via Navy tactical or dedicated systems and naval shore (field) activities served via common user facilities of the Defense Communications System (DCS).

The fleet center operates maritime and aeronautical distress and assigned maritime public service circuits, provides specialized message processing service as required for an effective interface of the several communication systems terminated. This service includes but is not limited to—

1. Ensuring message procedural compatibility and formating as required (e.g., codress/plaindress).
2. Conversion between modes, such as CW to TTY and vice versa.
3. Call sign encryption and decryption as required.
4. Off-line encryption as required.

Functionally, fleet centers are subdivided into several smaller centers, a description of which follows.

Tactical communication coordination center: It operates either a NAVCAM or NAVCAL (mentioned earlier). Further information can be found in the current version of OpNavInst 02000.28.

- Automatic tactical routing and distribution unit: All covered broadcast, ship-shore circuits, and other Navy special-purpose operational networks terminate in this section of a COMMCEN.
- Message center: A message center is the converging point of all messages sent or received by the command it serves. In the message center, messages are logged, placed in proper form for transmission, checked for accuracy and security violations, serviced as necessary, written up, distributed internally, and filed in appropriate reference files. A message center operates circuits with a relay station for reception or transmission of these messages.
- Unclassified communication unit (wire room): A wire room operates radio or landline circuits that are not cryptographically protected. Included are circuits to commercial communication companies, circuits to other Government agencies, fleet and general broadcasts, certain ship-shore circuits, and off-net local circuits.
- Graphics center: A graphics center operates equipment required for sending and receiving pictures, photographs, weather maps, charts, and other material in graphic form. Facsimile traffic is processed in message centers along with regular messages.
- Conference center: A conference center is used for conferences between major commands ashore and afloat when need arises. These conferences may be by teletype, voice radio, or the DCS automatic voice network (Autovon).

RELAY CENTER.—A relay center is the communication center's linkage with DCS common user networks. It contains automatic or semiautomatic teletype tape receiving, tape transmitting, and message numbering and monitoring equipment. A relay center also maintains a service section for the purpose of obtaining and making retransmissions, correcting tapes, handling misroutes, and performing other services necessary for final and accurate delivery of messages. A file of monitor tapes is maintained for an appropriate period of time.

DEFENSE COMMUNICATIONS SYSTEM

The Defense Communications Agency (DCA) exercises operational and management direction over the DCS. The DCA consists of a director (an officer of general or flag rank), a headquarters staff, and such other units as are specifically assigned the Agency by the Secretary of Defense or the Joint Chiefs of Staff.

The DCS includes all Department of Defense circuits, terminals, control facilities, and tributaries (regardless of military department to which assigned) required to provide communications from the President, down the chain of command, to the fixed headquarters of various subordinate commands. This broad inclusion takes in all point-to-point, long-haul Government-owned or -leased circuits that are a part of the Naval Communication System. Fleet broadcasts, ship-to-shore, ship-to-ship, and tactical circuits within a tactical organization normally are excluded from the DCS.

DCS AUTOMATIC VOICE NETWORK

The DCS automatic voice network (Autovon) offers rapid, direct interconnection of Department of Defense and certain other Government installations. Numerous overseas areas are now connected into the continental United States (CONUS) automatic system. As facilities become available, other overseas areas will be connected. The Autovon is intended to be a single, worldwide, general-purpose, direct dialing system. Its goal is to complete connections between two prearranged points, anywhere in the world, in about 2 seconds, and to complete regular connections with pushbutton speed. It is planned eventually to switch every type of information transfer, including voice transmission, teletype, and data.

Several installations, comparable in function to commercial telephone exchanges, constitute the Autovon system. An installation in the system is referred to as an Autovon switch, or simply a switch. Within individual areas are local command, control, and administrative voice communication systems. These systems can be connected into the worldwide Autovon through manually operated telephone switchboards, or automatic dial exchanges, by provision of direct in or out dialing capabilities.

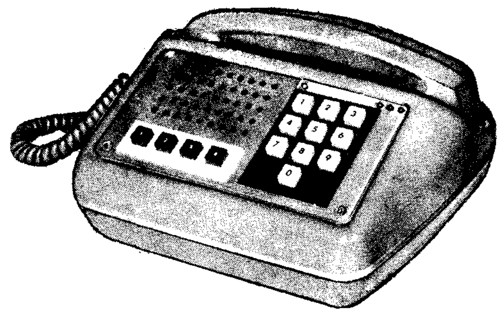
A naval station telephone system may be connected into the Autovon by its local private branch exchange (PBX) or private automatic branch exchange (PABX). In this usage the PBX or PABX would be considered the Autovon subscriber. Some offices and facilitates that have direct access to the Autovon system are considered individual Autovon subscribers.

Normal Service

Normal Autovon service provides a capability for subscribers to call other subscribers on a worldwide basis for day-to-day nonpreemptive traffic. Depending on the type of service available in each locality, Autovon calls may be accomplished either by direct dialing or through a local operator. Where users of this type of service require priority calls to be made, they must place the call with their local operator or the Autovon dial service assistance (DSA) operator.

Most military installations are provided connection into the general-purpose Autovon through their local PBX or PABX. These local systems are two-wire systems. Inasmuch as autovon is a four-wire system, its terminal equipment must also be four-wire. Where such terminal equipment as two-wire local switchboards are to be interconnected, four-wire/two-wire conversion equipment is used.

Besides general-purpose Autovon service through local PBX, certain selected subscribers are authorized direct four-wire access to the general-purpose network through pushbutton four-wire telephone sets (fig. 2-4) installed in their offices. These subscribers are furnished up to four classes of priority. Each level of priority can preempt any lower levels. A four-wire subscriber may employ any level of precedence he desires up to and including the highest level he is authorized. Precedence desired by a four-wire subscriber is selected by pushing one of four buttons on his set.



50.150X
Figure 2-4.—Type AE-023 four-wire subset.

DCS AUTOMATIC DIGITAL NETWORK

The DCS automatic digital network (Autodin) is a fully automatic digital data switching system. This network provides store-and-forward and circuit-switching message service to data and teletype subscriber terminals. It is capable of handling any type of information in digital form, including voice and graphics. The system consists of high-speed, electronic, solid state switching centers; various types of data and teletype subscriber terminals; and interconnecting transmission media.

The Autodin system replaces the 82B1 system in the continental United States (CONUS). Eventually it is planned to replace all manual and electromechanical relays overseas.

Administrative and logistic (operational) traffic from afloat units enter the Autodin system at Navy communication stations and units, which are provided direct access to the nearest Autodin switching center. Primary routes for Navy command and control traffic will continue to be through Navy dedicated circuits such as HiCom (teletype) ASC, Itinerant ship/shore Orestes, and the Full time termination.

When fully implemented, Autodin will afford instantaneous, error-free, and secure communications around the world to more than 4100 directly connected subscriber terminals. Automatic preemption will give immediate service to command and other top-priority users.

Daily capacity of the 19-switch Autodin system is 60 million data cards or an equivalent of 5 million average-length messages. Worldwide security is furnished by means of the link encryption concept explained in a later chapter.

Interconnection of Autodin switching centers is accomplished through a network of high-frequency radio channels, submarine cables, microwave and tropospheric channels, and a variety of wire lines. These transmission media are available from existing DCS transmission resources, Autovon, and from commercial communication facilities. At least one alternate route is held in reserve for each trunk. Activation of this alternate path is controlled from the Autodin supervisory position. All direct-current digital signals are converted to suitable analog signals by modulators-demodulators (MODEMS) before they are transmitted over interconnecting trunks.

Backbone of the Autodin system is the automatic switching center (ASC), which is self-supporting. It includes an automatic digital message switch, technical control facility, power generator and distribution equipment, a timing source, cryptographic and cryptoancillary equipment, and maintenance facilities. Basic functions of the AEC are to accept, store, and retransmit digital messages from one location to another, automatically detect and correct errors, and accomplish alternate routing. For locations requiring real-time service, CONUS switching centers provide automatic circuit switching (direct user-to-user) service.

Each switching center has a high degree of reliability resulting from duplicate major units, which can be activated with a minimum of disrupted service. A standby communication data processor is supplied at each center and is automatically tested for on-line use at regular intervals.

Once a message is accepted in the ASO, which automatically checks for valid control characters, probability of a message not being switched to its proper terminal is 1 in 10 million messages. (Specification for overseas switching centers specifies 1 in 1 billion.)

Routing information, message formats, and operating procedures utilized in the ASO are in accordance with effective editions of ACP 121, JANAP 128, and other applicable operating directives and practices.

Traffic classified higher than the security clearance of its intended destination(s) is not delivered by the ASC. Such messages are intercepted automatically at the last center, and the originator is informed (via service message) of a nondelivery resulting from a security mismatch.

Another special feature of the ASC is the provision of incoming and outgoing journals. These message journals store and present (on demand) synoptic information on each message sufficient to identify it, to record how the message was received, and to determine where and when it was sent to an outgoing line. Journal information is retained for up to 30 days in inactive storage. Sufficient active storage is maintained for a period determined by operating requirements. Current status of the ASC can be checked at any moment by obtaining a printout of exactly how many messages, by precedence and destination, are in the center.

Each overseas ASC is capable of recognizing and routing 3300 single routing indicators for local tributaries terminated in the center, 200 collective routing indicators, and routing indicators for 300 other switching centers. Service is provided to four types of terminal stations, for example, by CONUS Autodin. These terminal stations, by types, are (1) low-speed compound terminals (12 cards or 200 teletype wpm); (2) high-speed compound terminal (100 cards or 200 teletype wpm); (3) magnetic tape terminal (2400 baud); and (4) computer interfaces (21 to 2400 baud). (All speeds are given in bauds instead of wpms.)

Teletype subscribers are served by a controlled teletype terminal. It provides the following functions:

1. Automatic acknowledgment of end of message.
2. Automatic transmission interruption.
3. Automatic resumption of transmission of messages without rerun or intervention.
4. Automatic rejection and cancellation of messages.
5. Automatic message numbering.
6. Automatic verification of received message numbers.

By reducing manual handling of messages to a minimum, Autodin is revolutionizing communications. In the future, message delivery times and delays anywhere in the world will be measured in seconds instead of minutes and hours.

AUTOMATIC SECURE VOICE COMMUNICATIONS

Automatic Secure Voice Communications (AUTOSEVOCOM) is a world-wide, switched telephone network whose purpose is to provide authorized users with a means for exchanging classified information over cryptographically secure circuitry or officially designated as approved circuitry. The system consists of both manual and automated networks linked together to form a single system.

Interface arrangements are necessary to overcome differences in the security equipment and transmission modes between circuit switches and/or subscriber terminals of one system to the other. There are two types of switches in the AUTOSEVOCOM system:

(1) Switches that provide users with an automatically switched secure voice capability.
(2) Switches that require the assistance of an operator.

The interface service provided by switchboard operators is in addition to normal switch service provided for their locally connected subscribers. Additionally, some naval communications stations are equipped to extend AUTOSEVOCOM service to shipboard users.

Operating Procedures

A telephone directory, published periodically, contains subscriber listings, general instructions for placing calls, and trouble-reporting procedures. Additionally, JANAP 138 contains complete operating instructions on AUTOSEVOCOM.

NORATS

On-call radiotelephone is a ship/shore radiotelephone service that is provided through the navy operational radio and telephone switchboard (NORATS), installed at NavCommSta's throughout the world. It provides an interface between afloat voice radiotelephone circuitry and Government-owned and/or Government-leased telephone systems. This facility is used for official telephone calls only.

SATCOM

"This is TRICOM 60, roll call, over."

This terse phrase, spoken at 1600 Zulu on 16 March 1970 at Naval Communication Station Norfolk, ushered in a new phase in a continuing effort to improve tactical communications in the Navy.

The call signaled the beginning of the Fleet Operational Investigation for the Navy Tactical Satellite Communication System.

Tactical Communications are used in the command and control of naval forces at sea, on land, and in the air.

The Fleet Operational Investigation (FOI) is designed to fully investigate and evaluate the role that satellites can play in Navy tactical communications. Preliminary results are optimistic.

Funding and manpower restrictions resulted in delays in procurement of materials and installation of terminals, but the obstacles yielded to a system suitable for testing.

The system at Norfolk is essentially the same as those installed aboard ships and aircraft. The units require many hours of tedious inter-unit wiring as well as the extension of remoting capabilities. Since this was basically a research and development project, many hours of planning were also required to lay the groundwork for each installation.

The satellites currently in use with the Navy tactical terminals are the LES-6 (over the Atlantic) and TACSAT-1 (over the Pacific). The satellites are shared with other users. One of the purposes of the investigation is to provide communicators with an idea of the systems varied tactical capabilities.

JOINT COMMUNICATIONS

Need for coordinated and standardized communications among United States military services was clearly apparent during the early stages of World War II. Because Army and Navy facilities sometimes were duplicated in one location, differences in procedures made for inefficient interservice communications. Now communication procedures are standardized throughout the Department of Defense, hence the handling of interservice messages creates no special problems. Joint procedures are set forth in Joint Army-Navy-Air Force Publications (JANAPs). Radiomen are expected to become familiar with these publications while studying naval communications.

ALLIED COMMUNICATIONS

With worldwide cooperation between friendly nations and the United States, the need arose again for coordinated and standardized communications on an Allied basis. To meet this need, Allied Communication Publications (ACPs) were promulgated. The ACP series provides communication instructions and procedures essential to conducting combined military operations and communications in which two or more Allied Nations are involved. Radiomen's work in communications often requires familiarity with many of the ACPs.

NAVY-MARINE MILITARY AFFILIATE RADIO SYSTEM (MARS)

The Navy-Marine Corps Military Affiliate Radio System (MARS) provides Department of the Navy sponsored emergency communications on a local, national, and international basis as an adjunct to normal Naval Communications.

Recognizing the technical and operating proficiencies inherent in the possession of a valid Amateur Radio License issued by the Federal Communications Commission. The Navy has encouraged amateur radio operators to affiliate with Navy-Marine Corps MARS. The amateur radio operators, using their amateur stations on Navy radio frequencies, receive training in Naval Communications procedures and practices. They handle morale and quasi-official messages for Armed Forces and authorized U.S. Government civilian personnel stationed throughout the world, thus providing a potential reserve of trained radio communications personnel for military duty when needed.

NAVCOMM Instruction 2070.2 (series) and DNC 8 (series) publications are the governing directives.

SHIPBOARD COMMUNICATION ORGANIZATION

The complexity of a shipboard communication organization and the number of personnel assigned vary with the size and mission of a ship. Most large ships, especially those with a communication mission, have a separate communication department headed by the communication officer. In most ships, however, the communication officer heads a division within the operations department, and is responsible directly to the operations officer.

Figure 2-5 diagrams the functional arrangement of a large shipboard communication organization. It is composed of two divisions—the CR (radio), division headed by a radio officer, and the CS (visual signaling) division, headed by the signal officer. Some large ships have a third CM division message center. Also assigned are a custodian of registered publications, communication watch officers, cryptographers, and a cryptosecurity officer. Small ships may have only one communications division—OC.

In large ships with sufficient personnel, specific duties are clearly defined and standardized. In smaller ships with necessarily less manpower, individuals carry out more varied duties. In the description of responsibilities that follows, remember that in a small ship the communication officer may have no commissioned assistants, and is himself responsible for duties that in larger ships would be delegated to other officers. Further, he has deck as well as communication duties, and spends many hours on the bridge. Under these conditions, the communication officer relies heavily on his leading petty officers for assistance.

The communication organization is headed by a communication officer, who is responsible for all external communications sent and received by radiotelegraph, radiotelephone, radioteletype, facsimile, and visual means. He is not liable for the ship's interior communications. The communication officer is responsible also for (1) care and maintenance of communication equipment (including landlines and teletype switchboards on ships equipped with these facilities); (2) preparation of communication reports; (3) procurement, custody, correction, distribution of, and reports on, publications issued to the ship through the Registered Publication System; (4) supervision and training of the cryptoboard; and (5) cleanliness and upkeep of assigned spaces.

The radio officer, the communication officer's principal assistant, is liable for the work of the CR division and for operation and maintenance of assigned equipment. It is his duty to assure reliable, secure, and rapid handling of radio communications. Usually his responsibilities for internal handling, routing, and filing of messages are delegated to communication watch officers.

The signal officer, heading the CS division, is charged with operation of a ship's visual signaling facilities. His duties in handling

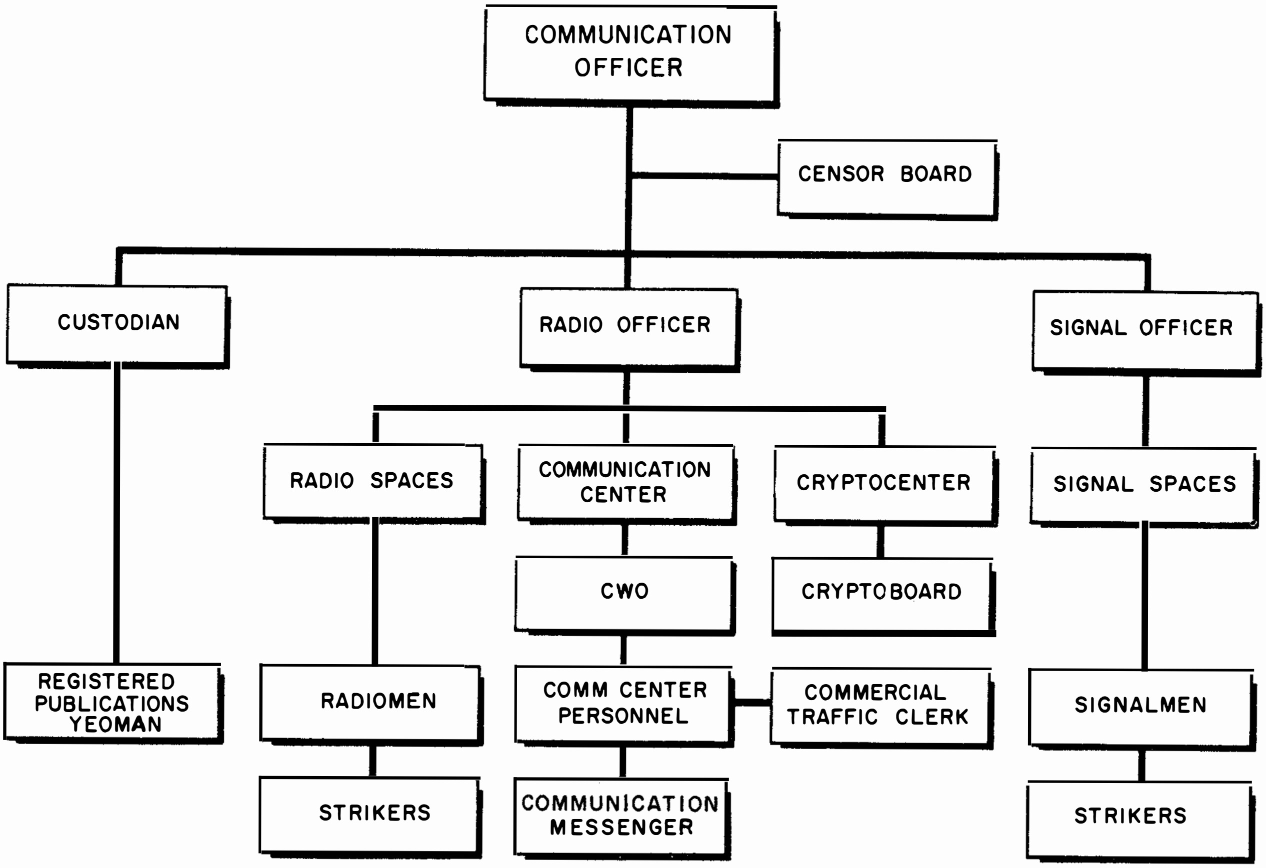


Figure 2-5.—Typical shipboard communication organization.

visual messages parallel those of the radio officer for radio messages.

The custodian, sometimes called the registered publications officer or RPS officer, is accountable to the commanding officer for keeping a complete, up-to-date, and corrected allowance of registered publications issued to the ship. He handles the drawing, stowage, correction, destruction, and issuance of these publications aboard his ship.

Communication watch officers (CWOs) include junior officers and often experienced Radiomen of the OR division. The CWO on watch is in active and immediate charge of a ship's communications. During his watch, he is the personal representative of the communication officer. He sees that incoming and outgoing messages are placed in correct form, delivered promptly and properly to action and information addressees, and that all rules governing the conduct and security of all forms of communication are observed carefully. Radiomen assist the CWO by routing messages, preparing file and routing copies, or serving as traffic checkers, messengers, or file clerks. Aboard small ships an experienced Radioman may act as CWO.

Cryptographic operators are generally classed as either on-line or off-line operators and are designated in writing by the commanding officer. These operators assist the CWO with encryption and decryption of messages when the traffic load is so heavy he cannot handle it by himself. Most commands have officers designated as off-line operators although they may use senior enlisted personnel. Your on-line operaters are generally the enlisted members of the communications team.

A cryptosecurity officer is assigned full time only on the largest ships. He is charged with the training, assignment, and detailed performance of the cryptoboard. He also serves as advisor to the communication officer and the commanding officer in all matters relating to cryptosecurity and physical security of crypto-materials. In most ships the custodian, a CWO, or some other communicator is given this responsibility as collateral duty. In small commands the communication officer usually serves as cryptosecurity officer. Other collateral communication duties to which an officer may be assigned include Top Secret control officer and member of the censoring board.

SHIPBOARD COMMUNICATION SPACES

The number, size, and arrangement of communication spaces of a ship depend on her size, type, and mission. Most large warships have communication spaces located fore and aft, as well as amidships. Besides scattering a ship's antennas, thereby helping to reduce interference, this arrangement minimizes danger of loss of communications in the event of heavy damage to a portion of the ship. Equipment is so distributed that any one space can carry on at least partial communications.

The most essential communication spaces aboard are amidships, where, under normal operating conditions, most radio traffic is handled. Here are located radio central (also called main radio or radio I) the message center, and the cryptocenter. Communication functions also are carried out in other radio spaces, in other battle control locations, and in visual signal stations.

Radio Central

Radio central is the largest and most completely equipped radio space on board ship. It contains local operating positions for radiotelegraph, radiotelephone, and radioteletype. Usually, it is where transmitters, receivers, and remote speakers and keying positions are selected and tied together to provide communication channels for remote operating stations elsewhere in the ship. Radio central is located close to the message center and cryptocenter. It is the duty station of the watch supervisor and of most of the ship's Radiomen.

Message Center

Convenient to radio central is the message center, where outgoing traffic is prepared for transmission and incoming traffic is readied for local delivery. It is the duty station of the CWO and other watch personnel.

An outgoing message is delivered "in rough" to the message center, where it is checked for possible drafting errors. It is then written up "in smooth" and sent to the releasing officer for his approval and signature. In some ships outgoing messages are delivered to the message center in the smooth, already signed and approved by the releasing officer. If the message is classified, and there are no on-line facilities aboard, it is passed to the cryptocenter, off-line encrypted, then given to radio central or the signal bridge for transmission. After incoming messages are received from radio central or the signal bridge, they are logged, decrypted if necessary, written up, routed, and delivered by messenger. All messages must clear the message center before internal routing or external transmission. Exceptions to this arrangement include operational messages received and sent direct from the OOD or CIC, and vice versa.

In ships without space allotted for a message center, message center functions are carried out in radio central.

Cryptocenter

Adjoining the message center is the cryptocenter, where outgoing messages are off-line encrypted and incoming messages are decrypted. Here are located cipher equipment and cryptographic publications (called crypto-aids), safes for stowage of classified messages, and desks and typewriters as necessary. Files kept in a cryptocenter include a file for classified general messages and one for edited plain language copies of encrypted messages. Access to a cryptocenter is strictly controlled. Admittance is limited to designated cryptographers. An authorized entry list is posted on the door. There is only one entrance, and it connects with the message center. Ordinarily the door is locked, and traffic is passed in and out through a window or slot in the bulkhead.

Other Radio Spaces

According to a ship's size, there may be one or more additional radio spaces containing special equipment, supplemental equipment, or duplicate facilities. Depending on their arrangement and intended use, they may be designated as transmitter room, emergency radio room, auxiliary radio, or other appropriate title.

Most transmitters are located in a ship's forward radio space, called the transmitter room or radio II. Usually this space is manned by a Radioman in charge, assisted by watch standers. Duties of the watch are to keep transmitters tuned to prescribed frequencies and connected or "patched" to keys, microphones, teletypes in radio central, and to remote operating positions in CIC, on the bridge, and in other parts of the ship. Receiving equipment includes one or two emergency receivers and the ship's entertainment receivers.

Originally, larger Navy ships kept their emergency radio room (radio III) in readiness for emergency use only. In many vessels, increasing demand for radio circuits has turned this space into an active transmitter room. In ships where radio III still serves as an emergency radio room, watches are stood only when the ship is at general quarters.

Other radio spaces are scattered throughout large combatant ships. Many of these spaces are small, supplementing the three main stations.

Remote Control Facilities

Remote control stations, consisting of receiving outlets and transmitter keying positions, are located on the bridge, in CIC, and other battle control spaces where need exists for direct radio communications. Receivers in radio central and transmitters in radio II and radio III can be connected to remote control positions as required. Positions on the bridge and in CIC are often paralleled. A tactical maneuvering net, for instance can be controlled from either the bridge or CIC by means of remote control units in these two spaces, which are connected through radio central to the same transmitter and receiver.

Visual Signal Spaces

Equipment and spaces for visual communications are provided in a ship's superstructure. Signal halyards extend from the yardarm to flag bags at the foot of the mast for flaghoist signaling. Signal searchlights and semaphore platforms are positioned where each one has the largest arc of vision, and so that their total coverage is 360°. Remote control keys for operating yardarm blinkers are placed in convenient and protected positions.

ENLISTED OPERATING PERSONNEL

Specific duties of enlisted personnel assigned to communication duties vary according to ship size, type, and mission. Principal duties of radiomen are to operate radiotelephone and teletype equipment in accordance with prescribed procedures.

The senior Radioman, as leading petty officer, is in direct charge of all enlisted men in the radio division. He prepares watch lists for Radiomen assigned to communications, and makes daily checks of message files and logs. Another of his primary duties is training, which he must organize and conduct so that his operators will be able to perform efficiently any communication function they may be assigned. Additionally, the leading petty officer has responsibilities for cleanliness and preventive maintenance of all radio and teletypewriter equipment and for compartments and deck spaces occupied by equipment under his cognizance.

The watch supervisor in radio central must be an experienced man. Proper handling of traffic is his main responsibility. Equipment in use and personnel on watch are under his direct supervision. He assists the CWO and, in organizations without a communication watch officer, may be designated to act as CWO insofar as internal routing and delivery of messages are concerned. His other duties include monitoring circuits, enforcing circuit discipline, accounting for classified matter in radio central, taking prompt action to prevent disruption of communications if equipment fails, and maintaining a communication status board listing information on radio nets and circuits in use.

Operators in radio central are under authority of the supervisor while on watch. They must know and use correct operating procedures for radiotelegraph, radiotelephone, and radioteletype; must keep accurate logs; must know how to tune transmitters, receivers, and associated equipment; and must be able to switch receivers and transmitters to remote operating positions. Other duties include message writeup, internal and external routing, delivery, and filing.

Communications Yeomen frequently are placed in charge of some of the additional radio spaces, such as the transmitter room and emergency radio room. They must be able to tune and calibrate each transmitter to every frequency within that equipment's range, and be familiar with power panels and switches for both normal and emergency power distribution systems. Other duties include switching transmitters and receivers to remote positions, and keeping records of equipment tests and inspections.

WATCH, QUARTER, AND STATION BILL

When a Radioman—or any other man—reports aboard, he is assigned by his division officer to a watch section, duty station, to battle and other emergency stations, and to a cleaning station. This information is posted in his work spaces on the watch, quarter, and station bill (fig. 2-6).

Normally, watches stood by communication personnel are based on the master bill of the ship or station. Watches of communication personnel, however, cannot always be made to conform to the hours or watches of other personnel of the command. Often, peakload message traffic occurs when other activities of the command are at a comparative lull. Hence, communication personnel often do not stand customary 4-on—8-off watches.

Aboard many ships, midwatch is from midnight to breakfast. Morning watch runs from breakfast to dinner. Afternoon watch is from dinner to supper. The first dogwatch runs from supper to 1800, or until movie call, and the second dogwatch until 2000. Evening watch is from 2000 until midnight.

A variation of this system is to have no dogwatches or perhaps only one. If there are no dogwatches, evening watch may last from supper until midnight. If there is one dogwatch, it is usually from supper to 2000 and is followed by evening watch that runs to midnight.

At most shore communication stations the day, evening, and midwatches are approximately 8 hours each. Radiomen usually rotate on a 4-section watch list, and stand a series of three watches in a row before rotating from days to evenings, evenings to mids, and mids to day watches. Certain peakload operators customarily are assigned to work during the busiest hours, and rotate watches differently from the rest of the station personnel.

During general quarters, Radiomen are assigned to each radio communication space. Every circuit or net is manned by a battle-efficient operator. Standby men maintain duplicate facilities in other radio spaces, keeping duplicate logs of traffic coming into radio central. A Radioman is placed in charge of the cleaning detail in each communication space. Available personnel are assigned specific areas for cleaning and upkeep.

Detailed information concerning special stations (such as fire, fire and rescue, collision, and abandon ship) is contained in each ship's organization book.

WATCH, QUARTER, & STATION BILL

SECTION 1 DIVISION OR

BILLET	NAME	BUNK NO.	LKR. NO.	RATE COMP.	RATE ALL.	RATE ACT'L.	CLEAN STATION	BATTLE STATIONS CONDITION I (GENL. QTRS.)	CONDITION II	CONDITION III	LANDING PARTY	EMERG. GETTING UND'WAY	WATCH DETAIL AT SEA	WATCH DETAIL IN PORT	SPECIAL SEA DETAIL	FIRE STATION	FIRE PROVIDE	RESCUE & ASSIST. PARTY	RESCUE & ASSIST. PROVIDE	COLLISION	ABANDON SHIP STATION	ABANDON SHIP PROVIDE	MAN OVERBD.	SPECIAL DETAIL
C-101	H.J. SAYER	4	4	RMC	RMC	RMC	←	IN CHARGE		→		RAD I				↑		↑		↑	6		↑	
C-102	R.E.L. CLARK	7	7	RM1	RM1	RM2	RAD I	SUPVR	SUPVR	SUPVR		RAD I									4			
C-103	J.D. BUCKNER	8	8	RM1	RM2	RM2	RAD II	RAD II	RAD II	RAD II		RAD II									2			
C-104	B.A. JOHNSON	12	12	RM2	RM2	RM3	RAD III	RAD III	RAD I	RAD I		RAD II				STANDBY		STANDBY		STANDBY	3		QUARTERS	
C-105	M.E. POPE	14	14	RM3	RM3	RM3	RAD II	RAD I	RAD I	RAD I	PORTABLE RAD/OPR	RAD I									4	PORTABLE RADIO		
C-106	W.A. SCRUGGS	17	17	RM3	RM3	RMSN	RAD I	RAD I	RAD I	RAD I		RAD I									6			
C-107	R.J. GILLETTE	20	20	CYN3	CYN3	CYN3	RAD I	JX TALKER	RAD I	RAD I		JX TALKER									5			
C-108	M.L. HAMILTON	15	15	RM3	RM3	RMSA	PSGY.	MSGR.	MSGR.	MSGR.	MSGR.	MSGR.				↓		↓		↓	3		↓	

76.6

Figure 2-6.—Watch, quarter, and station bill.

CHAPTER 3
COMMUNICATIONS SECURITY

The security of the United States in general, and of naval operations in particular, depends in part upon the success attained in safeguarding classified information. Every Radioman must be security conscious to the point that he automatically exercises proper discretion in the discharge of his duties and does not think of security of information as something separate and apart from other matters. In this way, security of classified information becomes a natural element of every task and not an additionally imposed burden.

In his daily work routine the Radioman learns information of vital importance to the military and to the Nation. Much of the vast amount of intelligence carried in messages handled by naval communications passes at some point through the hands of Radiomen data that, if available to an enemy, would enable him to learn the strength and intent of U.S. forces, and to gather a wealth of technical information relating to the procedures and operations of the United States Navy.

Radiomen will use many official documents and publications that relate to such communication matters as frequencies, call signs, and procedures. Their content must be protected because the more an enemy knows about our communications, the better are his chances of deriving intelligence from them.

Persons being assigned to duties requiring access to classified information, prior to being granted access, should be indoctrinated on the security aspects and responsibilities of their assignment or position. As part of the indoctrination program, personnel will be instructed to report promptly attempts by representatives or citizens of foreign governments to:

Cultivate a friendship to the extent of placing them under obligation, which they would not normally be able to reciprocate, or by money payments or bribery to obtain information of intelligence value.

Obtain information of intelligence value through observation, collection of documents, or by personal contact.

Coerce personnel by blackmail; by threats against or promises of assistance to relatives living under their control.

Appeal to personnel on a racial, nationalistic, or ideological basis.

Exploit personnel who may be disaffected or in personal difficulties.

Intimidate, harass, entrap, discredit, search, spy on, or recruit for intelligence purposes personnel traveling in foreign countries.

Induce personnel to defect or to induce those who have fled from communist countries to redefect.

Attempts by department of the Navy personnel to provide unauthorized services, information, or documents to anyone believed to be in contact with a foreign intelligence service.

Attempts by persons living in communist countries to obtain information of intelligence value from personnel by correspondence (including "Pen Pals"), questionnaires, "ham radio," or other forms of communications.

Individuals found responsible for the loss, unauthorized disclosure or possible subjection to compromise of classified information, and individuals who violate security regulations, shall be promptly and adequately disciplined regardless of rank or position. Disciplinary action may include, in the case of military personnel, trail by court-marital.

CLASSIFICATIONS

Security is a protected condition that prevents unauthorized persons from obtaining information of military value. Such information is afforded a greater degree of protection than is accorded other material, and it is given a special designation: classified matter. This term includes all publications, documents, cipher keys and aids, code books, letters, equipment, and messages in the three security classifications of Top Secret, Secret, and Confidential. Following on next page are examples and definitions of each category.

TOP SECRET

The Top Secret classification is limited to defense information or material requiring the highest degree of protection. It is applied only to information or material the defense aspect of which is paramount, and the unauthorized disclosure of which could result in EXCEPTIONALLY GRAVE DAMAGE to the Nation, such as—

1. A war, an armed attack against the United States or her allies, or a break in diplomatic relations that would affect the defense of the United States.
2. The unauthorized disclosure of military or defense plans, intelligence operations, or scientific or technological developments vital to the national defense.

Due to the sensitive nature of Top Secret material minimum handling requirements have been established. The commanding officer establishes control procedures which will insure that accounting of Top Secret Material meets the following minimum requirements.

Except for publications containing a distribution list by copy number, all copies of each Top Secret document or equipment will be serially numbered as follows: "Copy No.____ of____ copies."

Top Secret documents shall contain a list of effective pages in which shall be included a Record of Page Checks. When this is impracticable, as in correspondence or messages, the pages shall be numbers as follows: "Page____ of____pages."

The reproduction of all Top Secret documents is limited. The procedures for reproduction are covered in detail in the Security Manual for Classified Information.

When Top Secret materials are reproduced, all reproduced copies shall be serially numbered and immediately recorded with the Top Secret Control Officer (designated by the commanding officer) in order to maintain complete accountability.

Lists of names of all persons having knowledge of a particular item of Top Secret information shall be maintained until 2 years after the document has been destroyed, or the classification has been downgraded.

A continuous chain of receipts for Top Secret information shall be maintained until 2 years after a document has been downgraded or destroyed.

All Top Secret material will be prepared and marked as outlined in the Security Manual for Classified Material.

The Top Secret Control Officer will page check all Top Secret material upon receipt for completeness and accuracy. A page check is also required to be conducted after entering a change into a publication.

Top Secret documents shall be physically sighted or accounted for by examination of written evidence of proper disposition if less than two years old, such as, certificate of destruction, transfer receipt, etc., at least once annually.

Top Secret documents shall be kept to the minimum consistent with current requirements.

SECRET

The Secret classification is limited to defense information or material the unauthorized disclosure of which could result in SERIOUS DAMAGE to the Nation, such as—

1. Jeopardizing the international relations of the United States.
2. Endangering the effective of a program or policy of vital importance to the national defense.
3. Compromising important military or defense plans, or scientific developments of importance to nation defense.
4. Revealing important intelligence operations.

CONFIDENTIAL

The use of the classification Confidential is limited to defense information or material the unauthorized disclosure of which could be PREJUDICIAL TO DEFENSE INTERESTS of the Nation, such as—

1. Operational and battle reports that contain information of value to the enemy.
2. Intelligence reports.
3. Military radio frequency and call sign allocations that are especially important, or are changed frequently for security reasons.
4. Devices and material relating to communication security.
5. Information that reveals strength of land, air, or naval forces in the United States

and overseas areas, identity and composition of units, or 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 items 10, 11, and 12 is classified Confidential only if its unauthorized disclosure could in fact be prejudicial to the defense interests of the Nation.

ADDITIONAL MARKINGS

In addition to the three security labels mentioned already, other markings also appear on documents. Among these markings are such designations as Restricted Data, NOFORN, For Official Use Only, SPECAT, and LIMDIS.

Restricted Data

All data concerned with (1) design, manufacture, or utilization of atomic weapons, (2) production of special nuclear material, or (3) use of special nuclear material in production of energy bear conspicuous "Restricted Data" markings. Restricted data, when declassified under the Atomic Energy Act of 1954, must be marked "Formerly Restricted Data, Handle as Restricted Data in Foreign Dissemination, Section 144b, Atomic Energy Act, 1954."

NOFORN Designation

Whenever the anticipated distribution, transmission, or handling of classified documents is such that documents are liable to inadvertent disclosure to foreign nationals, originators should stamp the documents thus: "Special Handling Required, Not Releasable to Foreign Nationals." When this term is used in a message, it is abbreviated NOFORN.

For Official Use Only

The term "For Official Use Only" is assigned to official information that requires some protection for the good of the public interest but is not safeguarded by classification used in the interest of national defense.

SPECAT Designation

When the term SPECAT is assigned to a message, it identifies that message with a specific protect or subject requiring special handling procedures supplemental to the security classification to ensure that the message is handled and viewed only by properly cleared and authorized personnel.

LIMDIS Designation

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Messages that are identified with specific projects or subjects, and which must receive limited distribution but may be handled by regular communication personnel, in accordance with the security classification of the message, are designated LIMDIS messages.

CLASSIFICATION RESPONSIBILITIES

The responsible official, prior to signing or approving a document which bears security classification markings, should review its content specifically to ensure that the classification markings assigned to information contained therein, or which would be revealed thereby, are necessary, current and accurate and that all requirements have been met.

Each individual who originates a document or other material is responsible for identifying the items of information which, in his opinion, based upon available guidance or his own evaluation, require security protection through classification. He then shall classify the document or material. If he does not have the authority to classify, he shall refer the matter to the nearest knowledgable classifying authority for action.

SECURITY CLEARANCES

Before a person can have access to classified material, his character and his past must be checked to the extent appropriate to the sensitivity of the material he will be handling. Following are the two basic qualifications which must be met:

1. He must be of unquestionable integrity, trustworthiness, and loyalty to the United States.
2. He must be of excellent character and of such habits and associations as to cast no doubt upon his discretion and good judgment in the handling of classified information.

TYPES OF INVESTIGATIONS

To determine whether an individual meets the criteria for a security clearance, two types of personnel security investigations are employed—the National Agency Check (NAC) and the Background Investigation (BI).

National Agency Check

A National Agency Check consists of the review of the records and files of a number of government agencies to determine if any derogatory information exists on the individual or on an organization to which he may have belonged.

Background Investigation

The Background Investigation is much more extensive than a National Agency Check. It is designed to develop information as to whether the access to classified information by the person being investigated is clearly consistent with the interests of national security. It inquires into the loyalty, integrity, and reputation of the individual.

INTERIM CLEARANCE

A personnel security clearance is an administrative determination that an individual is eligible, from a security standpoint, for access to classified information of the same or lower category as the clearance being granted. Of the two types of clearances (interim and final), an interim clearance is granted as the result of a lesser investigative process and is a determination of temporary eligibility for access to classified information. Certain requirements, which vary with the classification category, must be met. These requirements are defined in chapter 15 of the Security Manual. An interim clearance is granted only when the delay in waiting for completion of the necessary steps for final clearance would be harmful to the national interest. Procedures to effect a final clearance are initiated simultaneously with the initiation of the procedures for an interim clearance. The only type of clearance which is not granted to military personnel is the interim CONFIDENTIAL.

FINAL CLEARANCE

A final clearance is granted when it has been determined that an individual is eligible, from a security standpoint, for access to classified information of specific levels.

CERTIFICATE OF CLEARANCE

Each clearance, final and interim, is evidenced by the issuance of a Certificate of Clearance.

Certificates of Clearance are made a matter of record and become a permanent part of an individual's service record.

Merely because an individual has been cleared for access to information of a certain classification category does not mean that he may have access to all classified information within that category. Classified information is made available to appropriately cleared personnel on a "need-to-know" basis.

NEED TO KNOW

"Need to know" is the term given to the requirement that the dissemination of classified information be limited strictly to those persons whose official military or other governmental duties require knowledge or possession thereof. As a Radioman you will be granted a security clearance to the degree necessary for you to perform your duties. Although you may be granted a Confidential, Secret or Top Secret Clearance you may not "need to know" all the materials at your command for which you are cleared to see. A "need to know" is recognized as established when (1) the disclosure is necessary in the interests of national defense; (2) there clearly appears from the position, status, duties, and responsibilities of the applicant that he has a legitimate requirement for access to the classified information in order to carry out his assigned duties; (3) there is no other equal or ready source of the same classified information available to him; and (4) the applicant is or can be appropriately cleared for access to the degree of classified information involved and is capable both physically and mentally of providing the degree of protection which that information requires.

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COMPROMISE

No one in the Navy is authorized to handle any classified material except that required in the performance of duty. All other persons are unauthorized, regardless of grade, duties, or clearance.

If it is known—or even suspected—that classified material has been lost, or that unauthorized persons has had access to it, the material is said to be compromised. The seriousness of the compromise depends on the nature of the material and the extent to which the unauthorized person may divulge or make use of what he learns. A Radioman should report any compromise to his communication officer.

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SECURITY AREAS

The shipboard and shore station spaces that contain classified matter are known as security areas. These security areas (sometimes called 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, three types of security areas have been established: exclusion, limited, and controlled areas.

EXCLUSION AREAS

Exclusion areas are fully enclosed by walls or bulkheads of solid construction. All entrances and exits are guarded, and only persons whose duties require access and who possess appropriate security clearance are authorized to enter, after being positively identified. Normally, a list of personnel authorized entry, signed by the CO, is posted in the area.

LIMITED AREAS

Radio central, message center, relay station, transmitter rooms, and other communication spaces usually are designated limited areas.

Operating and maintenance personnel whose duties require freedom of movement within limited areas must have proper security clearances. 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.

Entrances and exits of limited areas are either guarded or controlled by attendants to chcek personnel identification, or they may be protected by automatic alarm systems.

CONTROLLED AREAS

Passageways or spaces surrounding or adjacent to limited or exclusion areas are often designated controlled areas. Although a controlled area does not contain classified information, it serves as a security restriction buffer zone. Moreover, it provides greater control, safety, and protection for limited and exclusion areas.

Controlled areas require personnel identification and control systems adequate to limit admittance to those having bona fide need for access to the area.

COMMUNICATION SECURITY PHASES

Communication security (COMSEC) is the protection resulting from all measures designed to deny unauthorized persons information of value which might be derived from the possession and study of telecommunications, or to mislead unauthorized persons in their interpretations of the results of such possession and study. COMSEC includes: (1) physical security of communications security materials and information, (2) cryptosecurity, (3) transmission security, and (4) emission security.

PHYSICAL SECURITY

The physical security of classified material depends upon proper handling on the part of every user, proper stowage when it is not in use, and complete destruction when necessary.

Handling Precautions

Each individual in the communication organization must take every precaution to prevent intentional or casual access to classified information by unauthorized persons. When classified publications are removed from stowage for working purposes, they must be covered or placed face down when not in use. Unauthorized visitors must not be permitted in communication spaces. Never discuss classified information over the telephone. Rough drafts, carbon paper, worksheets, and similar items containing classified information should be destroyed after they serve their purpose. In the meantime, they must be handled and safeguarded as classified matter.

At the close of each watch or working day, all classified material that must be passed from watch to watch is inventoried properly, and custody is transferred to the relieving watch supervisor. All other classified matter must be locked up. Notes regarding classified matter must not be left on memorandum pads or under desk blotters. Wastebaskets should be checked to see that they contain no classified material such as notes, carbon paper, excess copies, or rough drafts. These items must be placed in burn bags with other classified material. Burn bags are properly stowed until destroyed according to a schedule promulgated by the communication officer or custodian.

Vaults, safes, or lockers used for stowage of classified matter must always be kept locked when not under the supervision of authorized personnel. Cryptographic aids and related classified matter must never be left unguarded by the water. Habitually rotate the dial of all combination locks at least three complete turns in the same direction when securing safes, files, and cabinets. In most locks, if the dials are given only a quick twist, it is possible sometimes to open the lock merely by turning the dial in the opposite direction. Always make sure that all drawers of safes and file cabinets are held firmly in the locked position.

If interrupted by a fire alarm or other emergency, when working with classified material, stow the material in the same manner as at the end of a working day. It is a Radioman's personal responsibility to safeguard all classified material in his possession.

Stowage

All classified matter not in actual use must be stowed in a manner that will guarantee its protection. The degree of protection necessary depends on the classification quantity, and scope of the material.

A numerical evaluation system has been developed for determining the relationship between the security interest and the level of protection required. The more secure the stowage facilities, the higher the numerical values assigned.

Figure 3-1 shows the numerical values required for quantity and type of documents of each classification. Table 3-1 is a guide for evaluating stowage facilities. The table and illustration must be used together.

Assume that a ship stows plain language translations of encrypted messages in the cryptocenter in a metal container with attached keylock. Visitors are not allowed in any of the communication spaces. Only cryptographers may enter the cryptocenter itself or remove anything from its safe. The cryptographer on watch acts as a guard in attendance at the container. From Table 3-1 a numerical value may be assigned to these facilities as follows:

	Value
Sheltered aboard a commissioned ship	25
Stowed in metal container with attached keylock	5
Military guard in attendance at container	60
Total	90

From the evaluation graph in figure 3-1 it can be seen that stowage facilities with a numerical value of 90 are secure enough for everything except large quantities of Top Secret equipment and large quantities of Top Secret documents covering a broad scope.

Keys or combinations to safes and lockers containing classified material are made available only to persons who duties require access to them. Safes containing cryptographic materials must have their combinations changed at least every 6 months and every 12 months for safes containing non-cryptographic classified material. They must also be changed whenever any person having knowledge of them is

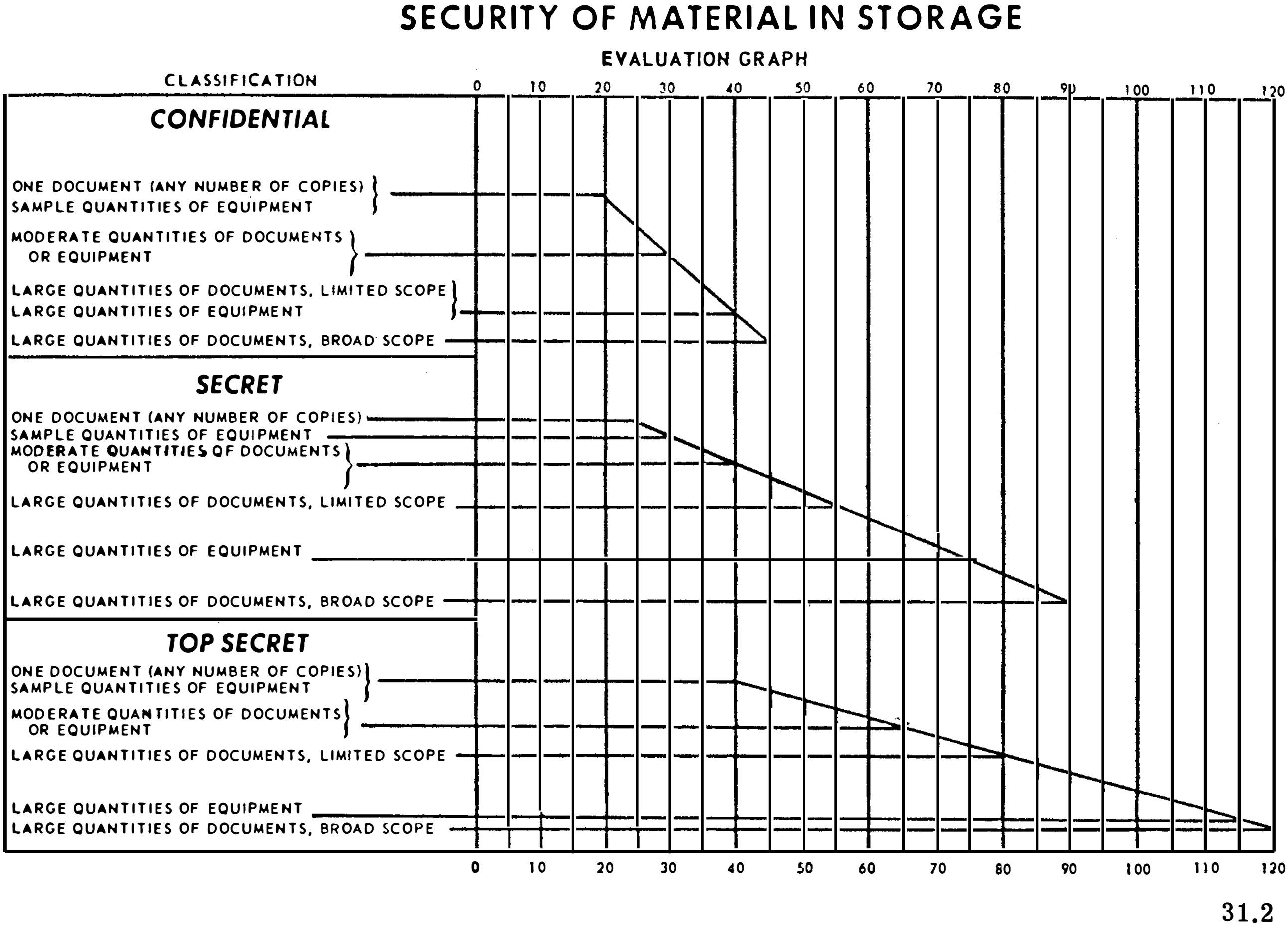

Figure 3-1.—Numerical values required for quantity and type of documents.

transferred from the organization, and at any time the keys or combinations are suspected of being compromised.

All safes and cabinets which contain classified matter that are found open and unattended should be reported to the senior duty officer. Do not touch the container or contents, but guard them until the duty officer arrives. The duty officer then assumes responsibility for such further actions as locking the safe, recalling the responsible person(s), and reporting the security violation to the commanding officer. The custodian must hold an immediate inventory of the contents of the safe and report any loss to the CO.

For further details on stowage of classified matter, consult chapter 6 of the Department of the Navy Security Manual for Classified Information, OpNavInst. 5510.1C.

Destruction

Destruction of classified matter falls into two categories: routine and emergency. Destruction, when authorized or ordered, must be complete.

- Routine destruction: Destruction of superseded and obsolete classified materials that have served their purpose is termed routine destruction. Routine destruction of publications, message files, and certain cryptomaterials is carried out when authorized by specific directives. These directives are found in the letter of promulgation of the publication itself, in cryptographic instructions and manuals, and in U.S. Naval Communications Instructions (DNC 5 series). Other materials, such as classified rough drafts, worksheets, and similar items, are destroyed, as necessary, to prevent their excessive accumulation.

Table 3-1.—Table of numerical equivalents

Element of Security	Value
1. Stowage Areas:	
a. Security Fences:	
(1) Classified area surrounded by a security fence with all gates secured or controlled	5
b. Protective Lighting:	
(1) Security areas lighted by protective lighting	5
c. Building or Ship:*	
(1) Conventional frame or good quality temporary structure	5
(a) Controlled areas within	15
(b) Limited areas within	25
(c) Exclusion areas within	35
(2) Masonry or steel structure with substantial partitions, floors and ceilings (including magazines)	10
(a) Controlled areas within	20
(b) Limited areas within	30
(c) Exclusion areas within	40
(3) Aboard a Commissioned Ship	25
(a) Controlled area	35
(b) Limited area	40
(c) Exclusion area	50
(4) "In Service" or MSC chartered vessel	10
(a) Controlled areas within	20
(b) Limited areas within	30
(c) Exclusion areas within	40
2. Stowage Containers:**	
a. Metal, keylock (built-in)	0
b. Metal, key padlock (attached)	0
c. Metal, high security key padlock (attached)	5
d. Metal, combination padlock (attached)	5
e. Metal, high security combination padlock (attached)	10
f. Metal, combination lock (built-in)	15
g. Strongroom or weapons magazine	15
h. Class C Vault	50
i. Class B Vault	60
j. Class A Vault	70
k. Class 2, approved GSA security container	60
l. Class 3, approved GSA security container	50
m. Class 4, approved GSA security container	60
n. Class 5, approved GSA security container	70
o. Class 6, approved GSA security container	55
p. Class 5 map and plan, approved GSA security container	70
2. Stowage Containers—Continued	
q. Class 6 map and plan, approved GSA security container	55
3. Guarding:	
a. Supporting Guard Force:	
(1) Civilian Supporting Guard Force	10
(2) Military Supporting Guard Force	15
b. Guards:	
(1) Civilian Guards:	
(a) Civilian guard in general area	10
(b) Civilian guard check of container each hour	15
(c) Civilian guard check of container each ½ hour	20
(d) Civilian guard in attendance at container	30
(2) Military Guards:	
(a) Military guard in general area	15
(b) Military guard check of container each hour	20
(c) Military guard check of container each ½ hour	25
(d) Military guard in attendance at container	60
c. Sentry dog accompanying military or civilian guard	10
4. Protective Alarm Systems:	
a. Area Alarm System:	
(1) Make or break (electro-mechanical) alarm to detect entry into immediate area	5
(2) Other alarm system to detect entry into immediate area	10
(3) Alarm system to detect entry or attempted entry into immediate area	15
(4) Alarm system to detect entry or attempted entry and approach to immediate area	25
b. Container Alarm Systems:	
(1) Make or break (electro-mechanical) alarm to detect opening of container	10
(2) Other alarm system to detect opening of container	15
(3) Alarm system to detect opening or tampering with container	20
(4) Alarm system to detect opening or tampering with and approach to container	25

* Buildings must be under U.S. Government control or if not under U.S. Government control the space occupied within the building must be at least a controlled area.

** Evaluate as indicated provided other elements in the security program are available to minimize the possibility of unauthorized access to the container.

The most efficient method of destroying combustible material is by burning. It is likely that Radiomen will be called upon to assist in burning classified material. Every member of the burn detail should know exactly what is to be burned and should doublecheck each item before it is burned. To facilitate complete destruction of bound publications, tear them apart, crumple the pages, and feed the pages to the fire a few at a time. If burn material is carried in a bag that is not to be burned, turn the bag inside out to make certain every piece of paper is removed and burned. All material must be watched until it is completely consumed. The ashes must be broken up and scattered so that no scraps escape destruction.

When no incinerator is available, which often is true aboard ship, classified material may be burned in a perforated metal drum or container with a cover of wire netting. Most ships now have paper shredders of the types listed in ONI publication 6-1 to facilitate the destruction of classified matter including cryptomaterial. (See RPS 4 in connection with destruction of cryptomaterial.)

- Emergency destruction: Emergency destruction of classified material is authorized any time it is necessary to prevent its capture by an enemy. On board ship, classified material is not normally subjected to the same risks as on land. If a ship is in danger of sinking or is severely disabled, however, action is taken in accordance with the ship's emergency destruction bill (fig. 3-2), the execution of which is an all-hands evolution—from communication officer to striker. This bill details the method and the order of destruction of classified matter. Each man in the communication division is assigned responsibilities by duty and watch instead of by name. The bill provides alternates for each billet to ensure effective action despite personnel casualties.

The importance of knowing how to accomplish emergency destruction is emphasized in chapter 6 of the Security Manual, which states in part, "Destruction plans of each activity will require of personnel at all levels, the highest degree of initiative practicable in preparing for and in actually commencing required destruction. Particular care will be taken to indoctrinate all personnel to ensure their understanding that, in such emergencies and when required, they will initiate necessary destruction under the plan without waiting for specific orders."

The order in which classified material is to be destroyed under emergency conditions should be determined in advance and the material so marked and stored. The effective editions of both the Security Manual and Cryptographic Operations, KAG-1, offer directions about the priority of destruction (see fig. 3-2 and fig. 3-3).

Cryptographic material has the highest priority for emergency destruction. Insofar as humanly possible, it must not be permitted to fall into enemy hands. After cryptomaterial is destroyed, other classified communication material is destroyed in the order of classification—highest classified material first. Next in importance in the destruction plan is classified (noncryptographic) communication equipment, followed (if time permits) by destruction of unclassified material and equipment.

Destruction by fire is the preferred method for all combustible materials. Oil or chemicals may be used to facilitate burning. In the event a ship is in imminent danger of sinking, or about to be scuttled in either deep or shallow water, sensitive cryptographic components and documents should not be jettisoned, but destroyed as completely as possible in the time available, locked in security containers or vaults and permitted to sink with the ship. If the ship is in imminent danger of capture, the materials should be completely destroyed if time permits. Materials not completely destroyed should be jettisoned.

In emergency situations, the classified elements of cryptographic equipments should be destroyed as completely as possible in the time available and at least destroyed beyond reuse.

A sufficient number of weighted, perforated canvas bags and tools, including sledge hammers, screwdrivers, explosive devices, and wire cutters, should always be kept in spaces that contain classified materials and equipments. Classified communications equipment, other than cryptographic, must be smashed beyond possible reconstruction and unclassified communications equipment should be demolished beyond repair or immediate reuse.

If feasible at shore locations, a supply of kerosene or gasoline should be kept in or near the cryptocenter. Kerosene is more desirable since it is less of a fire hazard in storage and does a more thorough burning job.

All Naval activities should periodically conduct emergency destruction drills. When a real emergency occurs, there will be no time for instruction and indoctrination. Below are listed

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PRIORITY	MATERIAL	LOCATION	RESPONSIBILITY	ALTERNATE	METHOD OF DESTRUCTION
ONE A. Top Secret Superseded and Effective keying material	KAK____ (Key lists) (Key cards)	Small box on top shelf of safe #1	Cryptocenter Supervisor	Cryptocenter Asst. Supervisor	A.1.
B. All remaining keying material NOTE: Destruction of keying material includes zeroizing the cryptoequipment if applicable.	KAK____ (Key lists) (Key cards) (See Item F, "Method of Destruction")	Large box on top shelf of safe #1	Asst. Supervisor	Operator #1	A.1. B.1. B.1. C. D. F.
C. Secondary Variables	KAR____ (Rotors) KAW____				C.
TWO Future (ROB) Material A. Secondary Variables	(KAR____) (KAW____)				C. D.
B. Top Secret keying material except point-to-point keying material	(KAK____)				A. B.
C. All remaining ROB keying material except point-to-point keying material	(KAK____)				A. B.
THREE Sensitive pages of classified maintenance manuals (See CSPM 1G, 1-63)	(KAM____)				A. B.
FOUR Classified elements from cryptoequipment. The individual element classifications are identified in the appropriate KAM or KAO and should be included as part of the destruction training on a particular equipment.	KLK-47 $ KWT/R-26* KWT/R-37* KW-7 * KG-14 *				C. D. E. F.
FIVE Classified Operating Instructions	(KAO____)				A. B.
SIX All remaining classified COMSEC information and material	(KAC____)				A. B.

The exact method of destruction must be determined by each command commensurate with equipment available and time permitted. Whatever method employed shall insure that all material is destroyed as completely as possible.

The following steps shall be considered the minimum destruction required:

BURNABLE

A. (Small volume)
1. Place in wastebasket and ignite. See Note 1.

B. (Large volume)
1. Destroy with document destroyer kits (M3, E-12, E-12R1). If kits are not available, burn in incinerator or as indicated in Note 1.

NON-BURNABLE

C. (Rotors)
Use (M3) document destroyers, if available. Otherwise, disassemble from any key list setting, cut wires, and smash with hammer.

D. (KW-26) Cut wires to card reader; render all classified coreboards in equipment and spare parts kits unusable using M3 document destroyers, if available. See Note 2.

E. (KW-7) Disengage all plugs from jacks in the plugboard, render all classified printed circuit boards from equipment and spare parts kits unusable using M3 document destroyers, if available. See Note 2.

F. KY-8/28/38: Destroy all keying material including zeroizing the code changer key (KYK-3) and the code changer (KYK-5, KYK 12, KYK 28). Destroy the KY-8/28/38 and classified spare parts as time permits. If possible, render equipment unusable and unrecognizable.

G. (Off-line) Render equipment unusable and if time permits destroy beyond recognition.

H. In case of fire in this cryptocenter, shut off all power, remove or secure keying material as the situation dictates. If feasible, post an armed guard. Upon returnin to the area a complete inventory shall be taken.

$ Disassemble rotors
*Remove classified boards

31.4.1

Figure 3-2.—Typical emergency destruction bill.

1. This plan shall be reviewed quarterly and revised as necessary.

2. This plan was reviewed by ______________________ on __________________________.

The foregoing emergency destruction plan is a compartmented plan to be used by the RPS Custodian and personnel assigned duties in areas of operations where cryptographic materials are in use. A command emergency destruction plan, of necessity, must be compartmented in order to ensure that all the requirements to be executed in an emergency situation are planned for. Therefore, the command emergency destruction plan must include a priority of destruction that includes all classified materials onboard. The following are the priorities that must be considered with drafting a command emergency destruction plan:

PRIORITY

1. A. Cryptographic material. (Detailed information concerning the order of destruction of cryptographic material is contained in the effective editions of KAG-1).

   B. All Top Secret materials and all classifications of Special Intelligence materials

2. Remaining classified material. Emergency destruction of remaining classified materials shall be carried outin order of priority as follows, beginning with the highest classification:

   A. Classified material pertaining to current and future operating plans and operations

   B. Classified material pertaining to standing or tactical procedures

   C. Equipment, other than cryptographic, of a classified nature together with pertinent, technical, descriptive and operating instructions.

NOTE 1: Nothing in the above priority of destruction precludes the simultaneous preparation/destruction of materials contained in separate operating areas/offices; however, care must be taken when preparing the emergency plan that sufficient personnel are designated to execute the necessary actions required in each area. Although small fires may be ignited in trash cans in specific areas to expedite the destruction of small amounts of paper material, care must be taken to ensure that large fires are not set in an enclosed area until such time as all items are prepared for destruction and all hands are prepared to evacuate the spaces. In small areas where large amounts of classified papers are stowed, the bound documents should be dismantled, crumpled, and thrown on the deck. All paper documents in the enclosed area should be prepared in this manner and sprinkled with any alcohol-base liquid to assist in the rapid burning. Fires should not be set until the command is given by a responsible individual. The senior at the scene must make the determination when to prepare for emergency destruction as well as when to execute destruction by igniting fires to destroy combustible materials. Items to be jettisoned must be jettisoned prior to igniting large fires in an area.

NOTE 2: If time permits, render remaining unclassified printed circuit/coreboards unusable.

31.4.2

Figure 3-3.—Typical emergency destruction bill—Continued.

a few of the most important points concerning emergency destruction:

1. As destruction is accomplished, a list or record should be kept of the material that has been destroyed. Informing higher authority of exactly which material has been destroyed is second in importance only to the actual destruction.

2. Personnel performing emergency destruction should possess clearances corresponding to the sensitivity of the material they are to destroy.

3. It is permissible to jettison classified materials only when the ship is in imminent danger of being captured.

4. When an aircraft is operating over or near hostile territory or water, and capture or other emergency appears imminent, keying material and associated cryptomaterial should be shredded as completely as possible and dispersed over as wide an area as possible. Classified elements of crypto equipments should be smashed beyond reuse and dispersed over as wide an area as possible.

5. When destroying large volumes of burnable materials by fire within an enclosed area, the paper materials to be destroyed should be separated from binders, crumpled, and thrown on the deck. When all materials have been prepared for burning all hands should be ready to evacuate the space. Just prior to evacuation,

sprinkle an alcohol solution over the material and ignite. If outdoor open-pit type burning is used for destruction of paper materials, it would be more efficient to utilize several small fires rather than one large fire.

EMERGENCY PLAN—The possibility of unauthorized access to classified information increases during times of emergency. It is necessary, therefore, that each unit holding classified material prepare an Emergency Plan for implementation when an emergency is imminent.

Emergencies can be roughly divided into three basic types. The action to be taken will be basically the same in any case, with modifications as necessary to meet the particular situation. The basic types of emergencies are:

1. Natural disaster (e.g., flood, fire)
2. Hostile action
3. Civil riot or uprising.

Assignment of responsibilities for action prescribed in the Emergency Plan will be made by billet, not by name. Therefore, because of various training cycles and normal job rotations, you must continuously review your responsibilities in the plan.

There are three basic courses of action to be considered in the Emergency Plan:

1. SECURING THE MATERIAL.—If the course of action during a natural disaster, for example, requires leaving the cryptocenter for a period of time, all material must be secured in authorized safes and vaults before leaving. All keying material must be removed from equipments and stored. All power should be shut down. If feasible, a guard should remain with the material. Upon return to the area, a complete inventory must be taken to determine what, if any, material is missing. If necessary, a report of possible compromise must be submitted.

2. REMOVING THE MATERIAL.—Units holding relatively small amounts of classified material may determine that it is best to remove the material if an emergency occurs and the area is abandoned. The material may either be taken with the personnel or removed to some predesignated secure area.

3. DESTROYING THE MATERIAL.—A decision to destroy the material should be considered last. All reasonable effort should be made to secure or remove the material. Should destruction be necessary, methods for destruction and the priority of destruction list discussed earlier will be followed.

It may be desirable in certain situations to combine the actions discussed above. For example, if it appears that a civil uprising will be short-lived, and the cryptocenter is to be abandoned for a short period of time, superseded keying material may be destroyed, future and current material taken with the personnel, and the equipment secured.

Determining when and how the plan is to be placed into effect is a command decision. It should be implemented when the commanding officer determines that the forces and facilities at his disposal are inadequate to protect classified material from impending loss or capture. The cryptosecurity officer, or other previously designated individuals, should be empowered to implement the plan on their own, should conditions prevent contact with the commanding officer.

In conjunction with the Emergency Plan, each activity has a Fire Plan. The Fire Plan includes provisions for manning of local firefighting equipment; evacuation of the area, including whether to store or remove classified material; and admission of outside fire fighters.

CRYPTO SECURITY

Cryptosecurity is that type of security obtained by the proper use of either a cipher system or a code system. In cipher systems, cryptographic treatment is applied to plain text elements of equal length. In code systems, cryptograms are produced by applying a cryptographic treatment to entire words, phrases, and sentences of the plain text message.

The command appoints individuals, officer and enlisted, to duties as on-line or off-line cryptographic operators in specific cryptosystems. The command's Communication Security officer, who may or may not also be the Communications officer, is responsible for ensuring that the individuals so appointed are qualified in all respects to use the specified cryptosystem(s). Nearly all radiomen are required to be on-line cryptographic operators in one or more on-line cryptosystems; many may also be appointed to off-line duties.

When using a cryptosystem, great caution must be taken to ensure that the system is used exactly as specified in the operating instructions, which vary with each cryptosystem. Consider the thought that your making an error in cryptosecurity would not only compromise the classified material which you intend to transmit, but also all the other classified material transmitted by the hundreds of other persons who have used that same cryptosystem before.

Other countries are constantly and diligently studying our code and cipher systems in order to try to discover the keys to our many cryptographic systems. This technique is called cryptoanalysis. Once it has been determined that there is a good possibility that one of our cryptosystems has been dangerously weakened by numerous instances of erroneous usage, that system must be cancelled and a new one issued to replace it—a process of tremendous cost, to say nothing about potential compromise of classified material.

TRANSMISSION SECURITY

Transmission security is that component of communication security resulting from all measures designed to protect transmission from interception and exploitation by means other than cryptoanalysis.

Some methods of transmission are more secure than others. In general, the means and types of transmission, in their order of security, are as follows:

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1. Messenger
2. Registered mail (guard mail, U.S. postal system, or diplomatic pouch)
3. Approved wire circuits
4. Ordinary mail
5. Nonapproved wire circuits
6. Visual (semaphore, flaghoist, flashing light)
7. Sound systems (whistles, sirens, bells)
8. Radio.

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. The ARFCOS courier transfer stations are located in designated areas. Every item of classified material sent via ARFCOS is in physical custody and control of a military courier from the time of entry into the system until the addressee or his authorized representative receipts for it. Classified material that may go by registered United States mail is not transmitted by ARFCOS.

Guard mail is another type of messenger service for transmitting classified material, although unclassified material is also delivered by this means. Reliable petty officers as well as commissioned officers are appointed as guard mail messengers. Guard mail is used, for instance, in a naval district for delivering mail to other military or Government activities located in the same area, and also in conjunction with ordinary mail service to and from ships in port.

Mail

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In addition to transmitting unclassified material, the United States postal system is used to transmit classified material except Top Secret matter and cryptographic aids and devices. Secret and Confidential cryptographic matter must be sent by registered mail instead of by ordinary mail, and must not enter a foreign postal system. Normal confidential matter will be sent by certified mail. The great bulk of the Navy's administrative traffic is sent by mail, thus reserving radio circuits for operational traffic insofar as possible.

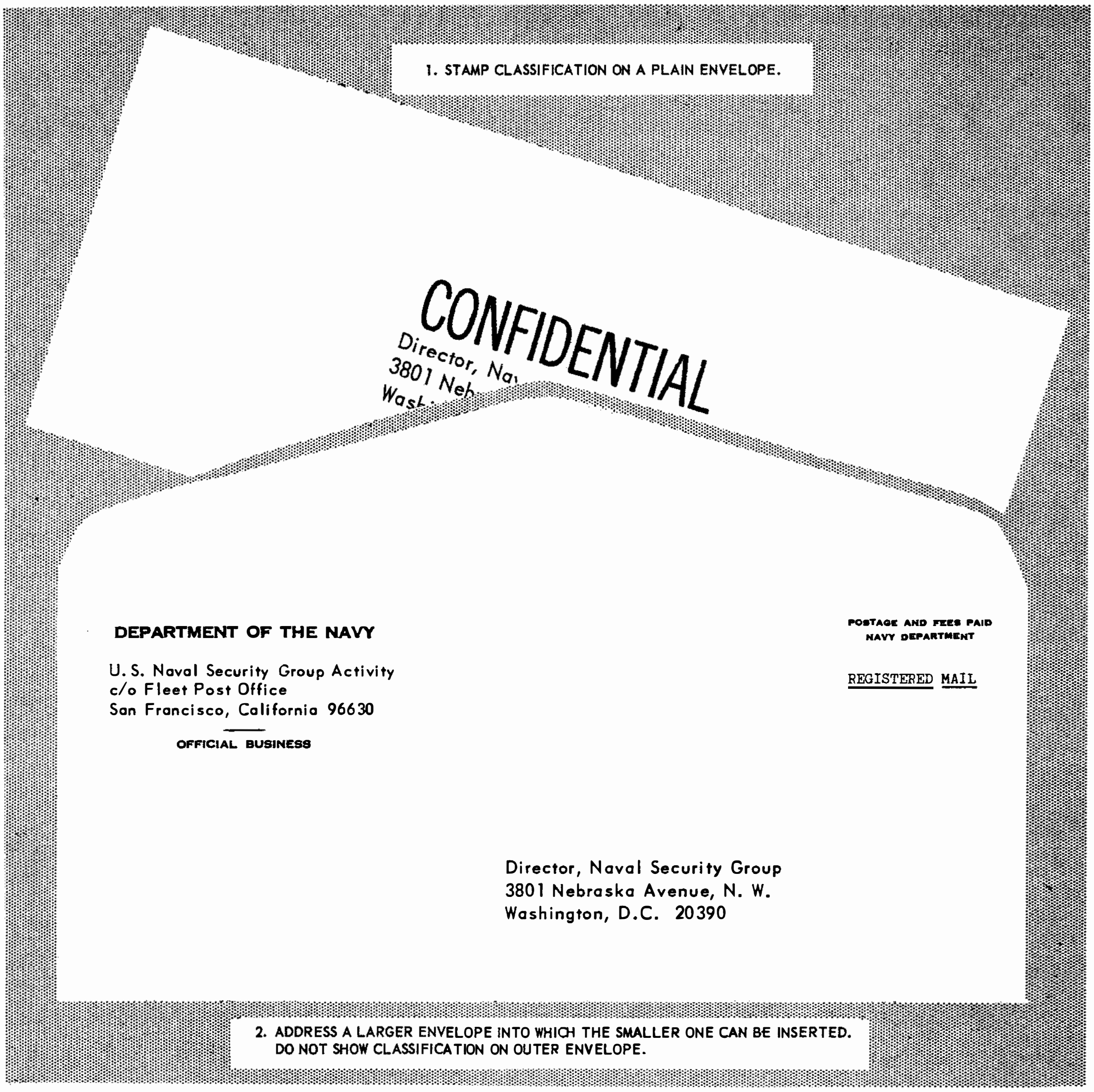
Mailable Secret and Confidential matter is double-wrapped, as shown in figure 3-4. Top Secret matter is prepared similarly, but does not, of course, go through the mails.

Wire Circuits

When available, wire circuits invariably are used in preference to radio, because they are less susceptible to interception. Wire systems are of two types: approved and nonapproved.

An approved circuit is specified by proper authority for transmission of classified information in the clear. Messages classified Secret and below may be transmitted on such circuits. Approved telephone circuits are equipped with security devices to minimize the possibility of wiretapping.

A nonapproved circuit is not designated for transmission of classified information in the clear. Telephone circuits normally are considered nonapproved and are not used to discuss



6.1

Figure 3-4.—How mailable classified matter is prepared.

classified data unless specifically designated as approved.

Often, wiretapping may be discovered by physical examination or by transmission irregularities. Interception by induction, however, can escape detection completely. Supersensitive devices placed near the wire circuit pick up sounds through a 2-foot wall. Tiny microphones, hidden in telephone receivers, detect not only telephone conversations but voices anywhere in the room.

Underwater cables also are liable to unauthorized interception, although they are more difficult to tap than landlines. Submarines are able to make successful interceptions through induction. The point where the cable emerges into shallow water is the most vulnerable.

Visual Communications

Visual communication systems are used in preference to radio except at night, when there is a possibility of divulging a ship's position. They are more secure than radio because reception is limited to units in the immediate vicinity of the sender.

In order of security, visual communication methods rank according to the distance from which signals can be seen. In daylight the relative order is semaphore, directional flashing light, panels, flaghoist, pyrotechnics, and nondirectional flashing light. At night the order is infrared, directional flashing light, pyrotechnics, and nondirectional flashing light.

Utmost care must be taken to ensure that signal lights are used only when necessary, and that minimum light is employed. An exception is for recognition signals, which must be sent on a light sufficiently brilliant to be seen.

Transmission of plain language messages is kept to a minimum because many persons are adept at reading lights and flags.

Sound Systems

Whistles, sirens, foghorns, bells, and underwater sound devices are common types of sound systems. They are utilized by vessels to transmit emergency warning signals (air raid alerts, mine sighting, etc.) and for signals prescribed by the Rules of the Road. Sound systems have the same range limitations as visual methods and also are less secure. Their use, for the most part, is restricted to maneuvering and emergency situations.

Radio

Radio is potentially the least secure means of communication. A message sent by radio is open to interception by anyone who has the necessary equipment and is within reception range. Thus, in addition to obtaining intelligence, an enemy may be able to fix the location of operating forces by means of direction finding. By employing deceptive techniques, he could confuse and hamper our communications and, by traffic analysis, forecast the intentions of our forces.

Uses of radio in the ultrahigh frequency (UHF), superhigh frequency (SHF), and extremely high frequency (EHF) ranges normally have security approaching visual means. Experience has proven, however that transmissions of these frequencies beyond line-of-sight distances have occurred frequently. It is important, therefore, that all users recognize the possibility of interception at distances far beyond the normal usable ranges.

Despite its shortcomings, though, radio still is the primary means of communication. It is fast, reliable, and often the only method of maintaining contact between distant and highly mobile units. The degree of security has been improved through the use of on-line cryptographic systems, but radio is still subject to jamming, interference and direction finding.

The following five topics describe the ways by which radio communications may be sabotaged by an enemy, and countermeasures that may be applied.

• Interception and direction finding: Strict radio silence is the best defense against enemy intelligence efforts by interception and direction finding. It is apparent that an enemy cannot gain intelligence from radio transmissions if none are sent. Radio silence is placed in effect when it is reasonable to assume that an enemy is unaware of the location or impending movements of a ship or force. If it is impracticable to maintain radio silence, the following defensive measures make interception and direction finding more difficult.

1. Avoid unauthorized transmissions and unnecessary testing.
2. Use combinations of transmitters, antennas, and power to produce minimum wave propagation and emission intensity consistent with reliable communications.
3. Use the broadcast method of transmitting traffic in preference to the receipt method.
4. Conceal instructions to shift frequency by using an encrypted message in the absence of a prearranged plan.
5. Adjust transmitters accurately and adhere to frequency tolerances, thereby preventing the need for repeating messages or parts of messages.
6. Maintain strict circuit discipline.

• Traffic analysis: By traffic analysis an enemy may gain valuable information from his study of U.S. communications. Traffic analysis includes studying message headings, receipts, acknowledgments, relays, routing instructions, and service messages; tabulating the volume, types, and directional flow at each point: and correlating information taken from unclassified messages, noting departures from normality.

Assume that within a short time a radio message is transmitted from point Bravo to Romeo, another to Victor, another to a unit of the fleet operating off point Whiskey, and a fourth to a unit off Oscar. Enemy traffic records show that messages rarely are transmitted to these four addressees simultaneously. They also reveal that previous transmissions of this type were followed by arrival of a convoy at point Romeo. An enemy logically may conclude that a convoy from Bravo to Romeo is planned, and that these transmissions probably are arranging for an escort.

Some measures that can be taken to render traffic analysis by an enemy more difficult and less reliable include—

1. Minimum use of radio.
2. Maintenance of strict circuit discipline.
3. Rotation of frequencies.
4. Rotation of call signs and address groups for encryption.
5. Minimum use of service messages, correction request, and repetitions.
6. Concealment of originator and addresses in the text of an encrypted message.
7. Avoidance of long, easily associated messages of a recurrent nature.
8. Control of the timing and volume of test transmissions to avoid revealing information about pending operations.
9. Keeping external routing instructions to a minimum.
10. Use of encrypt for transmission only (EFTO) procedure. (See OpNav Instruction 2220.3 for complete details.)

• Imitative deception: An enemy may attempt to enter communication nets used by the Navy in order to confuse and deceive U.S. forces. This practice is known as imitative deception. There are many deceptive techniques an enemy might use to obstruct radio communications. He may, for example—

1. Receive a message from one circuit and introduce it on another circuit to waste time, create confusion, and produce service messages.
2. Intentionally garble the text of a genuine message and combine it with the heading of another, then introduce it on a different radio net.
3. Originate and transmit false plain language messages.
4. Call a unit in the hope of taking bearings on the answering transmission.
5. Partly obliterate a false message to conceal lack of knowledge of authenticators or call signs.

Proper authentication is the best defense against imitative deception. This security measure is intended to protect communication systems against fraudulent transmissions. An authenticator is a group of characters (usually two randomly selected letters) inserted in a message to prove its authenticity. Any authentication system has accompanying instructions specifying the method of use and transmission procedures. By its correct use, an operator can distinguish between genuine and fraudulent stations or transmissions. A station may include authentication in a transmitted message. This security measure is called transmission authentication.

• Authentication is mandatory when—

1. Suspecting imitative deception on a circuit.
2. Challenging or requesting any station to authenticate.
3. Directing radio silence or requiring a station to break an imposed radio silence.
4. Transmitting a plain language cancellation of an encrypted message by radio or by other methods when sending stations cannot be recognized.
5. Transmitting to a station that is under radio silence.

• Authentication is advisable when—

1. Making contact and amplifying reports in plain language or brevity code.
2. Transmitting a plain language cancellation by radio or visual means when the sending station cannot be recognized.
3. Transmitting operating instructions affecting the military situation; for example, closing down a station or shifting frequency.
4. Making initial radio contact or resuming contact after prolonged interruption. Authentication should be exchanged to prevent an unauthorized station from opening a circuit by asking a legitimate station to authenticate.
5. A station failing, for any reason, to obtain an answer to its calls, is forced to transmit

its messages blind, that is, without getting a receipt from the intended receiving station.

Good judgment sometimes dictates that an operator accept a message instead of arguing over authentication, even though he may doubt its genuineness. Such a message should be delivered promptly to the addressee with the operator's notation that it was not authenticated properly. A decision regarding its authenticity is made by the addressee.

• Other effective defenses against imitative deception are—

1. Thorough training in operating procedures.
2. Alertness of operators to recognize irregularities in procedure and the minor implausibilities that often characterize enemy deceptive efforts.
3. Direction finding on transmissions of questionable origin.
4. Minimum use of plain language and procedure messages.

Maintaining a high degree of circuit discipline on the part of operators also lessens chances of enemy deception. Circuit discipline can be attained only through net control, monitoring, and training. It includes adherence to prescribed frequencies and operating procedure. Negligence, inaccuracy, and laxity—as well as lack of circuit discipline and operator training—are some of the common causes of violations that endanger radio transmission security.

• Jamming: Jamming is another method an enemy may use in his efforts to disrupt communications. It is accomplished by transmitting a strong signal on the victim frequency. A Radioman must be able to recognize jamming, cope with it, and simultaneously prevent an enemy from knowing the effectiveness of his efforts. Common forms of jamming are—

1. Several carriers adjusted to the victim frequency, each carrier modulated by an audifrequency.
2. Simulated traffic handling on the victim frequency.
3. Random noise amplitude-modulated carriers.
4. Continuous-wave carrier (keyed or steady).
5. Several audio tones in rapid sequence, modulating a carrier (called bagpipe, from its characteristic sound).
6. Electrical spark, consisting of numerous jagged peaks of noise of short duration, and having high intensity and a high repetition rate. Spark jamming is encountered more frequently than any other type because it is fairly easy to generate, and its broad radiofrequency characteristics enable an enemy to cover a number of communication channels with one jammer.

Many measures can be used to counter and minimize the effects of jamming. Some of these measures are to—

1. Route messages via alternate circuits, meanwhile continuing live traffic on the jammed circuit to create the impression that jamming is ineffective.
2. Use different receivers to take advantage of differences in selectivity. Selectivity is the ability of a receiver to discriminate between signals close together.
3. Make maximum use of directional effects of available antennas.
4. Request sending station to increase power or to shift frequency.
5. Take advantage of split-phone reception by copying signals keyed simultaneously on two frequencies.
6. Keep receiver volume at a low level when copying through jamming. One's hearing is better able to differentiate between signals that are not too loud.

Each occurrence of jamming must be reported promptly to cognizant authorities. Information concerning these reports is found in NWP 33.

• Security of radiotelephone: Radiotelephone transmissions are the least secure method of radio communication. Anyone within range, who speaks the language used, can understand the transmissions. Circuit discipline and procedure often are poor on radiotelephone circuits because the equipment can be, and often is, operated by someone besides trained radio personnel. Poor circuit discipline and improper procedure slow communications, cause confusion, and may divulge information to an enemy.

Probably the best defense against enemy intelligence efforts is strict adherence to prescribed radiotelephone procedures. With this knowledge in mind, here are a few precautions to observe when communicating by radiotelephone:

1. Use each circuit for its intended purpose only.
2. Keep number of transmission to a minimum.
3. Write message before transmission, if possible.
4. Keep transmissions concise and clear.
5. Transmit no classified information in plain language.
6. Avoid linkage between radiotelephone call signs and other types of call signs.

EMISSION SECURITY

Emission security is that component of communications security which results from all measures taken to deny unauthorized persons information of value which might be derived from intercept and analysis of compromising emanations from crypto-equipment and telecommunications systems.

The Telecommunication systems which utilize cryptoequipment capable of emitting compromising emanations are covered in detail in chapter thirteen of this publication, and therefore will not be discussed at this time.

Operating instructions for the various crypto equipments is classified and therefore cannot be discussed in this publication, but do explain in detail what you must know, as an operator, to prevent your equipment from emitting such compromising emanations.

CENSORSHIP

Censorship is an essential form of protecting military information. It includes censorship of personal communications as well as official communications. Personal censorship should be cultivated until it becomes second nature.

In the course of his duties, a Radioman may possess highly classified information, the knowledge of which is shared oftentimes only by the commanding officer, communication officer, and himself. Always be alert against a slip of the tongue that might reveal this information to someone not authorized to know. The Navy Security Manual states that "indiscreet conversation and personal letters constitute great menaces to security." The only safe policy to pursue, concerning classified information, is: Keep your MOUTH SHUT and your PEN DRY. When on duty, discuss classified subjects only as necessary to accomplish a job. When off duty, don't discuss classified matters with anyone--not even family nor a close friend. Usually the desire to impress others with the importance of one's job is quite strong. Divulging classified information is an unwise way of trying to impress anyone, particularly when by doing so a man may be endangering his country and many lives.

Loose talk in public places is even more dangerous. Conversation in restaurants, hotel lobbies, railroad stations, elevators, taverns, and other public places can be overhead easily. Foreign agents are trained scientifically to collect from such conversations particles of seemingly harmless information. Once pieced together and analyzed, these "innocent" bits of talk sometimes reveal military information of incalculable value.

Mail likewise is subject to interception by an enemy. The following topics must not be mentioned in personal correspondence:

- Location, identity, or movement of ships or aircraft.
- Forces, weapons, military installations, or plans of the United States or her allies.
- Casualities to personnel or material by enemy action.
- Employment of any naval or military unit of the United States or her allies.
- Criticism of equipment or morale of the United States or her allies.

Personal censorship also extends to telephone conversations. To repeat, telephone wires can be tapped, and conversations can be overheard at the switchboard and other points along the circuit. Never discuss classified information over a nonapproved telephone line.

Diaries can be fruitful sources of information for an enemy. They sometimes reveal secrets the enemy laboriously is attempting to extract through cryptoanalysis. Even the peacetime, lost and stolen diaries can cause serious damage to the prestige of the United States.

CALL SIGN ENCRYPTION

Call signs and address designators are encrypted to conceal the identity of the originator and addressees of certain types of messages. Encryption and decryption of these call signs is part of a Radioman's job, hence RM's must become proficient in using the call sign cipher device. Operating instructions for the device may be obtained from the registered publications custodian. More likely, though, a supervisor will know how to operate the device, and can instruct in its use.

An operator must exercise extreme care when transmitting a message containing encrypted call signs. From force of habit he may use the unencrypted international call sign in establishing communications, then send the encrypted version in the message. This blunder results in a compromise of the call sign, and gives enemy intelligence a lever with which to break the entire system.

EMISSION CONTROL (EMCON)

Emission control (from which EMCON is derived) is the regulation or restriction of equipment capable of emitting radio waves to reduce the likelihood of interception by an enemy. Included in EMCON are radio communication equipment, radar, navigational aids (beacons), identification devices (IFF), and aerological devices (radiosonde).

The EMCON program, which encompasses control of electromagnetic radiation, is Navy-wide in scope. In peacetime, EMCON restrictions are imposed only if required for operational purposes or for training. The various degrees of restriction are found in NWP 16.

SECURITY VERSUS SPEED

A variable relationship exists between security and speed in communications. In the planning stages of an operation, for example, when only a few persons should know what is planned, security considerations are paramount. As time of execution approaches, additional persons must know the plan, and preparations cannot be concealed so effectively. Then, speed is increasingly important. In actual combat, plain language transmission of classified information may be authorized, although even then security cannot be totally disregarded.

AUTOMATIC DOWNGRADING AND DECLASSIFICATION

The automatic downgrading and declassification system was instituted to insure all classified matter is made available to the general public when secrecy is no longer necessary and to relieve the originator of future concern for the classified aspects of documents or material they produce.

Depending on the contents of the material, classified information is placed into one of four groups. The assigned grouping indicates whether material may automatically be declassified at any time in the future, and if so, when. The grouping by category is as follows:

A document assigned to—

Group 1	Is completely excluded from automatic downgrading or declassification.
Group 2	Is Top Secret or Secret material that normally would fall in Group 3 or 4, but is individually and specifically exempted from automatic downgrading or declassification in the interest of national security.
Group 3	Warrants some degree of classification indefinitely; it is downgraded at 12-year intervals, but not automatically declassified.
Group 4	Is downgraded at 3-year intervals and is declassified after 12 years.

With few exceptions, classified material is conspicuously marked, on the front cover or on the first page, with an appropriate downgrading and declassification notation as follows:

Group 1	EXCLUDED FROM AUTOMATIC DOWNGRADING AND DECLASSIFICATION
Group 2	EXEMPTED FROM AUTOMATIC DOWNGRADING BY
Group 3	DOWNGRADED AT 12-YEAR INTERVALS: NOT AUTOMATICALLY DECLASSIFIED.
Group 4	DOWNGRADED AT 3-YEAR INTERVALS: DECLASSIFIED AFTER 12 YEARS.

These procedures apply to classified messages as well as other forms of recorded information. To eliminate transmission volume, the originator includes, at the end of the text, the abbreviated marking GP-1, 2, 3, or 4 in lieu of the standard notation.

ADDITIONAL SECURITY INFORMATION

Security precautions mentioned in this rate training manual do not guarantee complete protection. Nor do they attempt to meet every conceivable situation. Anyone who adopts a commonsense outlook can, however, solve most security problems. Moreover, he will gain a knowledge of basic security regulations. For information on local security rules, study ship or station security regulations. Effective editions of the following publications contain additional information on security.

Department of the Navy Security Manual for Classified Information, OpNavInst 5510.1C

U.S. Navy Physical Security Manual, OpNavInst 5510.45

Security, Armed Forces Censorship, OpNavInst 5530.6

U.S. Navy Regulations

Naval Communications, Bulletin, published bimonthly by ACNO(COMM)/COMNAVCOMM

Navy directives in the 2200-2260 series (communication security) and in the 5500-5599 series (administrative security)

DNC 5, ACP 122, NWP 16, and RPS 4 (classified).

CHAPTER 4
THE MESSAGE

A message is a thought or idea expressed briefly in plain or cryptic language, and prepared in a form suitable for transmission by any means of communication.

CLASSES OF MESSAGES

Messages are of five classes: A, B, C, D, and E. Classes A, B, and C are Government messages, and D and E are non-Government (or private) messages. The purpose of this classification system is to aid administration and accounting.

By far the largest volume of message traffic handled by the Navy is class A messages consisting of official messages and replies thereto, originated by the Department of Defense (including the U.S. Coast Guard when operating as part of the Navy).

Class B is made up of official messages of U.S. Government departments and agencies other than the Department of Defense. (The U.S. Coast Guard is included under class B except when operating as a part of the Navy).

Class C messages consist of broadcast traffic in special forms, available to ships of all nationalities. Class C messages are concerned with special services, such as hydrographic data, weather, and time signals.

Class D is composed of private messages for which the Navy collects tolls. This group includes radiotelegrams and press messages sent by correspondents aboard ship.

Class E messages are personal messages to and from naval personnel, handled free of charge over naval circuits. Charges are collected from the sender only when a commercial communication company, such as Western Union, handles the message over part of its route. Suppose your ship is in the Atlantic and has a class E message addressed to a man stationed aboard another ship in the Atlantic or Pacific. The message never leaves Navy channels, and the originator pays nothing. If the message were addressed to Louisville, Ky., Western Union would handle it out of Washington, and the ship would collect tolls from the originator for the distance between Washington and Louisville. Your ship would forward the money to the Navy Finance Center, Washington, D.C., for payment to Western Union, in accordance with instructions found in the effective edition of DNC 26.

The class E message privilege is mainly for purposes of morale. It affords naval personnel at sea a means of communication of urgent personal matters without incurring prohibitive expense. It is unavailable between points on shore within the United States. In general, the privilege is used sparingly. Subjects ordinarily acceptable for transmittal or delivery are matters of grave personal concern, such as serious illness of a close relative, birth announcements, important nonrecurring business communications, matters of life and death, and occasional greetings on important anniversaries. Not acceptable are trivial or frivolous messages, those of unnecessary length, and ordinary congratulations.

ORIGINATOR; DRAFTER; RELEASING OFFICER

An originator of a message is the command by whose authority the message is sent. The drafter—usually a department head—is the person who actually composes the message for release. A releasing officer authorizes transmission of the message for and in the name of the originator. Ordinarily the commanding officer is releasing officer, but he may delegate releasing authority.

A Radioman charged with acceptable locally originated messages must know who has releasing authority. He also should check every message for the releasing officer's signature.

ADDRESSEES

Most messages have at least one addressee responsible for taking action on the contents and for originating any necessary reply. Other addressees with an official concern in the subject of a message, but who do not have primary responsibility for acting on it, receive the message for information. Do not be confused by the term "information addressee." Even though an information addressee usually is concerned only indirectly with a message, frequently he must take action of some nature within his own command. Some messages have only information addressees.

Messages may be divided into types, according to the way they are addressed, as (1) single-address, (2) multiple-address, (3) book, and (4) general. These four types of messages will be covered more extensively later in the chapter.

RED CROSS MESSAGES

The American Red Cross is permitted free use of naval communication facilities for sending and receiving messages regarding emergency welfare in the interest of armed forces personnel. Red Cross messages are handled as class B messages. They normally are in plain text, but may be encrypted for transmission only (E F T O).

The Red Cross messages you are most likely to see concern personal hardship, death, or serious illness of relatives of military personnel. You will receive from the fleet broadcast many such messages addressed to ships at sea.

When emergencies or disasters occur involving Red Cross relief work, Red Cross messages may be handled over naval circuits whether they are in the interest of armed forces personnel or not.

Red Cross messages normally are not accepted for transmission unless delivery can be effected entirely by naval communications.

SPECIAL-PURPOSE MESSAGES

A number of messages are named for the purpose they serve. They usually contain reports or information of a recurring nature and may follow a specific format. A few of the more common types of special-purpose messages are explained in ensuing topics.

CONTACT AND AMPLIFYING REPORTS

A contact report is a message reporting the first contact with an enemy force. Speed of handling such a message is of the utmost importance. Contact reports have priority over every other type of traffic handled by naval communications.

An amplifying report follows up a contact report. It contains further data about an enemy force, such as number, type, position, course, speed, and distribution. A contact report may be followed by many amplifying reports as information becomes available and the enemy shows his intentions. Often it is possible to transmit some amplifying data with the contact report.

MOVEMENT REPORTS

The Navy has hundreds of fleet units always on the move. It is necessary, for command purposes and for efficient administration, to have an up-to-the-hour knowledge of the location of every vessel. Dissemination of movement information is a function of the movement report system.

The controlling agency of the entire movement report system is the Movement Report Control Center at Washington, D.C. (MRCC WASHDC). For reporting purposes, the world is divided into five zones, of which only four presently are assigned. Each zone is controlled by a movement report center (MRC). Each zone is further subdivided into areas controlled by movement report offices (MRO's). An MRC may receive information on movements all over the world, but MRO's have information only on movements in their own areas of responsibility.

Before getting underway, a ship sends a movement report message stating the time of departure, destination, route, speed of advance, and any other information the ship may be directed to furnish. The message enters the movement report system through the MRO or MRC controlling the area the ship is in. It then is the responsibility of the MRO or MRC to relay the information to military and civilian activities that have an official interest in the location of the vessel. Included are such activities as supply centers, fleet post offices, fleet broadcast stations, and customs authorities.

Movement report messages are prepared in accordance with NWIP 10-1.

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HYDRO MESSAGES

The U.S. Navy Oceanographic Office originates notices or messages concerning navigation warnings. These messages are given wide distribution on special hydrographic broadcasts of which there are two subdivisions. HYDROLANTS contain navigational information relating to the Atlantic, Mediterranean, and Indian Oceans. HYDROPACS furnish like information for the Pacific Ocean areas.

NOTICE TO AIRMEN

Notices to airmen (NOTAMs) are originated by military activities and civil agencies concerned with safety of aircraft. The NOTAMs are composed of data relating to aerological facilities, services, and hazards.

Q MESSAGES

The classified portions of the navigational warning systems of Allied Nations are known as Q messages. They contain information affecting navigation that an enemy would find difficult to obtain on his own. Do not confuse Q messages with Q signals, which are explained later in this chapter.

ALL SHIPS PRESENT MESSAGES

All ships present messages are originated by the senior officer present afloat (SOPA), and relate to such matters as storms, port security regulations, and local liberty policy. The SOPA prescribes local instructions governing initiation, transmission, and relay of all ships present messages.

MINIMIZE MESSAGES

In an emergency—either actual or simulated—it may be necessary to reduce message and telephone traffic to prevent delay in handling vital messages. This reduction in traffic is accomplished by promulgation (usually by message) of the word MINIMIZE, which has the following meaning: "It is now mandatory that normal message and telephone traffic be reduced drastically in order that vital messages connected with the situation indicated shall not be delayed." A message ordering minimize consists of the word minimize, followed by scope (area affected), reason, and duration of its imposition (when known). Messages imposing minimize must be brought to the immediate attention of the communication officer.

STATION AND ADDRESS DESIGNATORS

Station and address designators are formed of combinations of characters or pronounceable words for use in message headings to identify originators and addressees. Station and address designators are of four kinds: Call signs, address groups, routing indicators, and plain language address designators.

CALL SIGNS

Call signs are letters, letter-number combinations, or one or more pronounceable words, used chiefly to identify communication activities and for establishing and maintaining communications. They are applicable in both civil and military communications. Call signs are of several categories, with some calls belonging to more than one category.

International Call Signs

International call signs are assigned radio stations of all countries—civil and military, afloat and ashore—according to international agreement. The first letter or first two letters of an international call indicate the nationality of the station. The United States has the first half of the A block (through ALZ) and all of the K, W, and N blocks. The United States reserves A calls for the Army and Air Force. The K and W blocks are assigned to commercial and private stations, merchant ships, and others. The N block is only for use by the Navy, Marine Corps, and Coast Guard.

Naval shore communication stations have three-letter N calls. If necessary, these calls may be expanded by adding numerical suffixes. Thus, additional call signs are provided for radio transmitting and receiving facilities located remotely from the parent station. Examples:

NAM . . . . . NAVCOMMSTA Norfolk.
NAMI . . . . Headquarters, CINCLANTFLT, Norfolk.
NAM2 . . . . Naval Shipyard, Norfolk.

Exceptions to the three-letter N calls for Naval shore communications stations are as follows: U.S. NAVRADSTA Thurso, Scotland "GXH," NAVCOMMSTA Morocco "CNL" and NAVCOMMSTA Spain "AOK."

Call signs for fixed and land radio stations are listed in Allied Call Signs and Address Group System Instructions and Assignments (ACP 100) and U.S. Supplement 1 thereto.

International call signs assigned to U.S. naval vessels are four-letter N calls, which are used unencrypted only. They have no security value, hence they are utilized for all nonmilitary international communications. Example:

NJFK. . . . . USS John F. Kennedy (CVA 67).

International call signs for USN, USMC, and USCG aircraft are composed of the N, NM, or NC, respectively, followed by the last four digits of the serial or systems command number of the aircraft.

Military Call Signs

Most ships of the Allied Nations are assigned military call signs in addition to their international call signs. From these military call signs are derived encrypted call signs for CW and Ratt communications, likewise, military call signs form the basis for both encrypted and unencrypted call signs for voice communications. They are never used in their basic form to address messages, consequently military call signs are assigned only to ships capable of encrypting call signs. Both international and military call signs are listed in Call Sign Book for Ships (ACP 113).

Indefinite Call Signs

Indefinite call signs represent no specific command, authority, facility or unit. They may, depending upon the need, be used for temporary communications to conceal the identity of the user. Indefinite call signs are two letter combinations using the letters NA through NZ (combination NR not being allowed). These call signs are used when handling codress message traffic (usually by ships) to conceal the identity of the originator. In such instances the identity of the originator and the addressees are encrypted in the text of the message.

Collective Call Signs

Collective call signs pertain to two or more facilities, commands, or units. Examples:

NATA . . . . . . All U.S. Navy ships copying this broadcast.
NIMK. . . . . . . All U.S. submarines copying this broadcast.

Net Call Signs

Net call signs represent all stations within a net. (A net is a group of stations in direct communication with each other on a common channel.) Examples:

NQN . . . . All U.S. Navy radio stations in the Pacific guarding the ship-shore high-frequency calling series.
OVERWORK . . All U.S. Navy stations on this (radiotelephone) circuit.

Tactical Call Signs

Tactical call signs, with the exception of task organization and aircraft call signs, are limited in application. They normally are used in tactical communications only, to identify tactical commands or communication facilities. Tactical call signs are composed of letter-number combinations. They are listed in Tactical Call Sign Book (ACP 110).

Voice Call Signs

Voice call signs are words or combinations of words—such as SUNSHINE or HIGH HAT—limited to radiotelephone communications. Call signs in Joint Voice Call Sign Book (JANAP 119) and in Allied Tactical Voice Call Sign Book (ACP 119) are only for tactical circuits. On ship-shore administrative circuits, phonetically spelled international call signs are given as ships voice calls. Under certain conditions, ships names are used as voice call signs on local harbor circuits. All the various types of voice call signs and the rules for their application in radiotelephone communications are treated in a later chapter.

Visual Call Signs

Visual call signs are groups of letters, numerals, special flags and pennants, or any of these combinations, for use in visual communications. They are listed in the Visual Call Sign Book (ACP 118).

ADDRESS GROUPS

Address groups are four-letter groups assigned to represent a command, activity, or unit. They are used mainly in the message address. In military communications, although, they can be used in the same manner as call signs to establish and maintain communications. In general, call signs and address groups are used by the Navy in exactly the same way. Address groups never start with the letter N, hence they are easily distinguished from naval radio call signs. Unlike international call signs, address groups follow no distinctive pattern. For example, you learned the difference in call signs for naval ships and shore radio stations. In address groups, however, arrangement of the four letters conveys no significance whatsoever.

Afloat commands (except individual ships), and shore-based commands, authorities, or activities not served by their own communication facilities are assigned address groups. For example, (1) senior commands and commanders ashore, such as the secretaries of Defense and of the Navy, bureaus, system commands, and offices of the Navy Department, and district commandants; (2) fleet, type, or force commanders ashore (3) elements of operating forces permanently ashore who are in frequent communication with forces afloat; and (4) elements of the shore establishment (such as weather centrals) having a need for direct addressing and receipt of the messages.

Among other uses, address groups facilitate delivery of messages when a communication center serves so many activities that its own call sign is insufficient to identify the addressee. Address groups are contained in the Allied Call Signs and Address Group Systems, Instructions and Assignments (ACP 100) and its U.S. Supplement 1.

Address groups, like call signs, are divided into types. They are individual activity, collective, conjunctive, geographic, address indicating, and special operating groups.

Individual Activity Address Groups

Individual activity address groups are representative of a single command or unit, either afloat or ashore. Examples: DTCI—COMPHIBLANT; SSMW—CNO.

Collective Address Groups

Collective address groups represent two or more commands, authorities, activities, units, or combinations of these four. Included in the group are the commander and his subordinate commanders. Examples: DSWN—DESRON 16; AMGK—SIXTHFLT.

Conjunctive Address Groups

Conjunctive address groups, remember, have incomplete meanings. It is always necessary to complete the meaning by adding other address groups denoting a specific command or location. It is for this reason that conjunctive address groups are used only with one or more other address groups. The conjunctive address group XZKW, for example, means "all ships present at________." To complete the meaning, this particular group must be followed by a geographic address group.

Geographic Address Groups

Geographic address groups are the equivalent of geographical locations or areas. They are always preceded by conjunctive address groups. Assuming the geographic address group for Newport, R.I., to be DEXL, all ships present at Newport would be addressed XZKW DEXL.

Address Indicating Groups

Address indicating groups (AIGs) represent a specific set of action and/or information addressees. The originator may or may not be included. The purpose of AIGs is to increase the speed of traffic handling. They shorten the message address by providing a single address group to represent a number of addressees, thus eliminating individual designators for each address. For example, AIG 31 is a hypothetical AIG used to address air defense messages originated by COMEASTSEAFRON to 24 action addressees and 37 information addressees. By using a single AIG in this example, 60 call signs and address groups are eliminated from the heading of the message.

Special Operating Groups

Special operating groups (SOGs) are utilized for passing special instructions in message headings. They are four-letter groups that are identical in appearance to address groups. Special operating groups are not used by the Navy unless specifically authorized by CNO. When they are authorized, they must always be encrypted. A list of SOGs, together with their meanings, is in ACP 100.

ROUTING INDICATORS

Routing indicators are groups of letters whose purpose is to identify stations in a communications relay network. Depending on the type of station, routing indicators vary in length from four to seven letters. It is easy to distinguish routing indicators from call signs or address groups because routing indicators always begin with the letter R. Routing indicators are never encrypted. A complete discussion of routing indicators and their usage is included later in this book.

PLAIN LANGUAGE ADDRESS DESIGNATORS

Plain language address designators are the official, abbreviated, or short titles of commands or activities, used instead of call signs or address groups in headings of messages. Some abbreviated titles are written as single words. Others have conjunctive titles and geographical locations. Example: CNO; NAVCOMMSTA GUAM.

Plain language address designators are used almost exclusively in modern-day communications ashore. They also have very wide application in fleet communications, as well as in communicating with the armed forces of allied nations. They are not used in headings of codress messages, nor in radiotelegraph messages.

TIME IN MESSAGES

For reckoning time, the surface of the earth is divided into 24 zones, each extending through 15° longitude. Each zone differs by 1 hour from the zone next to it.

The initial time zone lies between 7-1/2°E and 7-1/2°W. of zero meridian, which passes through the town of Greenwich, England. The time in this zone—zone zero—is called Greenwich mean time (GMT). More commonly referred to as "ZULU" time, both names mean the same. Each zone, in turn, is indicated by the number that represents the difference between local zone time and Greenwich mean time.

Zones laying in east longitude from zone zero are numbered from 1 to 12 and are designated minus, because for each of them the zone number must be subtracted from local time to obtain Greenwich mean time. Zones lying in west longitude from zero zone are numbered from 1 to 12 also, but are designated plus, because the zone number must be added to local zone time to obtain GMT. In addition to the time zone number, each zone is further designated by letter. Letters A through M (J omitted) indicate minus zones; N through Y, plus zones. (See fig. 4-1.) The designating letter for GMT is Z.

The 12th zone is divided by the 180th meridian, the minus half lying in east longitude and the plus half in west longitude. This meridian is the international date line, where each worldwide day begins and ends. A westbound ship crossing the line loses a day, whereas an eastbound ship gains a day.

The number of a zone, prefixed by a plus or a minus sign, constitutes the zone description. Zones crossing land areas are often modified to agree with boundaries of countries or regions using corresponding time.

The approved method of expressing time in the 24-hour system is with hours and minutes expressed as a four-digit group. The first two figures of a group denote the hour; the second two, minutes. Thus, 6:3Ø a.m. becomes Ø63Ø; noon is 12ØØ; and 6:3Ø p.m. is 183Ø. Midnight is expressed as ØØØØ—never as 24ØØ—and 1 minute past midnight becomes ØØØ1. The time designation 1327Z shows that it is 27 minutes past 1:ØØ p.m., GMT. Numbers are prefixed to the time to indicate the day of the month; in other words, to form a date-time group (DTG). The DTG 171327Z Nov 70 means the 17th day of November plus the time in GMT. Dates from the 1st to the 9th of the month are preceded by the numeral Ø.

A date-time group is assigned to a message by the message center at the time a message is prepared for transmission. For standardization, time expressed by a date-time group normally is GMT. The date-time group in a message heading serves two purposes: It indicates time of origin of the message, and it provides an easy means of referring to the message.

In addition to the external DTG, an encrypted message has a DTG buried within the text. This time is called the true date-time group (TDTG) and it is inserted by the cryptocenter. The TDTG is used when referring to a message that has been encrypted.

The DTG assigned to a general message always has a slant sign (/) and additional digits added to the DTG. Additional digits represent the general message sequential serial number. Example: 102347Z/35 Nov. 70.

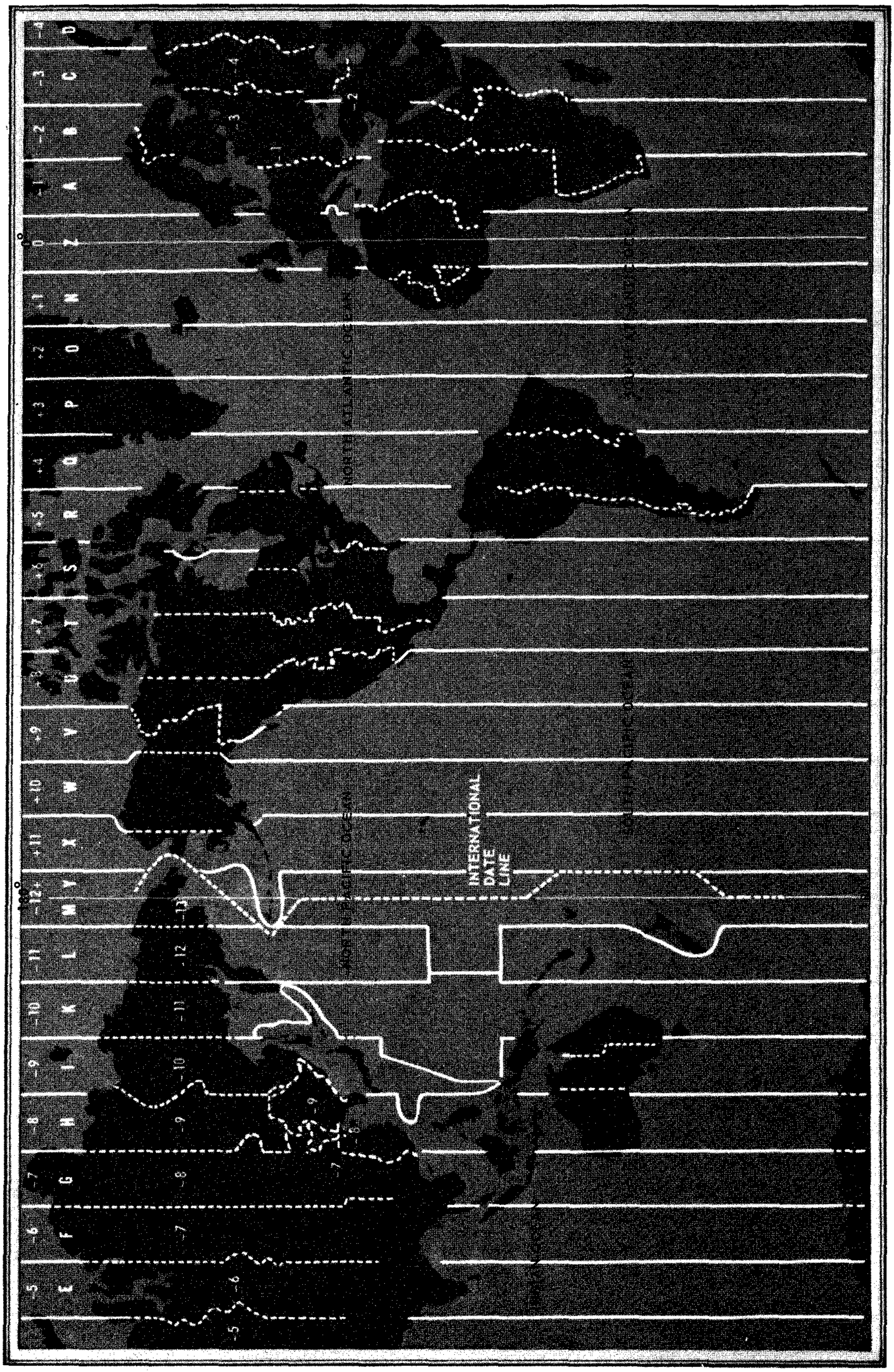

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Figure 4-1.—Time zone chart of the world.

Local time is used sometimes to indicate date and time in the text of a message, but must be accompanied by the zone designating letter—as in 170812Q. When local time is referred to frequently in the text, the suffix may be omitted if a covering expression is used, such as ALL TIMES QUEBEC.

TIME CONVERSION TABLE

The time conversion table (Table 4-1) is useful for converting time in one zone to time in any other zone. Vertical columns indicate time zones. Zone Z is GMT. Time in each successive zone to the right of zone Z is 1 hour later, and to the left of zone Z is 1 hour earlier. Time in each successive shaded area to the right is 1 day (24 hours) later; to the left it is 1 day (24 hours) earlier.

To calculate time in zone U when it is Ø5ØØ hours in zone I, for example, proceed as follows: find Ø5ØØ in column I and locate the time (12ØØ) in the corresponding line in column U. Inasmuch as 12ØØ is not in the shaded area, the time is 12ØØ hours yesterday.

PRECEDENCE

Precedence is an important concept in communications. To communication personnel, it indicates the relative order in which a message must be handled and delivered. To the addressees, precedence shows the relative order in which the contents are to be noted. Precedence is assigned by the originator on the basis of message content and how soon the addressee must have it. No message is assigned a precedence higher than that required to ensure that it reaches all addressees on time.

Multiple-address messages having both action and information addressees are often assigned two precedences, called dual precedence. One precedence is for the action addressees, and a lower precedence is for information addressees.

Use of higher precedences is limited to certain types of urgent traffic, and standards for handling each precedence are prescribed in ACP 121 and U.S. Supplement 1 thereto. The rules governing precedence are set forth in table 4-2.

PROSIGNS

Procedure signs, or prosigns, are letters or combinations of letters that convey in short, standard form certain frequently sent orders, instructions, requests, reports, and the like, relating to communications. Although some prosigns seem to be abbreviations of their assigned meanings, prosigns are never referred to as abbreviations.

Following is a complete list of authorized prosigns. Memorize them now. It may be helpful to prepare a number of small cards, with the prosign on the front and its meaning on the back. Use the cards for self-drill.

1. Precedence Prosigns:

   Z .... FLASH.
   O .... IMMEDIATE.
   P .... PRIORITY.
   R .... ROUTINE.
2. Prosigns that identify portions of a transmission:
   AA .... All after.
   AB .... All before.
   WA .... Word after.
   WB .... Word before.
3. Ending prosigns:
   K .... Go ahead; or, this is the end of my transmission to you and a response is invited.
   AR .... End of transmission; no receipt required.
4. Pause prosigns:
   AS .... I must pause for a few seconds.
   AS AR .... I must pause longer than a few seconds; will call you back.
5. Separation prosigns:
   BT .... Break. (Separates text of message from heading and ending.)
   II (Written in messages as a short dash) .... Separative sign. (Used to separate certain elements of message headings. Not to be used as punctuation to represent a hyphen or dash in message texts.)

Table 4-1.—Time Conversion Table

PREVIOUS DAY	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	SAME DAY
	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	
	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	
	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	
	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	
	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	
	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	
SAME DAY	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	NEXT DAY
	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	
	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	
	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	
	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	
	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	
	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	
	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	
	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	
	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	
	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	
	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	
	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	
	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	
	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	
	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	
	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	
	Y	X	W	V	U	T	S	R	Q	P	O	N	Z	A	B	C	D	E	F	G	H	I	K	L	M	
	+12	+11	+10	+9	+8	+7	+6	+5	+4	+3	+2	+1	0	−1	−2	−3	−4	−5	−6	−7	−8	−9	−10	−11	−12	

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6. Prosigns always followed by one or more call signs and/or address groups:
   - DE . . . . From (in call).
   - FM . . . . Originator's sign.
   - TO . . . . The addressee designations immediately following are addressed for action.
   - INFO . . . . The addressee designations immediately following are addressed for information.
   - XMT . . . . Exempt. (Used to exempt addressees from a collective call or address.)
7. Prosigns used in transmission instructions of a message:
   - T . . . . Transmit this message to all addressees or to the addressee designations immediately following.
   - G . . . . Repeat this entire transmission back to me exactly as received.
   - F . . . . Do not answer.
8. Group count prosigns:
   - GR plus numerals . . Group count.
   - GRNC . . . . The groups in this message have not been counted.
9. Prosigns used with the executive method:
   - $\overline{\text{IX}}$ . . . . Action on the message or signal that follows is to be carried out upon receipt of "Execute."
   - $\overline{\text{IX}}$ Plus 5-second dash . . . . "Execute"—carry out the purpose of the message or signal to which this applies.
10. General:
    - $\overline{\text{AA}}$ . . . . Unknown station.
    - B . . . . More to follow.

Table 4-2.—Precedence of Messages

Prosign	Designation	Definition and Use	Handling Requirements
Z	FLASH	FLASH precedence is reserved for initial enemy contact messages or operational combat messages of extreme urgency. Brevity is mandatory. Examples: (1) Initial enemy contact reports. (2) Messages recalling or diverting friendly aircraft about to bomb targets unexpectedly occupied by friendly forces; or messages taking emergency action to prevent conflict between friendly forces. (3) Warnings of imminent large-scale attacks. (4) Extremely urgent intelligence messages. (5) Messages containing major strategic decisions of great urgency.	FLASH messages are hand-carried, processed, transmitted, and delivered in the order received and ahead of all other messages. Messages of lower precedence will be interrupted on all circuits involved until handling of the FLASH message is completed. Time Standard: Not fixed. Handled as fast as humanly possible with an objective of less than 10 minutes.
O	IMMEDIATE	IMMEDIATE is the precedence reserved for messages relating to situations that gravely affect the security of national/allied forces or populace, and require immediate delivery to the addressee(s). Examples: (1) Amplifying reports of initial enemy contact. (2) Reports of unusual major movements of military forces of foreign powers in time of peace or strained relations. (3) Messages that report enemy counterattack or request or cancel additional support. (4) Attack orders to commit a force in reserve without delay. (5) Messages concerning logistical support of special weapons when essential to sustain operations. (6) Reports of widespread civil disturbance. (7) Reports or warnings of grave natural disaster (earthquake, flood, storm, etc). (8) Requests for, or directions concerning, distress assistance. (9) Urgent intelligence messages.	IMMEDIATE messages are processed, transmitted, and delivered in the order received and ahead of all messages of lower precedence. If possible, messages of lower precedence will be interrupted on all circuits involved until the handling of the IMMEDIATE message is completed. Time Standard: 30 minutes to 1 hour.
P	PRIORITY	PRIORITY is the precedence reserved for messages that require expeditious action by the addressee(s) and/or furnish essential information for the conduct of operations in progress when ROUTINE precedence will not suffice. Examples: (1) Situation reports on position of front where attack is impending or where fire or air support will soon be placed. (2) Orders to aircraft formations or units to coincide with ground or naval operations. (3) Aircraft movement reports (messages relating to requests for news of aircraft in flight, flight plans, or cancellation messages to prevent unnecessary search/rescue action). (4) Messages concerning immediate movement of naval, air, and ground forces.	PRIORITY messages are processed, transmitted, and delivered in the order received and ahead of all messages of ROUTINE precedence. ROUTINE messages being transmitted should not be interrupted unless they are extra long and a very substantial portion remains to be transmitted. PRIORITY messages should be delivered immediately upon receipt at the addressee destination. When commercial refile is required, the commercial precedence that most nearly corresponds to PRIORITY is used. Time Standard: 1 to 6 hours.
R	ROUTINE	ROUTINE is the precedence to use for all types of messages that justify transmission by rapid means unless of sufficient urgency to require a higher precedence. Examples: (1) Messages concerning normal peacetime military operations, programs, and projects. (2) Messages concerning stabilized tactical operations. (3) Operational plans concerning projected operations. (4) Periodic or consolidated intelligence reports. (5) Troop movement messages, except when time factors dictate use of a higher precedence. (6) Supply and equipment requisition and movement messages, except when time factors dictate use of a higher precedence. (7) Administrative, logistic, and personnel matters.	ROUTINE messages are processed, transmitted, and delivered in the order received and after all messages of a higher precedence. When commercial refile is required, the lowest commercial precedence is used. ROUTINE messages received during nonduty hours at the addressee destination may be held for morning delivery unless specifically prohibited by the command concerned. Time Standard: 3 hours — start of business following day.

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RM 2 FEB 74

C . . . . Correct.
EEEEEEEE . . . . . . Error.
EEEEEEEE AR . . . . This transmission is in error. Disregard it.
HM HM HM. . . . . . . Emergency silence sign.
IMI . . . . Repeat.
INT . . . . Interrogative
J. . . . . Verify with originator and repeat.
NR . . . . Station serial number.
R . . . . I received your last transmission satisfactorily.

USE OF OPERATING SIGNALS

Operating signals are prescribed for every form of electrical telecommunication except radiotelephone. Instead of using customary operating signals, a radio-telephone operator transmits operating information in brief spoken phrases (PROWORDS). An exception to this rule is made when a message containing an operating signal is relayed by radiotelephone; then the operator transmits the group phonetically.

Many operating signals may be used in either of two ways—as a question or as a statement. The prosign INT before a signal places it in the form of a question. Example: USS Epperson (DD 719) asks USS John F. Kennedy (CVA 67): NJFK DE NTGT INT QSO AOK K, Meaning "are you in communication with NAVCOMMSTA Spain. John F. Kennedy replies: NTGT DE NJFK QSO AOK K, meaning I am in communication with NAVCOMMSTA Spain, over.

When communicating with nonmilitary stations, the prosign IMI, after the Q signal, is employed instead of INT ahead of the Q signal to give an interrogatory meaning.

Some signals must be accompanied by a numeral suffix that completes, amplifies, or varies the basic meaning. Example: A teletype operator checks circuit operation with the query INT ZBK meaning "Are you receiving my traffic clear?" the receiving station has a choice of replies: ZBK1 means "I am receiving your traffic clear," or ZBK2, "I am receiving your traffic garbled."

Many operating signals contain blank portions in their meanings that are filled in to convey specific information. To illustrate, INT ZRE means "On what frequency do you hear me best?" In ACP 131 the declaratory meaning listed for ZRE is "I hear you best on ________kHz (mHz)." The operator fills in the necessary information thus: NWBJ DE NJFK ZRE A2C, which means "I hear you best on A2C." The frequency, encoded, from JANAP 195 is used.

Other signals, in their meanings, have blanks enclosed in parentheses. Filling in such a blank is optional. For example, INT ZHA means "Shall I decrease frequency very slightly (or _____kHz to clear interference?" The operator receiving the signal INT ZHA without the frequency added knows it means "Shall I decrease frequency very slightly?"

During wartime, operating signals often are encrypted, especially those revealing.

1. Specific frequencies.
2. Cryptographic data.
3. The organization of networks.
4. Ship movements (estimated times of arrival, departure, and kindred data).

Unless they are encrypted, operating signals possess no security and must be regarded as the equivalent of plain language.

Some of the most commonly used operating signals are listed in table 4-3. Remember that the Q code is used internationally, and speaks of "telegrams" where a U.S. Navy communicator would say "message."

BASIC MESSAGE FORMAT

With a few exceptions, military messages sent by electrical telecommunications are arranged according to a standard joint form. This is called "basic message format" and stays substantially the same for all methods of transmission.

The basic message format is divided into three parts; the heading, text and ending. There are a total of sixteen format lines for use in making up these three parts. All sixteen format lines need not be used to construct a complete message. Also, there is no relationship between format lines and handwritten or typed lines. Format lines are merely a method of placing the message contents in a standard sequential order.

In the following paragraphs we will discuss the three parts of a message and their contents as to format lines, components and elements.

Table 4-3.—Operating Signals

Signal	Question	Answer, Advice, or Order
QRK	What is the readability of my signals (or those of________)?	The readability of your signals (or those of_______) is__ ______(1 to 5).
QRM	Are you being interfered with?	I am being interfered with.
QRO	Shall I increase power?	Increase power.
QRP	Shall I decrease power?	Decrease power.
QRU	Have you anything for me?	I have nothing for you.
QSA	What is the strength of my signals (or those of________)?	The strength of your signals (or those of_______) is____ ______(1 to 5).
QSV	Shall I send a series of Vs on this frequency [or _____ kHz (or MHz)]?	Send a series of Vs on this frequency [or ____ kHz (or MHz)].
QSY	Shall I change to transmission on another frequency?	Change to transmission on another frequency [or on _____ kHz (or MHz)].
ZAR	. . . .	This is my____request (or reply). [(1) First, (2) second, (3) third, etc.]
ZBK	Are you receiving my traffic clear?	I am receiving your traffic______[(1) clear; (2) garbled].
ZDK	Will you repeat message_________(or portion _________)? Or, rerun No.______?	Following repetition (of______) is made in accordance with your request.
ZEC	Have you received message___________?	Message__________[(1) not received, (2) unidentified, give better identification data].
ZEN	. . . .	This message has been delivered by other means or by a separate transmission to the addressee(s) immediately following this operating signal.
ZEX	. . . .	This is a book message and may be delivered as a single address message to addressees for whom you are responsible.
ZFH	. . . .	This message (or message________) is being (or has been) passed to you (or___) for_______[(1) action, (2) information, (3) comment].
ZFI	Is there any reply to message___________?	There is no reply to message_________.
ZIA	. . . .	This message (or message_____) is being (or has been) passed out of proper sequence of station serial numbers.
ZII	What was___of your (or____'s) number_____? [(1) date-time group, (2) filing time].	My (or____'s) number_____had following_____ [(1) date-time group, (2) filing time].
ZKP	Are you (or is ____) radio guard for__________ [on ____ kHz (or MHz)]?	I am (or ____ is) radio guard for____ on ____kHz (or MHz)].
ZNB	What is authentication of______ [(1) message__ _____, (2) last transmission, (3) _______]?	Authentication (of____) is_______ [(1) message______, (2) last transmission, (3) ___________].
ZOC	. . . .	Station(s) called relay this message to addressees for whom you are responsible.
ZON	. . . .	Place this message (or message______) on broadcast indicated by numerals following_______(numeral may be followed by specific broadcast designator) [(1) NSS; (2) NPG; (3) NPM; (4) NBA; (5) NPN; (6) NPO; (7) NHY; (8) NAM; (9) NAF; (10) NPL; (11) NDT].
ZOV	. . . .	Station designation preceding this operating signal is the correct routing for this message rerouted by_____.
ZUE	. . . .	Affirmative (Yes).
ZUG	. . . .	Negative (No).
ZUI	. . . .	Your attention is invited to _______________.
ZUJ	. . . .	Standby.

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HEADING

The heading is the most complex part of a message and understandably so as it sometimes contains up to ten of the sixteen format lines. The heading has four components; the beginning procedure, preamble, address and prefix. Some of the contents of these components have already been discussed, so arranging them in their proper format line order should be comparatively easy.

Beginning Procedure Component

This is one of the "changeable" portions of a message as it is prepared by you, the radio operator. It contains format lines one through four. The construction of the beginning procedure component varies as there are five separate methods of transmission. Depending on the method of transmission, you will be using call signs, address groups, plain language designators or routing indicators and prosigns and operating signals to prepare this component giving necessary instructions to effect delivery of the message to all addressees.

Format line one is called handling instructions and is used only in tape relay and automatic digital networks.

Format line two contains the called stations element as required in the following order: designations of the station(s) called, the prosign XMT and designations of the exempted station(s).

Format line three is the calling station element and contains the prosign DE followed by the designation of the station calling. When transmission identification is used, the prosign NR followed by a number or a letter and number follows the designation of the station calling.

Format line four is called the transmission instructions and may contain the prosigns F, G, and T, operating signals and station designators.

As we stated earlier, the construction of this component varies according to the type of transmission media used. What we have discussed in the preceding paragraphs is merely the basics for this component. Explicit instructions for preparation of this component for each transmission media is discussed in the following chapters and appropriate procedure publications (ACP's and JANAP's).

Preamable Component

Format line five contains the entire preamble component. There are three elements in the preamble; the precedence, date-time-group (including the month and year abbreviated) and the message instructions.

The first element, the precedence, is the appropriate precedence prosign Z, O, P or R as assigned by the originator. In the case of dual precedence, both precedence prosigns appear in this element.

The second element, the date-time-group (DTG) appears as a six digit number suffixed by the letter "Z" to indicate Greenwich Mean Time. The abbreviation for the month and year follows the date-time-group.

The third and last element, the message instructions, is used to express specific handling or delivery instructions desired by the communication center of the originator. These instructions are in the form of operating signals or the prosign $\overline{\text{IX}}$ when appropriate.

Address Component

This component uses format lines six, seven, eight, and nine when the requirement exists. In other words, the format line is used only when the originator has designated action, information and/or information addresses. Format line nine is not used unless a collective address appears in format line seven or eight.

Format line six is the originators element. It is identified by the originators prosign FM and contains the designation of the originating station.

Format line seven is the action element. It is identified by the action prosign TO and contains the designation(s) of the action addressee(s).

Format line eight is the information element. It is identified by the information prosign INFO and contains the designation(s) of the information addressee(s).

Format line nine is the exempted element. It is identified by the exempted prosign XMT and contains the designation(s) of the exempted addressee(s).

Addressee designations in this component may be call signs, address groups, plain language designators, a combination of routing indicators and plain language designators, depending on the method of transmission.

Prefix Component

Format line ten is called the prefix component. The elements of the prefix are the accounting information and the group count.

The accounting information is a combination of letters called an "accounting symbol" used to indicate the agency, service or activity which assumes financial responsibility for the message. Messages originated by the agencies of the Department of Defense (DOD) destined for non-DOD agencies use an accounting symbol in the prefix. Messages that must be commercially refiled to effect delivery also carry an accounting symbol. The accounting symbol indicating financial responsibility for the Department of the Navy (used by all Navy commands and activities) is "NAVY."

The group count appears as the prosign GR followed by a number, indicating the number of words in the text. If the text is not counted, the prosign GRNC, indicating groups not counted may be used. Either the group count or prosign GRNC must be used when an accounting symbol is used. A numerical group count must be used on all coded group messages.

SEPARATION

Format line eleven is the separation sign "$\overline{BT}$" meaning break. Its purpose is to provide a distinct separation between the "heading" and the "text." Although, the separation is not considered a message part, it is an essential format line.

TEXT

Format line twelve contains the entire text of a message. The text is the basic idea or thought of the originator. It also follows a standard format as explained elsewhere in this chapter. Remember, regardless of the number of lines written or typed by the drafter, the text uses only one format line: format line twelve.

SEPARATION

Format line thirteen again contains the separation sign "$\overline{BT}$." The purpose in this format line is to separate the "text" from the "ending."

ENDING

The ending, the third and last part of a message, is another changeable portion. It contains the ending procedure and uses format lines fourteen, fifteen, and sixteen.

Format line fourteen is the time group element. When used, this element contains the time group expressed in hours and minutes, plus the zone suffix. This element normally is used only with the abbreviated plaindress message.

Format line fifteen is called the final instructions. The operator may use this line to correct transmission errors, indicate a pause, execute a message, or indicate more traffic for a specific station by the use of prosigns, operating signals and station designators as required.

Format line sixteen is called the ending sign. For voice and cw transmission, this is proword/prosign OVER(K) or OUT(AR) as appropriate. This format line is used merely to indicate the end of transmission.

As the ending is a changeable portion and its construction varies according to the method of transmission, detailed instructions for its use and construction will be covered in chapters devoted to each transmission media.

SEQUENCE OF TEXUAL MATTER

The contents of format line 12, the text, are arranged in a standard sequence, or form. The intent in arranging the text in this manner is to make maximum use of teletypewriter capabilities, thereby eliminating much of the processing time formerly required for incoming messages. It also decreases originator preparation time and enables the addressee to comprehend the message content much faster.

Some messages, such as short one or two line messages, tactical messages, contact and amplifying reports, casualty reports, logistic requests, etc., are exempt from using this form. These "proforma" messages have a firmly established format using letters or numbers that have a prearranged meaning particular to each separate form.

The content of the text for all messages, except those having prearranged forms, is arranged in the following sequential order. NOTE: All messages do not necessarily contain all the elements listed below. If this is the case, the form is merely adjusted by omitting the nonessential elements.

SEQUENCE	CONTENT
1.	Security classification or abbreviation UNCLAS if message is unclassified.

SEQUENCE	CONTENT
2.	Special handling designators: a. Special Category (SPECAT), e.g., SPECAT SIOP-ESI; SPECAT EXCLUSIVE FOR_____. b. Limited Distribution (LIMDIS), e.g., NOFORN; RESDAT; CRYPTO; LIMDIS EXCLUSIVE FOR_____. c. Other, e.g., Encrypted for Transmission Only (E F T O).
3.	Exercise Identification, Code Words, Names or Nicknames of Special Projects or Operations, Flag Words, e.g., EXERCISE BLUE JAY; PROJECT HOLY STONE; OPERATION SKY HOOK; REDLINE.
4.	Standard Subject Identification Code (SSIC), e.g., //N02300//.
5.	Internal message handling or passing instructions, e.g., FOR CAPT SMITH; ATTN CODE 333.
6.	Subject line.
7.	References.
8.	Text (basic thought or ideas of originator).
9.	Downgrading / Declassification marking, if message is classified.

NOTE: The contents of sequence numbers 1 through 4, when required, are arranged in order of appearance on the first line of the text. All other sequence items begin on a separate line starting at the left hand margin of the page.

PREPARING THE TEXT

Brevity in messages is desirable. However, to avoid misinterpretation or further explanatory messages, clarity should not be sacrificed for the sake of brevity. A proper balance between brevity and clarity can be achieved through the proper choice of words, good writing techniques, and the use of proper abbreviations and symbols.

Although communication personnel are not reviewing authorities for message drafters, they must be able to recognize authorized forms of abbreviations and symbols and their use in messages. The following paragraphs explain the general rules and techniques of preparing the text.

SECURITY CLASSIFICATION

The first word of the text is always the security classification or the abbreviation UNCLAS, if the message is unclassified. When the message is prepared for transmission, the letters of the security classification are separated by spaces, e.g., S E C R E T. Unclassified messages are indicated by the abbreviation UNCLAS with no separation between the letters.

Special Handling Designators

Messages of a sensitive nature are assigned special handling designators. When required, the special handling designators are placed on the same line and immediately follow the security classification. Most of the designators indicating special handling requirements are easily recognizable abbreviations. They are typed with no separation between the letters except for the abbreviation indicating "encrypted for transmission only" (E F T O).

Code Words, Flag Words, Names or Nicknames of Exercises, Projects or Operations

Code words, flag words, names or nicknames of exercises, projects or operations indicate some form of special handling or internal routing requirements. When used they immediately follow the security classification, or special handling designators, if used. These code words or names are prepared with normal spacing, e.g., PROJECT HOT HOUSE.

Standard Subject Identification Code (SSIC)

The SSIC is indicated by a five digit number found in SECNAVINST 5210.11 correctly identifying the subject matter content. If the SSIC contains only four numbers, it is preceded by a zero to make a five digit number. The SSIC is preceded by the letter N, to denote a standard

Navy subject and is enclosed with double slant signs, e.g., //N02300//. The SSIC is used by the radioman to accomplish internal message routing. Many ships and stations accomplish internal routing by the use of computers programmed with the SSIC numbers. Messages containing flag words, code words, or names of exercises, operations or projects of some other method identifying the subject matter content do not normally contain an SSIC.

Internal Message Handling or Passing Instructions

In many cases, an originator may wish to send a message to an individual or to a particular office that is not assigned an address group or routing indicator. To ensure delivery to the individual or office, he addresses the message to the parent command or activity serving the office with appropriate internal passing or handling instructions to effect delivery. For instance, a message destined for a specific office, identified as CODE 333, at the Naval Supply Center, Oakland, Calif., would be addressed to NSC OAK. To effect delivery to the office, the phrase ATTN CODE 333, would be included in the text as internal passing instructions. These instructions in many cases speed up delivery of the message to the addressee who must take action or originate a reply to the message.

Subject Line

The subject line should be concise and untitled (i.e., the word SUBJECT is not used). If the subject line will cause an otherwise unclassified message to become classified, it is not used. On classified messages, the classification of the subject line should be indicated. This is indicated by the first letter of the appropriate security classification. For example, a message with a subject line entitled, COMMUNICATION GUARD SHIP (U), indicates that the subject line is unclassified. NOTE: The subject line of a classified message should not be classified higher than the classification of the message.

References

Many messages refer to other messages relating to the same subject. When references are used in a message, they are indicated by a letter, e.g., A.; B.; C.; D.; etc., for as many references required.

The reference is also identified by an indication of the originating command plus the date-time-group (DTG), month and year. If the originator refers to a message he previously originated, it is so indicated by the word "MY" preceding the DTG, e.g., A. MY 121212Z OCT 70. When the originator refers to a message originated by the addressee of a single address message, the reference is preceded by the word "YOUR," e.g., B. YOUR 142345Z SEP 70. A reference originated by a third party, or an addressee of a multiple address message is preceded by the short title of the command originating the message, e.g., C. CNO 122132Z SEP 70; D. COMCRUDESPAC 131415Z SEP 70.

References that are not addressed to all addressees must also bear an indication of that fact. A reference that is "not to or needed by all" is suffixed by the abbreviation "NOTAL." A reference that is "not to all, but is needed and is being passed separately" is suffixed by the abbreviation "PASEP." If there is no indication after the DTG, month and year, it is understood that all addressees have the reference.

Text

Again, the need for brevity is stressed, but not to the point where a loss of clarity will arise. Abbreviations and short titles should be used in order to shorten the text, thereby saving transmission time. Abbreviations and short titles however, should be limited to those common to a particular field or branch of service.

Punctuation in messages is not used unless it is necessary to the sense of the message. A list of authorized punctuation, abbreviations and symbols is contained in the effective editions of ACP 121 and DNC 5.

When it is necessary to include isolated letters within the text, such as a letter indicating a predetermined point or position, the phonetic equivalent of the letter should be used.

Numbers in the text may be written as digits or spelled out. When spelled out, they are expressed digit by digit, except the numbers 1 (one) through 20 (twenty) and exact hundreds or thousands may be expressed as one word.

The basic thought, or idea, is arranged in a form similar to the rules for outlining procedures. Each paragraph is identified by a number. Sub-paragraphs are indented and identified by letters. Sub-sub-paragraphs are further indented and identified by a number enclosed in parenthesis. Each paragraph of a classified message bears a letter indicating the classification of that particular paragraph. The letters used to indicate the classification should be the first letter of the appropriate security classification enclosed in parenthesis. The letter indicating the classification immediately follows the identifying number of each paragraph. NOTE: No paragraph may be classified higher than the classification of the message.

Downgrading/Declassification Marking

All classified messages must be assigned a downgrading/declassification marking in accordance with OPNAVINST 5500.40. This marking appears as the last word (group) of the text and is indicated by the groups GP-1, GP-2, GP-3, or GP-4, as assigned by the originator. These abbreviations are described in the effective edition of DNC 5.

TYPES OF MESSAGES

Messages are also grouped according to type of address. The succeeding paragraphs give a brief explanation of the four major types of messages handled by naval communicators.

SINGLE ADDRESS

This type of message is described by its name alone - single address. It is a message that is destined for only one addressee. The addressee may be designated as either an action or information addressee.

MULTIPLE ADDRESS

A multiple address message is one destined for two or more addressees, each of whom must be informed of all the other addressees. In the event numerous transmissions are required to effect delivery each transmission must contain all the addressees.

In most cases, a few addressees are designated as action and a few as information addressees. There may be situations when all addressees are designated action and still other times when all may be information. In all cases the addressees must be designated as either action or information.

In the interest of circuit efficiency, the number of addressees per message must be kept to the barest minimum—those commands with a "need to know." The originator should also consider the necessity of each addressee knowing the other addressees, if there is no "need to know," a book message should be used.

BOOK MESSAGE

A book message is one destined for two or more addressees but the originator considers it to be of such nature that no addressee "need to know" the other addressees. This type of message is used quite frequently when numerous transmissions are required to effect delivery to all addressees, especially when commercial facilities are used and tolls are incurred. The addressees must be designated as action or information on each separate transmission.

When this type of message is sent, the operating signal "ZEX' is included in format line five as message instructions indicating to the addressees that the message is being sent as a book message and there is no need to know the identity of the other addressees. NOTE: The originators copy of the message will always show all addressees receiving the message.

GENERAL MESSAGE

A general message provides a standard distribution to a large group of addressees as in a particular area, fleet or operation. All commands to whom general messages are addressed are considered to be action addressees. It is the command's responsibility to determine what action, if any, need be taken.

General messages are of sufficient importance that they will be explained in depth in a later paragraph.

FORMS OF MESSAGE

Messages handled over military circuits should be prepared in plaindress, abbreviated plaindress, or codress form except when commercial or International Civilian Aviation Organization (ICAO) procedure is authorized. The following paragraphs contain an explanation of the contents and rules governing the use of these forms.

PLAINDRESS

A plaindress message is one in which the originator and addressee designations appear externally in the address component. The plaindress message is the most common form handled on naval circuits.

The plaindress form contains all the components of the basic message format except that the group count may be omitted. However, if an accounting symbol is required or the message has an encrypted text, the group count prosign (GR 4-54) must be included in the prefix component.

To prevent duplication of effort and to conserve valuable circuit time, format lines 6, 7, 8 and 9 may be omitted when the call serves as the address. Remember, when the call serves as the address, the originator must be in direct communications with the addressees.

Let's take a look at a couple of examples of a plaindress message as they would appear on a radioteletype circuit. In the first example, the USS BORIE sends a message to NAVCOMSTA YOKOSUKA for relay to add addressees. In the second example, we will use the same message, but the USS BORIE will send the message direct to the addressees.

EXAMPLE 1:

Format line	Transmission
2 & 3	NDT DE NBCD NR6
4	T
5	P 231640Z NOV 7Ø
6	FM USS BORIE
7	TO USS AJAX
8	INFO COMSERVRON THREE
11	BT
12	TEXT (PLAIN LANGUAGE)

In example 1, we can see the originator and addressee designations in the appropriate format line. The text is in plain language and no accounting data is required, so we omitted the prefix component.

EXAMPLE 2:

Format line	Transmission
2 & 3	NABC SROR DE NBCD
4	ZFH2 SROR
5	P 231649Z NOV 7Ø
11	BT
12	TEXT (PLAIN LANGUAGE)

In example 2, we have the same message, the originator is in direct communications with the addressees; therefore, the call serves as the address. Again we omitted the prefix component as there is no accounting data and the text is in plain language. The operating signal ZFH2 indicates to SROR that he is to get the message for information. It is understood that the message is for action to NABC as there are no operating signals indicating otherwise.

ABBREVIATED PLAINDRESS

Where operational requirements are of such a nature that speed of handling is of prime importance, the plaindress message may be abbreviated. This form is used extensively, but not restricted to, voice communications. The abbreviated plaindress message would most likely be employed to send an enemy contact report.

In the abbreviated plaindress form, the call normally serves as the address. Therefore, format lines six, seven, eight and nine do not appear in the heading. Also, any or all elements of the preamble and prefix components may be omitted. This includes the precedence, date, date-time-group and group count.

The following examples are of abbreviated plaindress messages as they would appear on a radiotelephone circuit.

EXAMPLE 1:

Format line	Transmission
2 & 3	BULLNOSE THIS IS HARDHEAD
5	FLASH
11	BREAK
12	TEXT (PLAIN LANGUAGE)
13	BREAK
16	OVER

In the above example, the originator (HARDHEAD) is in direct communications with the addressee (BULLNOSE). Therefore, the call serves as the address and format lines six and seven are not used. In this case speed of handling is of prime importance so we use the proword FLASH to indicate the precedence. The date-time-group is omitted as there is not expected to be any future reference to the message. The group count is omitted as the text is plain language and no accounting symbol is used.

EXAMPLE 2:

Format line	Transmission
2 & 3	BULLNOSE THE IS HARD-HEAD
5	TIME ONE SIX ONE SEVEN ZULU
11	BREAK
12	TEXT (PLAIN LANGUAGE)
13	BREAK
16	OVER

In example 2, the originator and addressee are in direct communications, so the call serves as the address. The precedence, date and group count have been omitted as there were no requirements for them. The time group is employed because the originator felt there may be references made to this message at a later time.

CODRESS

The heading of a codress message contains all the components of the basic message format except the address component. It always contains a numerical group count in the prefix. The entire address component is included within the encrypted text. This makes the codress message a valuable security measure which the originator may employ when he wishes to conceal the identity of the addressees. By using the codress message we are denying the enemy the luxury of being able to make inferences from established originator/addressee traffic patterns that would otherwise be revealed by the use of an external address.

Security is the watch word in the codress message; therefore, call signs, address groups and transmission instructions must be limited. Call signs and address groups are encrypted in accordance with current call sign encryption policies. Transmission instructions are limited to those required to effect delivery of the message to the addressees served by a particular circuit. In other words when two or more transmissions are required to effect delivery, the beginning procedure component of each transmission is different.

Detailed instructions for preparation and transmission of the codress message are contained in the current editions of ACP 121 and Cryptographic regulations.

GENERAL MESSAGES

The general message provides standard distribution to a large group of addressees. There are many types of general messages, (see table 4-4) each carrying an identifying title as the address. Each type, or series, is also serially numbered beginning with the first message of the calendar year. The sequential serial numbers appear immediately following the date-time-group separated by a slant sign. The serial number is not included as a part of the text. All commands included in the address of a general message are considered as action addressees. It is the responsibility of the command, however, to determine what action need be taken, if any.

EXAMPLE:

R 161743Z/
12 MAR 71 . . . . . 12th message of this calendar year.
FM SECNAV . . . . . Originator of this particular series.
TO ALNAV . . . . .Identifying title, distribution to the entire Naval Establishment, including the Marine Corps. All considered action addressees.

Some commonly seen general messages are ALNAV, NAVOP, ALCOMLANT, ALCOMPAC, JFPUB, etc. There are many other types originated by sea frontier commanders, commandants of naval districts and fleet, force and type commanders for the purpose of publishing information within their respective commands or area of responsibility. Refer to the effective edition of NWP 16 for a table of general message types, their contents and distribution.

Originators of general messages, other than those included in the Navy Directive System (NDS), conduct a review and promulgate as the first message of the calendar year a list of previously issued general messages that remain in effect. In some cases an originator of numerous general messages promulgates a consolidated list of effective messages using the general message with the widest dissemination. General messages included in the NDS are automatically canceled 90 days after their date of issue unless otherwise indicated within the text.

Table 4-4.—General Messages

Originator	Title of Series	Description
SECNAV	ALNAV	Messages intended for wide distribution throughout the entire Naval Establishment, including the Marine Corps. They deal with administrative matters, such as fiscal policies, changes in personnel allowances, legislation affecting the Navy, promotions of officers, etc.
	NAVACT	Similar in content to ALNAV, but of no interest to the Marine Corps.
	ALNAVSTA	Administrative information requiring wide dissemination to the shore establishment of the Navy—including shore-based elements of the operating forces—and to the Marine Corps.
	ALSTACON and ALSTAOUT	Similar to the above but of interest, respectively, to activities inside and activities outside the continental United States.
CNO	NAVOP	Similar in content to ALNAV but distribution list does not include attaches, missions, observers, or minor shore activities.
	NAVOP "Z"	Policy changes initiated by CNO, concerning personnel.
	ALCOM	Usually used for, but not restricted to, promulgation of communication information throughout the Navy.
	ALCOMLANT and ALCOMPAC	Subdivisions of the ALCOM series for, respectively, Atlantic-Mediterranean areas and Pacific area.
	MERCAST	The merchant ship equivalent to an ALNAV. Distribution includes ships guarding MERCAST (merchant ship broadcast) schedules, naval port control and naval control of shipping officers, and MSTS commands.
CINCPAC	JANAFPAC	Messages pertaining to the Pacific commands on matters of joint interest.
CINCPACFLT	ALCOMPAC(P)	May be originated by CINCPACFLT when coordination unnecessary with CNO. Numbered sequentially and suffixed by letter P.
	ALPACFLT	Messages for general distribution to commands under CINCPACFLT.
	MERCASTPAC	The merchant ship equivalent to an ALPACFLT.
COMMANDANT, MARINE CORPS	ALMAR	Messages for general dissemination to all Marine Corps activities.
	ALMARCON	Messages for Marine Corps activities within the continental United States.
CINCLANTFLT	ALCOMLANT(A)	May be originated by CINCLANTFLT when coordination with CNO is unnecessary. Numbered sequentially and suffixed by letter A.
	ALLANTFLT	Messages for general distribution to commands under CINCLANTFLT.
	MERCASTLANT	The merchant ship equivalent to an ALLANTFLT.
	LANTFLTOPS	Designates general messages concerning fleet units and their operational commanders within commands under CINCLANTFLT.
JCS (MCEB)	JAFPUB	Designates general messages that promulgate information pertaining to all branches of the Armed Forces.
COMMANDANT, COAST GUARD	ALCOAST	Messages for general dissemination within the Coast Guard. The Coast Guard equivalent of ALNAV.
	ALDIST	Provide Coast Guard district commanders with policy instructions and other information.
COMMANDER, MSTS	ALMSTS	Messages for all MSTS commands and offices.

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Maintenance of the general message file is one of the duties of the Radioman. The general message file is separate from all other files and subdivided according to identifying title or type. The messages are filed in serial number order and retained until canceled or superseded.

BASEGRAMS

General messages that are not of sufficient operation importance to warrant immediate delivery to forces afloat by fleet broadcast or other rapid means, yet is of sufficient interest that it should be received by afloat commands as soon as possible following arrival in port, may be designated as a "BASEGRAM."

The purpose of the basegram system is to reduce the volume of message traffic transmitted by fleet broadcasts in order to keep the relatively limited broadcasts available for vital messages which must be delivered by rapid means to the forces afloat. It also provides a means for all afloat forces to obtain general messages designated as basegrams from established basegram authorities.

A basegram authority is a shore commander, designated by competent authority, responsible for providing plain-text copies of basegrams to afloat forces operating within his area of responsibility. The basegram authority maintains a stock of plain-text copies of all general messages applicable to forces afloat for pick-up upon their arrival in port. Basegram authorities also deliver copies of basegrams by mail, when requested by forces afloat whose extended deployment and ports of call make pick-up impractical. Refer to the effective edition of DNC 5 for a list of authorized basegram activities.

The communication center serving the originator places the operating signal "ZFP" (Basegram) in the message instructions of all general messages designated by the originator as basegrams. The word "BASEGRAM" is the first word of the text immediately following the security classification. Communication center personnel prepare a service message to all NAVCOMSTA's/NAVCOMMU's originating fleet broadcast indicating that the message is being delivered to all basegram authorities and will be available for pick-up. The message then is routed by rapid means to all applicable or designated basegram authorities and all addressees within the continental United States, Alaska, Hawaii and Puerto Rico.

NAVCOMSTA's/NAVCOMMU's receiving a basegram service message originates a service message to the forces afloat using the operating signal "ZFO" (Message -------- is being delivered as a basegram) to indicate to fleet units that the message is available for pick-up from basegram authorities.

The Radioman aboard ship receiving a "ZFO" service message on the broadcast pulls the service message, makes a notation in the broadcast file and places the original copy in the applicable general message file. Prior to entering port, the Radioman should conduct a review of all general message files and compile a list of all basegrams and other missing general messages. Immediately upon arrival, a memorandum should be delivered to the communication center of the basegram authority requesting copies of all basegrams and missing general messages. When copies of the basegrams are received the "ZFO" service message should be returned to the broadcast file.

SERVICE MESSAGES

Service messages are short, concise messages between communications personnel pertaining to any phase of traffic handling, communication facilities or circuit conditions. They are identified by the abbreviation SVC immediately following the security classification of the abbreviation UNCLAS.

Service messages may be prepared in plaindress, abbreviated plaindress or codress format. Procedures for the actual construction of service messages vary with the operating procedure being used; therefore, the applicable JANAP or ACP publication must be referred to for exact procedure to be employed for each type of operating procedure.

In the text of a service message, maximum use should be made of operating signals and prosigns. In addition to operating signals and prosigns enough plain-language should be used to identify the exact message and parts thereof in question.

On radiotelegraph, radiotelephone, and radioteletype circuits a form of service message known as an abbreviated service message may be used. Abbreviated service messages are originated by the radio operator and may contain any of the elements of the basic message format. However, the date-time-group is to be employed only when it is necessary to indicate the time at which the message was originated or when it is considered that further reference may be made to the message. When the date-time-group is omitted the message separation prosign, BT, is omitted.

The most common use of an abbreviated service message is in requesting repetitions and/or corrections in actual circuit operation.

READDRESSING MESSAGES

At times an originator or an addressee wants to readdress a message for action or info to other ships or activities not included in the original address. The following rules apply:

1. All format lines preceding line 5 (precedence, DTG) of the original message heading are deleted.
2. No alteration can be made to the original message from the precedence to the end of the text.
3. A supplementary heading is inserted in front of the original heading.
4. The precedence indicated in the supplementary heading pertains to the supplementary address only.
5. The DTG of the original message is used for purposes of reference, reply, and filing.

Assume that on receipt of the following plaindress message, NTAA readdresses it to NUYO for information. Here is the original message received from NTSY:

NTAA DE NTSY -
P - 281634Z NOV 70
FM NTSY -
TO NTAA -
INFO NBFJ
GR32
$\overline{\text{BT}}$
TEXT
$\overline{\text{BT}}$

Station NTAA adds his supplementary heading and transmits to NUYO the following message:

NUYO DE NTAA -
R - 281832Z NOV 70
FM NTAA -
INFO NUYO -
P - 281634Z NOV 70
FM NTSY -
TO NTAA -
INFO NBFJ
GR32
$\overline{\text{BT}}$
Text
$\overline{\text{BT}}$

Additional message examples are described in later chapters of this manual.

COMMUNICATIONS ADVISORIES

Virtually every task performed by a ship or station requires some form of rapid reliable communications. Naval Communications are the means by which a commander exercises command. Therefore, maximum cooperation is necessary between shore stations and afloat commanders in order to maintain the necessary communications to meet the requirements of the command.

By means of several proforma messages, or advisories, afloat units keep the shore stations advised of outages, numbers missed on broadcasts, intent to shift broadcast areas, changes in guard ship/guard station arrangements, etc. Close coordination is also required in the establishment and maintenance of ship/shore communications. Three typical communications advisories are discussed below; additional information and specific formats can be found in the effective edition of DNC 5.

Termination Requests

Sometimes a ship or station has a need to establish a circuit with another station for a limited time. It reserves the circuit by means of a termination request.

Ships having a requirement for full-period ship/shore/ship termination will address a message request to the NAVCAMS in whose area the ship is operating. The request will include such items of information as:

- Time termination is required
- The NAVCOMMSTA with whom termination is desired
- Mode of operation and number of channels to be activated in multichannel termination
- Estimated duration of circuit

Ships having a requirement for full-period ship/shore/ship communications will be assigned a routing indicator by the cognizant NAVCAMS and will be a part of the circuit.

Broadcast Shifts

The shift from one broadcast to another is normally effected at ØØØ1Z. In shifting from one broadcast to another, an overlap period before and after the time of shift should be observed, when equipment and personnel permit, to ensure that no messages are lost.

When a command afloat shifts broadcasts at a time other than that indicated by this movement report, a Broadcast Shift message must be sent to the NAVCAMS of the communications area or areas from which the old and the new broadcast originate. Submitted under the above conditions, Broadcast Shift messages identifies the command or ship shifting the broadcast, time the shift will be effective, the reason for the shift, the broadcast shifted from and the broadcast shifted to, and several other items.

SIGINT Communication Advisories

SIGINT (COMM ADVISORIES) are originated by afloat units as often as considered necessary to ensure proper delivery of traffic, keeping in mind requirements levied by operational commanders for maintaining EMCON. Comm Advisories remain in effect until cancelled or superseded by a subsequent advisory.

Tracer

Tracer action is the process by which an investigation is conducted to determine the reason for inordinate delay in delivery or nondelivery of a message.

ACP 127, and US SUPP-1 thereto, and JANAP 128 set forth the procedure for tracer action; however, pertinent aspects are discussed below. (Note: tracer action must commence within 30 days from the date on the message being traced.)

Feb 74 RM2

Delayed messages - The communication center serving the addressee shall originate tracer action. However, it shall carefully examine records and the message heading to determine if the cause can be ascertained and adequately explained prior to commencing tracer action. Cognizance must be taken of any adverse circuit or traffic conditions previously known or reported by intermediate relay station which would have caused delay.

If the cause of delay cannot be locally established, the addressee communication center normally transmits a routine tracer message to the station from which the delayed message was received, citing all available information.

Example: Excessive delay tracer to last relay serving addressee:

RR RUEC
DE RUECW Ø25 116ØØ3Ø
ZNR UUUUU
UNCLAS SVC ZUI ECA225 CKA41 DE
RUCKHC
115A 241615Z APR 70. TOR 24/2320Z
SEVEN HOUR DELAY
ZDN
NNNN

Tracer action continues on a station-to-station basis, in inverse order, until the cause of delay has been determined. Upon receipt of an excessive delay tracer, each station examines its records for time of transmission of the message being traced. This information is compiled and transmitted with the tracer action to the preceding station and to the station which originated the tracer. Any station which caused a delay cites the reason for the delay and a resume of corrective action in the report.

CHAPTER 5

COMMERCIAL TRAFFIC AND DISTRESS COMMUNICATIONS

Naval communications does not compete with privately owned and operated commercial communication companies. By terms of the Communication Act of 1934, however, the Navy is authorized to use its radio stations for reception and transmission of press messages and private commercial messages between ships, between ship and shore, and between shore stations and privately operated ships whenever privately owned and operated stations are incapable of meeting normal communication requirements.

Instructions contained in DNC 26 cover the handling by U.S. naval communications of all commercial communications, including official Government traffic involving tolls, and unofficial traffic involving and not involving tolls. These instructions are based upon the International Telecommunications Convention, Geneva, 1959, and the telegraph regulations (Geneva revision, 1958) annexed thereto; additional radio regulations, resolutions and recommendations, Geneva 1967; the Communication Act of 1934, as amended; rules and regulations of the Federal Communications Commission; and Western Union Telegraph Company tariff books.

COMMERCIAL TRAFFIC CLERK

Each Navy ship, station, or activity authorized to handle commercial traffic or to receive personal messages for transmission via naval communications has a commercial traffic clerk. He is designated in writing by the commanding officer. An experienced Radioman is selected for this task, although usually not the senior Radioman aboard.

The commercial traffic clerk handles all commercial traffic funds. He is not required to be bonded unless Commander, Naval Communications command so directs. A summary of duties of the commercial traffic clerk follows.

1. Maintain a complete file of all commercial messages accepted for transmission.
2. Keep a complete file of all incoming commercial messages and all official Government messages, received from other sources than naval communications, for abstracting purposes.
3. Maintain and understand all instructions and materials concerned with handling commercial traffic, such as rate sheets, bulletins, publications, and forms.
4. Collect proper charges and safeguard funds collected and in his custody.
5. Prepare prescribed reports on time and forward them to the communication officer for review.

The commercial traffic clerk performs his duties under supervision of the communication officer. All reports or other correspondence addressed to the Commanding Officer, U.S. Navy Regional Finance Center (Code FR-FC), Washington D. C. 20390 or to the Chief of Naval Operations (Commander, Naval Communications) are prepared for the commanding officer's signature.

WORD COUNT SYSTEMS

As a means of collecting fees for expense incurred when handling commercial communications, the Navy uses two systems of word count. Domestic word count applies to domestic messages and is based on domestic rules and regulations. International word count is used for radiotelegrams and international telegrams, and is based on international rules and regulations.

Domestic telegrams are messages originated at and addressed to points on shore within the continental United States, Canada, Mexico, Alaska, or Saint Pierre-Miquelon Islands, and transmitted in domestic form by wire or radio over all or part of its route.

A radiotelegram is a message originating in or intended for a mobile station, transmitted over all or part of its route by radio communication channels of the mobile service. International telegrams are messages originating at or destined to points outside the continental United States, Canada, Mexico, Alaska, or Saint Pierre-Miquelon Islands. Both radiotelegrams and international telegrams are drafted in international form.

A detailed explanation of both word count systems is given in DNC 26; hence, it is not repeated here. Many examples in DNC 26 illustrate the rules effectively, showing how representative words and groups are counted differently according to their location in a message address, text, or signature.

COMMERCIAL TRAFFIC FUNDS

The commandant of a naval district or commanding officer of a ship, station, or activity establishes the maximum amount of naval commercial traffic funds permitted to accumulate in the possession of the commercial traffic clerk. Unless approved by Commander, Naval Communications Command, however, this sum cannot exceed $100. Accumulated funds must be deposited at least weekly with the supply officer or disbursing officer. Only such amount is retained as is needed to make change.

When required for remittance, funds so deposited must be made available to the commercial traffic clerk by U.S. Treasury check, payable to the order of U.S. Navy Regional Finance Center, (Code FR-FC), Washington, D.C., 20390 or Western Union Telegraph Company, as appropriate.

Commercial traffic funds are kept separate and independent from other funds. Records are inspected at least once a month by an auditing board. If practicable, this board includes as members the communication officer and supply officer. Their inspection includes verification of the cash balance and a complete audit of all accounts, including verification of rates used.

Reports of inspections are retained for one year if no irregularities are indicated. Original copies of records are subject to call by Commander, Naval Communications Command or Commanding Officer, NAVREGFINCEN Washington. Any report of inspection showing irregularity must be forwarded to NAVREGFINCEN Washington, via official channels, with endorsements to show what action, if any, has been taken or is recommended.

Whenever the commercial traffic clerk is relieved, a special inspection and audit must be made. The report is forwarded to NAVREGFINCEN Washington. If the commercial traffic clerk is relieved and no replacement is nominated immediately, commercial traffic funds are retained in custody of the supply officer or assistant for disbursing.

Neither the communication officer nor the naval postal clerk is authorized to handle commercial traffic funds.

Uses of Commercial Traffic Funds

Expenditures of commercial traffic funds are authorized for the following purposes:

1. Money order fees.
2. Postage (as necessary) to mail reports, or for mailing class D messages when originator requests delivery by mail.
3. Postage (as necessary) to mail reports, officer determines that registered mail is necessary to protect or ensure delivery of the reports.
4. Refund of charges paid on non-Government messages when delivery cannot be made owing to causes not considered the responsibility of the sender.

An exchange-for-cash U.S. Treasury check may be used in preference to a money order. Use of these checks is a protection to the commercial traffic clerk, because, in case of loss, a second original can be issued without necessity of filling a bond.

All such expenditures of commercial traffic funds must be reported in detail on the statement of account form submitted with a message abstract.

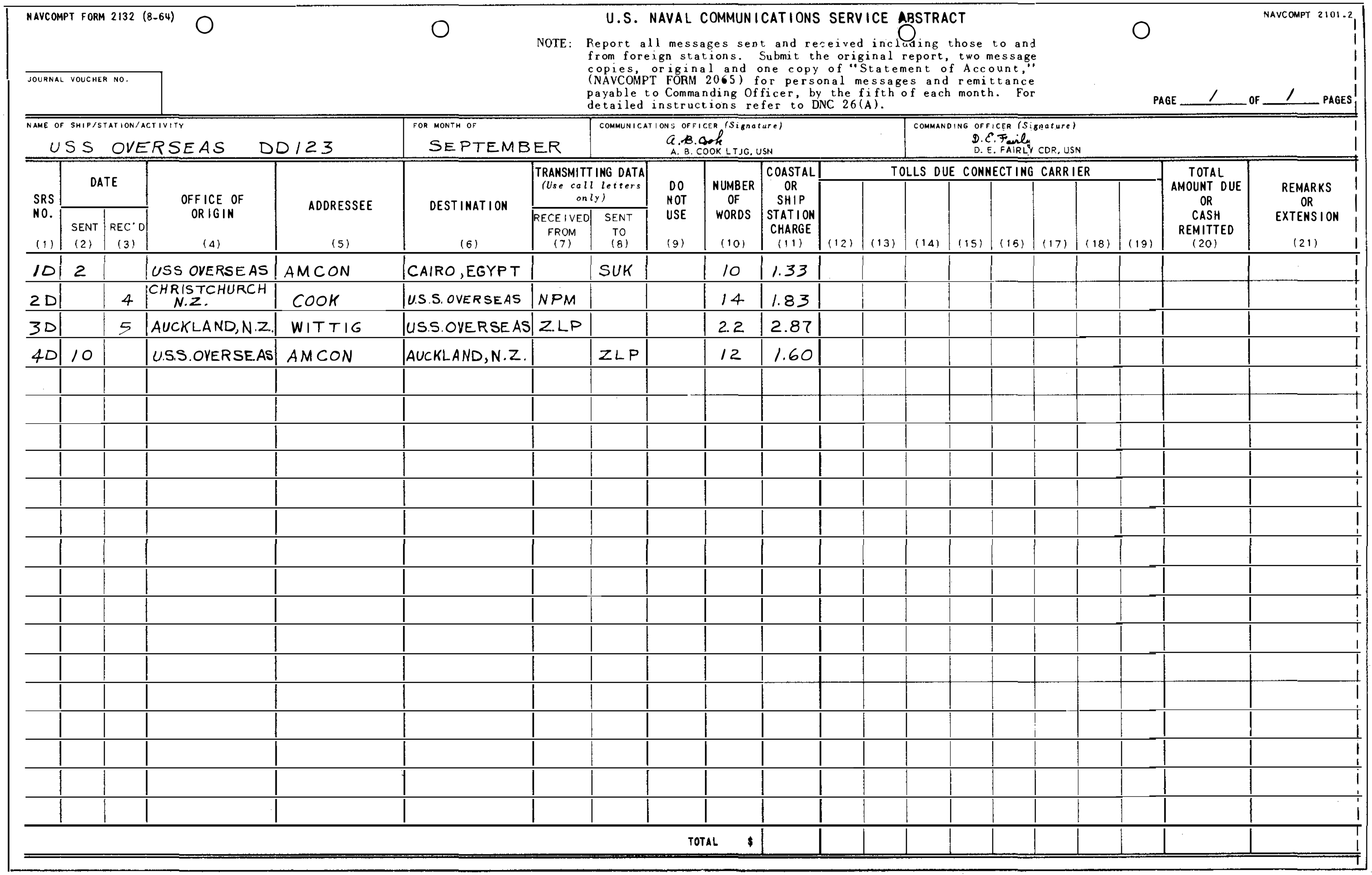
Commercial traffic funds cannot be used for such purposes as taxi fare, messenger service, special delivery, or telephone toll calls.

ABSTRACT FORMS

The word "abstract" refers to the series of report forms used for tabulating, reporting, and accounting various categories of commercial traffic handled by naval communications. Three forms are utilized in reporting commercial traffic. Each one is illustrated and described later in this chapter. Following are the form numbers and titles, plus a brief rundown of classes of traffic reported on each form.

1. NavCompt Form 2132, U.S. naval communication service abstract (fig. 5-1): It is used for—

a. All class D messages, including those by radio telephones, originated by a naval ship.



NAVCOMPT FORM 2132 (8-64)

U.S. NAVAL COMMUNICATIONS SERVICE ABSTRACT

NAVCOMPT 2101.2

NOTE: Report all messages sent and received including those to and from foreign stations. Submit the original report, two message copies, original and one copy of "Statement of Account," (NAVCOMPT FORM 2065) for personal messages and remittance payable to Commanding Officer, by the fifth of each month. For detailed instructions refer to DNC 26(A).

JOURNAL VOUCHER NO.

PAGE / OF / PAGES

NAME OF SHIP/STATION/ACTIVITY: USS OVERSEAS DD123

FOR MONTH OF: SEPTEMBER

COMMUNICATIONS OFFICER (Signature): A. B. Cook — A. B. COOK LTJG, USN

COMMANDING OFFICER (Signature): D. E. Fairly — D. E. FAIRLY CDR, USN

SRS NO. (1)	DATE SENT (2)	DATE REC'D (3)	OFFICE OF ORIGIN (4)	ADDRESSEE (5)	DESTINATION (6)	TRANSMITTING DATA (Use call letters only) RECEIVED FROM (7)	SENT TO (8)	DO NOT USE (9)	NUMBER OF WORDS (10)	COASTAL OR SHIP STATION CHARGE (11)	TOLLS DUE CONNECTING CARRIER (12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	TOTAL AMOUNT DUE OR CASH REMITTED (20)	REMARKS OR EXTENSION (21)
1D	2		USS OVERSEAS	AMCON	CAIRO, EGYPT		SUK		10	1.33										
2D		4	CHRISTCHURCH N.Z.	COOK	U.S.S. OVERSEAS	NPM			14	1.83										
3D		5	AUCKLAND, N.Z.	WITTIG	U.S.S. OVERSEAS	ZLP			22	2.87										
4D	10		U.S.S. OVERSEAS	AMCON	AUCKLAND, N.Z.		ZLP		12	1.60										
									TOTAL $											

50.134

Figure 5-1.—U.S. Naval communication service abstract, NavCompt Form 2132.

b. All class D messages received and delivered on board or relayed by a naval ship.

c. All class D messages originated, received, forwarded, or delivered by a naval station or activity.

d. All class A and B messages (including official radiotelephone messages) transmitted by a naval ship direct to a domestic or foreign commercial shore radio station.

e. All class A and B messages received by a naval ship direct from a commercial shore radio station.

2. NAVCOM Form 2065, statement of account (fig. 5-2): This form is required when forwarding remittances for class D private commercial messages, press messages, and radiophotos, and for class D messages entitled to class E privilege. It is not required for class E messages.

3. NAVCOMP Form 2067, abstract of class E messages (fig. 5-3): This form is used by both ships and shore stations originating class E messages involving tolls, and class D messages entitled to class E privilege.

Abstract forms and message copies comprising commercial traffic reports must be retained on file by the commercial traffic clerk for a period of 12 months.

SERIAL NUMBERS

For identification and accounting purposes, all commercial traffic handled by naval communications is assigned serial numbers. These numbers are known as SRS numbers. They are in addition to regular station serial numbers normally assigned. The SRS numbers are never transmitted with the message. They are written or typed on each commercial message and are listed on commercial abstract forms for identification and accounting.

Each commercial message handled (including paid service messages) must be assigned an SRS number by each ship or station participating in its disposition. As a result, the same message bears a different SRS number at each station handling it.

Additional information concerning specific uses of SRS numbers appears later in this chapter. Naval communication stations assign SRS numbers consecutively up to 10,000. All other Navy activities and ships assign SRS numbers consecutively up to 1,000 on an annual basis commencing with number 1 on 1 January each year.

A capital letter (called a suffix) is added to the SRS number to identify the class of commercial message reported. When service messages concerning a message are sent, they are given the SRS numbers of the message to which they refer, succeeded by letter "A" for the first service, "B" for the second, and so on. A group of suffix letters, together with an example of each, is given in the accompanying list.

Class of message	Suffix letter	Example
A	A	SRS 1A
B	B	SRS 2B
D (radiogram)	D	SRS 3D
D (press)	P	SRS 4P
D (radiophoto)	R	SRS 5R
D (entitled to class E privilege)	C	SRS 6C
E	E	SRS 7E
Service message		SRS 7EA

REPORT SYMBOLS

The Comptroller of the Navy has assigned NavCompt report symbols to commercial communication reports to aid in handling, auditing, and accounting for these reports. Report symbols consist of the word NavCompt followed by a number. For example, NavCompt 7210-1 is the Statement of Accounts report. Other report symbols are given in separate discussions of each message class. The appropriate report symbol must be placed on envelope or cover when forwarding commercial traffic reports. It should also appear on the abstract form itself. More than one report symbol may be used on one abstract form.

Responsibility for Reports

Commercial traffic reports are required whenever commercial messages involving tolls are handled by a ship or station during any calendar month. Monthly traffic reports, consisting of an abstract form, message copies, a remittance, and a statement of account, are mailed to the Commanding Officer, Navy Regional Finance Center, Washington, D.C. 20390. Ships must mail their traffic reports by the 5th day of the month; shore stations by the 10th.

STATEMENT OF ACCOUNT
(NAVAL COMMUNICATIONS)
NAVCOMPT FORM 2065 (REV. 8-64)

NAVCOMPT 7210-1

REPORT FOR THE MONTH OF

TO: COMMANDING OFFICER, U.S. NAVY FINANCE CENTER (CODE FC), WASHINGTON, D.C. 20390

REPORTING ACTIVITY (SHIP OR STATION): U.S.S. OVERSEAS DD 123

DATE FORWARDED: 1 SEP. 66

INSTRUCTIONS

1. Forward in duplicate with remittance to Navy Finance Center, Washington, D.C. 20390 for Class "D" and Class "D" entitled to "E" privilege traffic.
2. Naval Commercial Traffic Funds shall be forwarded by exchange-for-cash U.S. Treasury check when possible.
3. For further instructions refer to DNC-26.

RECEIVED		AMOUNT		PAID OUT		AMOUNT	
CHARGES ON MESSAGES FILED DURING THE CURRENT MONTH		$ 23	15	REFUNDS			
FEDERAL TAX COLLECTED DURING THE CURRENT MONTH		1	05	MONTH	ERROR NOTICE REFERENCE NUMBER		
COLLECTIONS ON MESSAGES PREVIOUSLY REPORTED ON WHICH NO CHARGE OR A SHORT CHARGE WAS MADE						$	
MONTH	ERROR NOTICE REFERENCE NUMBER						
				REPLY PAID VOUCHER NUMBERS			
				REMITTANCE HEREWITH:		24	20
				CHECK OR MONEY ORDER NUMBER 384552			
				DATED 9/1/66			
				DRAWN ON			
TOTAL AMOUNT RECEIVED		$ 24	20	TOTAL AMOUNT PAID OUT		$ 24	20

TOTAL AMOUNT RECEIVED MUST EQUAL TOTAL AMOUNT PAID OUT

FOR USE BY REGIONAL ACCOUNTS OFFICE ONLY

I certify this is a true statement of all moneys received and disbursed by me this month for the Naval Commercial Traffic Fund of this command, Class "D" Traffic. There is forwarded herewith a remittance in the sum recorded on this form.

CERTIFICATION: *(Commercial Traffic Clerk)*
G. H. Isaly
G. H. Isaly RMI, USN
(Signature)

REVIEWED: *(Communications Officer)*
A. B. Cook
A. B. Cook LTJG, USN
(Signature)

FORWARDED: *(Commanding Officer)*
D. E. Fairly
D. E. Fairly CDR USN, USN
(Signature)

D-10504

50.18

Figure 5-2.—Statement of account, NavCompt Form 2065.

NAVCOMPT FORM 2067 (REV. 8-64)

U. S. NAVAL COMMUNICATION SERVICE

Abstract of Class "E" messages

NAVCOMPT 2101-1
SHEET NO. ONE E

To: Commanding Officer, U.S. Navy Finance Center (Code FC), Washington, D.C. 20390

DURING MONTH OF: SEPTEMBER

NAME OF ACTIVITY: USS OVERSEAS DD123

COMMUNICATIONS OFFICER (Signature): A. B. Cook — A. B. Cook LTJG USN

COMMANDING OFFICER (Signature): D. E. Fairly — D. E. Fairly CDR, USN

SRS NO.	DATE	ADDRESSEE	DESTINATION	STATION SENT TO (Call Letters)	DO NOT USE	NO. WORDS	CREDIT TOLLS	CREDIT TAX	DR. CASH
5E	2	JONES	MOREHEAD CITY, N. C.	NSS		15	1.29		1.29
6E	10	TAYLOR	ELLWOOD CITY, PA.	NSS		10	1.08		1.08
7E	12	CUNNINGHAM	BERKLEY, W. VA.	NSS		8	1.13		1.13
8E	18	TURNER	WALTHAM, MASS.	NSS		12	1.29		1.29
						TOTALS	4.79	—	4.79
						TOTALS BROUGHT FORWARD FROM SHEET NO.			
						GRAND TOTAL			4.79

CERTIFICATION (Commercial Traffic Clerk)
I certify this is a true statement of all moneys received and disbursed by me this month for the Naval Commercial Traffic Fund of this Command, CLASS "E" Traffic. There is forwarded herewith a remittance of $ 4.79

SIGNATURE: G. H. Isaly — G. H. Isaly DATE: 1 SEP. 66

50.20

Figure 5-3.—Class E message abstract, NavCompt Form 2067.

If a ship or station has not handled any class D or class E traffic during any calendar month, a negative report is not required. A statement is required, however, on the first line of the first class D or class E abstract submitted for any subsequent month; for example, "No class D (or E, as appropriate) traffic handled during the month(s) of ________________."

Class A and class B messages are refiled only by those shore stations and activities designated in ACP 117 U.S. Supp-1 as commercial refile activities. Their reports must be forwarded direct to Commander, Naval Communications Command within 10 days after receipt and verification of the commercial communication carrier's refiled traffic billing. Negative reports to Commander, Naval Communications Command are required of these stations for any month in which no class A or class B messages are refiled.

Considerable time may elapse before NAVREGFINCEN Washington is billed for commercial messages. In extreme cases concerning messages sent to foreign radio stations, involved international paperwork may take more than 1 year before NAVREGFINCEN Washington finally gets the bill. If NAVREGFINCEN Washington then finds that the message has not been reported, that office must check with the originating ship before payment can be made. This procedure takes additional time, and may be hard to do after so much time has elapsed. The originator's message files may have been disposed of already, for instance, and responsible personnel transferred, discharged, or retired. Thus, it is readily apparent that incorrect or incomplete reports can lead to complications.

Not all commercial traffic reports are sent to NAVREGFINCEN Washington. Later portions of this chapter explain which reports are sent to NAVREGFINCEN Washington and which ones go elsewhere.

COMMERCIAL ABSTRACTING

This section is devoted to a more detailed discussion of message classes and methods of commercial abstracting.

Of the five classes of messages, class C messages are not involved in commercial abstracting, thus they are not mentioned further.

CLASS A AND CLASS B MESSAGES

Class A and class B messages are official U.S. Government messages. Class A messages consist of official messages of the Department of Defense. Class B comprises official messages of U.S. Government departments and agencies except for Department of Defense messages. Both classes are treated together in this section because of similarities in handling, abstracting, and accounting.

Both class A and class B messages are prepared in joint form for transmission over military circuits. Detailed coverage of procedures for handling messages over military circuits are provided in a later chapter.

Class B messages requiring commercial refile must always carry an accounting symbol to denote the Government department or agency responsible for payment of commercial charges. When filed with a domestic communication company, the accounting symbol is preceded by the Government indicator GOVT. This indicator appears as the first word in the address. In messages sent to or via foreign communication companies, the Government indicator is changed to US GOVT.

Handling Over Commercial Communication Systems

When it is necessary to file or refile a class A or class B message with a commercial communication company, the following rules apply.

1. When filed directly with a commercial communication company by an originator outside the continental United States, or destined to an addressee outside the U.S., messages are sent via the nearest U.S. military communication facility serving the area in which originated.
2. Provided either originator or addressee is not served by military communications, messages may be filed directly or refiled with Western Union without further transmission on military circuits. This rule applies when charges for delivery to an addressee are the same as (or less than) such charges for delivery from a designated commercial refile point.
3. When refiled by a shore station with the continental U.S. and addressed to a point in the United States, Canada, Mexico, Alaska, or Saint Pierre-Miquelon Islands, domestic form with domestic wordcount is used. The point of actual origin is added to the signature.
4. When refiled by a shore station in the continental U.S. and addressed to points outside the United States, Alaska, Canada, or Mexico, international form and word count are used. The point of refile is treated as the point of origin; point of actual origin is added to the signature.
5. When filed or refiled by a shore station outside the continental U.S., international form and word count are used. The point of file serves as point of origin, or point of refile is the point of origin, and point of actual origin is added to the signature.
6. When a message in joint form must be sent through a commercial communication system for further transmission by a military system, the message in joint form—complete with heading—is embodied in the text of the commercial message.
7. When transmitted direct by a Navy ship to a commercial shore radio station, international form and word count are used.

The following example shows the form for a GOVT NAVY message as transmitted by a ship to a shore station for refile with a commercial communication company.

NSS DE NMWW—
T—
R—291646Z—
FM USS GOODSHIP—
TO JOHN X DOE 1014 BEACHTREE LANE
ERIE PA

BT
UNCLAS
YOUR LEAVE EXPIRES ON BOARD AT NORFOLK VA
0745 6 AUG 70
BT
K

The preceding message would be commercially refiled in the following form. (Chargeable words are underscored.)

CK 12 WASHINGTON DC 29 JULY 70 515PME
GOVT NAVY
JOHN Q DOE
1014 BEACHTREE LANE ERIE PA

YOUR LEAVE EXPIRES ON BOARD AT NORFOLK VA
0745 6 AUG 70
COMMANDING OFFICER
USS GOODSHIP

Abstracting Class A and B (Messages)

Class A, B and official radiotelephone messages transmitted direct to a commercial shore radio station by a Navy ship must be reported on NAVCOMPT Form 2132. (See fig. 5-1.) This monthly report under symbol NAVCOMPT 2102.2, must be forwarded to the U.S. Navy Regional Finance Center, Washington, 20390. Two copies of all messages are required with each report. No remittance is made; settlement of accounts is the responsibility of COMNAVCOM. Reports from ships must be mailed by the 5th of the month after handling.

Incoming class A and B messages received by Navy ships direct from commercial shore radio stations are reported on NavCompt Form 2132. Other requirements are the same as for outgoing messages explained earlier.

Naval shore stations designated commercial refile activities in ACP 117, U.S. Supp-1 are required to submit monthly reports of all class B messages refiled with commercial communication companies. A speedletter report is made, and does not utilize any of the NavCompt forms mentioned previously.

Reports are mailed direct to the Commander, Naval Communications Command within 10 days after receipt and verification of the commercial communication company's traffic billing. A speedletter report must contain the following information in the order indicated.

1. Report of class B messages.
2. Calendar month and year of report.
3. Inclusive class B message serial numbers reported.

The speedletter report must be accompanied by two copies of each message reported.

One copy must be in the military form in which received, arranged in SRS number order, on metal file fasteners, between cardboard covers, and in groups of 100 or fewer messages. Its cover must be labeled to indicate type of traffic, name of reporting station, and month and year of commercial refile.

The second copy of each message must be in the commercial form in which refiled, segregated into packets according to accounting symbols.

Both message copies must bear complete transmission data, and include the following information in the lower right corner:

1. SRS number (e.g., SRS 23B).
2. Accounting symbol (e.g., INT).
3. Commercial company and city where refiled (as Western Union, WASHDC).
4. Commercial service indicator (e.g., NL).
5. Commercial charges (e.g., $1.25).
6. Date and time of refile (as 011300Z/AUG,70).

Copies of service messages relating to commercially refiled class A and B messages must be forwarded with a copy of message to which they pertain.

Responsibility for Payment

A reporting activity does not collect toll charges not send remittances when forwarding class A and B messages reports. In brief, payment for class A and B messages refiled with commercial communication companies is effected according to the ensuing explanation. For class A and B messages transmitted by Navy ships to commercial shore stations, CNO is responsible for settlement of accounts. Because bills submitted by commercial companies often contain amounts for other classes of messages, however, initial payment is made by NAVREGFINCEN Washington.

Charges for class B traffic are then billed to COMNAVCOM by NAVREGFINCEN Washington. In turn, COMNAVCOM bills other Government agencies responsible for originating their class A and B messages involving toll charges. Thus, naval communications is reimbursed for non-Navy messages handled.

Payment is handled differently for class A and B messages refiled with commercial companies by shore stations. Commercial communication companies bill a refile activity directly. The refile station verifies the monthly billing, certifies it as official U.S. Government traffic, and forwards the certified billing (with supporting message copies), for payment, to the local disbursing office of the NAVFINCEN serving the area in which refiling activity is located.

CLASS D MESSAGES

Class D messages are non-Government (private-commercial) messages handled by naval communications that were received or sent via commercial communication companies. Class D messages include—

1. Commercial (private) messages.
2. Commercial (private) messages entitled to class E privilege.
3. Press messages.
4. Radiophotos.

Class D messages are always in commercial form. Handling of class D traffic by Navy ships and stations usually is suspended or curtailed in wartime.

Each category of class D messages is discussed in greater detail in the remainder of this section.

Commercial (Private) Messages

Any naval ship at sea, or in a port that has inadequate or unreliable commercial communication facilities, is authorized to file class D commercial (private) messages. This same authorization extends to overseas shore stations at locations where adequate and reliable commercial facilities do not exist.

Only three shore stations are presently authorized to handle commercial ship-to-shore and shore-to-ship traffic. These authorized shore stations are NavCommStas Balboa, Guam, and Kodiak.

In the following example of class D commercial messages in international form, chargeable words or groups are underscored. An explanation of component parts if given at the conclusion of this message example.

PCH DE NMWW NR1 INTL USS GOODSHIP/NMWW CK26
12 1430
$\overline{BT}$ MP $\overline{BT}$
LOUIS COLBUS
69 EASTTHIRTYSIXST
NEWYORKCITY
$\overline{BT}$

SELL TEN SHARES COMPTOMETER AND TWENTY SHARES PULLMAN BUY SIXTY SHARES MAGNAVOX ALL AT MARKET ADVISE TRANSACTION DATE $\overline{BT}$ FORD COX $\overline{AR}$ NMWW K

After the call and station serial number in this example appears the international abbreviation INTL. Next is the office of origin, USS GOODSHIP, followed by her call sign. The check (CK26) consists of the number of chargeable words in the address, text, and signature. (Remember that chargeable words are underscored in this example.) In a commercial message such as this one, the date and local time of filing are always given in two numeral groups, with the date separated by a space from the four-digit hours and minutes group.

The message address contains the paid service indicator MP in addition to the name and address of the addressee. This particular paid service indicator (MP) means that the sender requests delivery of his message to the addressee in person-not by mail or telephone. More than a dozen different service indicators are authorized; DNC 26 carries the complete list. As shown in this message example, the paid service indicator is the first word of the address; it is counted as a chargeable word, and is included in the CK.

After the text is the sender's name, called the signature. Although it is not obligatory to transmit the signature, when transmitted it is chargeable and is separated from the text by the prosign $\overline{BT}$. The prosign $\overline{BT}$ in this message example has many appearances. This prosign separates the preamble from the paid service indicator, paid service indicator from the rest of address, address from text, and text from signature. Prosign $\overline{BT}$ is never counted or charged in the CK.

Charges and Accounting

Charges to be collected from the sender by the commercial traffic clerk for class D messages include the following specific instances.

1. Charges that accrue to land radio stations.
2. Charges that accrue to the ship radio station.
3. Charges for service over landlines or cable, if any.
4. Relay charges of any intermediate land or mobile radio station.
5. Charges, if any, for special service requested by a sender.

Rate Requests

The International Telecommunications and Radio Conferences held at Geneva in 1959 authorized shipboard stations to make inquiry without cost to coastal stations concerning proper rates for messages for which they do not have necessary information. Because Navy ships are not issued commercial tariff books used for computing charges for class D messages, it is necessary to send a rate request (QSJ or service message) to determine charges on each message. Operating signal QSJ (preceded by $\overline{\text{INT}}$ for military usage, or followed by $\overline{\text{IMI}}$ when operating with commercial stations) means "What is the charge to be collected per word to ____________ including your internal telegraph charge?" As a reply QSJ means "The charge to be collected per word to ____________ including my internal telegraph charge is ____________ francs."

Examples of rate requests are not shown in DNC 26. Two examples are given here. The first one shows the procedure observed by Navy stations on point-to-point circuits. Transmissions from a Navy ship to a commercial shore station constitute the second example of a rate request.

In point-to-point circuit operation between military stations, the total charge for a message is given in United States dollars. Consider the following teletypewriter message, originated at Kwajalein and sent to Honolulu for commercial refile. Note how the operator added INT QSJ at the end of the message.

```
RR RBHPU
DE RBHPV ØØ9 Ø74Ø74Ø
ZNR UUUUU
KWAJALEIN CK13  Ø745
POLAROID CORP
CAMBRIDGEMASS

REFERENCE YOUR WIRE MARCH 3
  DELAYED SHIPMENT
K6732 PERMISSIBLE
TRATEXCO. INT QSJ
15/1945Z
```

After computing charges, the operator at Honolulu replied with the following service message:

```
RR RBHPV
DE RBHPU 58 Ø742Ø25
ZNR UUUUU
R 152Ø31Z MAR 71
BT

UNCLAS. YOUR ØØ9/15 Ø745 COML CHGS
  TWO DOLLARS FORTYSEVEN CENTS.
  NAVY CHGS SEVENTYEIGHT CENTS.
  TOTAL PLUS TAX
BT
15/2Ø31Z
```

Accordingly, the commercial traffic clerk at Kwajalein collected the following charges from the sender:

Commercial charges	$2.47
Navy charges	.78
	3.25
10% tax	.33
Total	$3.58

A transmission by a shipboard operator to a foreign commercial shore station forms the second example of a rate request. Commercial charges in international communications are quoted per word in gold francs or centimes (100 centimes = 1 gold franc). The gold franc is an international monetary unit used by all member nations in the International Telecommunications Union. Rate of exchange with United States currency is 3.061 gold francs per U.S. dollar.

Assume that NHDY has a 10-word class D message for an addressee in Rotterdam. After establishing communications with foreign commercial station PCH, the Radioman transmits:

PCH DE NHDY QSJ ROTTERDAM $\overline{\text{IMI}}$ K
Station PCH replies:
NHDY DE PCH QSJ ROTTERDAM CC 4Ø LL 17.5 CTMS K

Station PCH's reply has the following meaning: CC (costal charge) represents charges that accrue to the land radio station; LL (landline) is the charge for service over landlines or cable; CTMS is an abbreviation for centimes.

According to the preceding explanation, charges for this message to Rotterdam are 57.5 centimes (40 + 17.5), or 0.575 franc, per word. For NHDY's message of 10 chargeable words, the total charge to be collected from the sender is 5.75 francs (0.575 x 10). This amount, converted to U. S. dollars at the 3 for 1 rate explained previously, would be $1.92 (5.75 francs ÷ 3).

An important point to remember when obtaining rate requests from commercial stations is to be sure that the operator includes all charges due his station: his station charge, plus any landline or cable charge, relay charge, or charges for special service requested by the sender. This remainder is mentioned here in discussing class D messages, but it applies as well to all classes of messages involving commercial refile. Operators sometimes fail to include all these charges in their QSJ, yet include them in their company's billing. This problem causes no end of difficulty to NAVFINCEN Washington in settling the account. It may test an operator's patience and tact in overcoming language barriers on a radiotelegraph circuit. That commercial charges are computed accurately in most instances attests to the ability and commonsense of radio operators, both Navy and commercial.

Copies of all QSJ exchanges must be forwarded to NAVFINCEN Washington, with the series of messages to which they pertain.

Abstracting Class D Messages

Class D messages are reported on NavCompt Form 2132. Whenever class D messages originate in own ship or station, money paid by senders must be forwarded with the abstract. The Treasury check or money order used for a remittance must be made payable to the U.S. Navy, Finance Center, Washington, D.C. Actual transfer of funds between naval communications and commercial communication companies is made by NAVFINCEN Washington.

A complete class D message report consists of the—

1. Abstract (NavCompt Form 2132).
2. Copy of each class D message.
3. Statement of account, NavCompt Form 2065.
4. Remittance.

Special attention is directed to the necessity of reporting all class D messages handled (whether charges are involved or not), together with any QSJ or service message exchanges. Ships sometimes mistakenly fail to report class D messages received over Navy circuits. Failure to make these reports often results in financial loss to the Government. Such failure to make the required report of either sent or received messages usually causes needless correspondence and delay in settlement of accounts.

Message copies forwarded with an abstract must be legible and complete, including full transmission or receiving data. Duplicates must be retained in ship or station files for at least 12 months. Message copies forwarded and duplicates retained in files must show any discrepancies in counting chargeable words; an explanation of delays exceeding 1 hour between receipt and transmission in relaying, or between filing time and transmission time; charges collected, if any; and other pertinent information deemed appropriate.

In communications with naval or merchant ships, be sure to indicate the call sign, on both abstract and message copy, immediately after name of ship. A fraction bar (/) separates the ship's name and call sign.

Class D Messages Entitled to Class E Privilege

Occasionally, because of the location of addressees, naval personnel are unable to send a message in class E form, even though message contents comply in all respects with provisions for class E messages. In other words, the addressee will be at a geographical location other than the continental United States; for example, Hawaii, Puerto Rico, Panama, Japan, or Europe.

A category of messages known as "Private commercial message (class D) entitled to class E privilege," has been established with the view of making available to such personnel a modified version of class E message. Particular care must be taken in handling this category of message, and accounting for it, to ensure that it is not combined and reported with regular class E traffic.

Class D messages entitled to class E privilege are handled in international form as shown in the message example at the conclusion of this explanation. For identification purposes, each message carries the symbol COMLE as the first word of text; COMLE is counted and charged for as one word. Following is an example of a class D message entitled to class E privilege.

NSS DE NMWW—
T —
R — 271949Z
BT
USS GOODSHIP/NMWW CK21 27 1500 BT
MRS J V KELLY
CARIBE HILTON HOTEL
SAN JUAN PR
BT

COMLE MOTHER AND I WILL MEET YOU THURSDAY IN CHICAGO BT JIM
BT
K

Handling this type of message by naval communications is without charge. The sender, however, must pay charges incurred by commercial refile at San Juan. To determine the amount, the ship must send a rate request by QSJ or service message. Charges must be ascertained and paid before transmission of class D message.

An exception to the foregoing rule applies in a class D message entitled to class E privilege destined to an addressee on the island of Oahu, Hawaii. Such a message is delivered by the refile activity at Honolulu by phone or other means not involving commercial refile. The message is written up and handled as a class E message free of toll charges and, as such, is not included in the commercial traffic report. This exception does not apply to messages destined to Hawaiian islands other than Oahu. Commercial refile is then required, resulting in toll charges, abstracting, and accounting.

Abstracting

Ships and stations originating class D messages entitled to class E privilege are required to submit monthly reports under report symbol NavCompt 2101-1 covering all messages originated. For this report, NavCompt Form 2067 is used.

Reports of class D messages entitled to class E privilege are comprised of the following forms:

1. Abstract, NavCompt Form 2067.
2. One copy of each message, showing complete transmission data. A related rate request (QSJ or service message) must be attached to the messate.
3. Statement of Account, NavCompt Form 2065, in duplicate.
4. The remittance, made payable to U.S. Navy Regional Finance Center, Washington, D.C. 20390.

An additional monthly report is required of shore stations effecting commercial refile of class D messages entitled to class E privilege. For this report, NavCompt Form 2132 is the proper form. If the shore station also handled "regular" class D traffic during the month, the two reports can be combined.

PRESS MESSAGES

In peacetime, the Navy frequently grants permission for duly accredited news reporters to go to sea in Navy ships for the purpose of reporting naval operations and activities. In such instances reporters usually are authorized to file press messages on board. The same privilege may be extended at isolated overseas bases where commercial communication facilities are unavailable.

Three examples of press messages illustrate the message form. The first example shows an international form press message from a Navy ship to a commercial shore station.

ZLB DE NMWW NR 1
INTL USS GOODSHIP/NMWW CK 145 16 1430 BT
PAGE 1/50 BT
PRESS BT
YOMIURI PRESS TOKYO BT

(FIRST 46 WORDS OF PRESS TEXT WHICH, ADDED TO SERVICE INDICATOR AND 3 WORDS OF ADDRESS, MAKE 50 WORDS IN PAGE 1) $\overline{BT}$
NR 1 USS GOODSHIP 1430 PRESS PAGE 2/50 $\overline{BT}$ (NEXT 50 WORDS OF PRESS TEXT) $\overline{BT}$
NR 1 USS GOODSHIP 1430 PRESS PAGE 3/45 $\overline{BT}$ (REMAINING 44 WORDS OF PRESS TEXT AND ONE WORD OF SIGNATURE $\overline{BT}$
TSUBOKAWA $\overline{BT}$ K

Note the page identification in the preceding message example. A radiotelegram of more than 50 words is transmitted in pages of 50 words. The page number is separated by a slant sign from the figure indicating numbers of words. Included in the first page are the paid service indicator, PRESSE (used only in international communications), and the in address. Each succeeding page is identified as in the example.

The next example shows a domestic/commercial form press message with Navy heading for transmission to a continental Navy shore station for refile with Western Union to an addressee in the continental United States.

NSS DE NMWW —
T —
R — 252130Z MAY 71
$\overline{BT}$
UNCLAS
CK 95 DPR COLLECT USS GOODSHIP/ NMWW
25 JUL 1970 415PME VIA WESTERN UNION $\overline{BT}$
DPR COLLECT
NEW YORK JOURNAL AMERICAN 220 SOUTH STREET NEW YORK $\overline{BT}$
(PRESS MESSAGE TEXT) $\overline{BT}$
TSUBOKAWA $\overline{BT}$ K

In the preceding press message the domestic service indicator DPR (day press rate) is used instead of the international indicator PRESSE (in the first example). Indicator DPR is for all press messages to or from a continental Navy activity and handled commercially by Western Union. As appropriate, DPR is followed by COLLECT, as in this example, or PAID.

The third example is of a press message for an addressee outside the continental United States transmitted to a Navy shore station. The message is in international form but has a Navy heading added for handling over Navy circuits.

NPM DE NMWW —
T —
P — 162045Z MAY 71
$\overline{BT}$
UNCLAS
USS GOODSHIP/NMWW CK 145 16 1435
$\overline{BT}$
PAGE 1/50 $\overline{BT}$
PRESSE $\overline{BT}$
(PRESS MESSAGE TEXT DIVIDED INTO PAGES AS IN FIRST EXAMPLE) $\overline{BT}$
TSUBOKAWA $\overline{BT}$ K

Abstracting Press Messages

Ships and stations handling press messages are required to submit monthly reports. Press messages are reported on NavCompt Form 2132.

The SRS serial numbers assigned to press messages use the suffix letter P after the number; for example, SRS 116P. Remember that SRS numbers are used for message identification in abstracting and accounting only. They are never transmitted.

Press message abstracts, accompanied by message copies and remittances, are forwarded to U.S. Navy Regional Finance Center, Washington. Remittances are by Treasury check or money order, made payable to U.S. Navy Regional Finance Center, Washington, 20390. Reports from ships are due in the mail by the 5th of the month after handling; from shore stations, by the 10th.

RADIOPHOTOS

Radiophoto transmission is between Navy facsimile units only. Exceptions to this rule must be authorized by COMNAVCOM.

In addition to official Navy pictures and graphic material, including those for general distribution to news associations, Navy radiophoto services may be authorized for transmission of commercial pictures. Commercial pictures are of two classes: (1) those for general distribution to newspapers and news associations, and (2) exclusive commercial pictures filed by correspondents and addressed specifically to newspapers or news associations to which they are accredited.

Exclusive commercial pictures are the only ones for which the Navy charges for handling. Thus they are the only ones requiring abstracting and accounting.

Exclusive commercial pictures are abstracted in the same manner as press messages. They also are reported on the same NavCompt form. Abstracts forwarded to NAVREGFINCEN Washington should be mailed by the 5th of the month from ships, by the 10th from shore stations, and must be accompanied by a copy of each exclusive commercial picture transmitted and received.

For exclusive commercial pictures, SRS numbers are followed by the letter R; for example SRS 24R.

Normally, charges for exclusive commercial picture transmissions are not collected at the time of transmission. Accounting necessary for settlement of Navy charges due is performed by NAVREGFINCEN, Washington. If the sender desires, however, charges may be collected in advance of transmission. In such an instance the remittance and statement of account are included in the report. The flat rate charge for a 7-by 9-inch glossy picture is $30.00.

CLASS E MESSAGES

Class E messages, as defined earlier in this chapter, are personal messages. Part of the leading Radioman's job is to restrict the routing of such messages so as to keep them personal. Subordinates should be instructed that under no circumstances are they allowed to divulge the contents of class E messages to any unauthorized person.

On board ship, incoming class E messages normally are received on the fleet broadcast. They are typed on a regular message form and routed only to the communication officer and addressee. Usually the addressee is called to the communication office to accept delivery. A personal message concerning death, serious illness, or injury is routed to the chaplain for delivery to the addressee. If the ship has no chaplain, the message is routed first to the captain or executive officer.

Class E messages are handled free of charge by naval communications. The only complication concerning class E messages is that most of them must be refiled with Western Union because of the location of the addressee with respect to the sender. This procedure involves toll charges that must be paid by the sender, and accounting and abstracting by the commercial traffic clerk.

To narrow the present discussion, those class E messages that are free of toll charges are eliminated. In general, these toll-free messages are personal messages handled between ships, and from ship-to-shore, shore-to-ship, and shore-to-shore, when both originator and addressee are outside the continental United States and in the same ocean area. Outbound class E messages also are eliminated from this coverage. Outbound class E messages are originated in the United States and addressed to naval personnel aboard ships or overseas bases. The originator of such a message usually sends a Western Union telegram (he can also use mail) to one of four refile points for outbound class E messages. Depending on the location of the addressee, these refile points are NavCommSta San Francisco, Washington and Norfolk. When an outbound class E message arrives at one of these refile stations, the sender already has paid Western Union for transmission from point of origin to refile point. The refile station places the message on an appropriate fleet broadcast or overseas circuit, for which there is no charge. No accounting or abstracting are necessary because the Navy handled no money whatsoever.

The foregoing treatment of class E messages is confined to those originating aboard ship or overseas bases addressed to persons within the United States. These inbound class E messages are subject to toll charges because the refile station must transfer them to Western Union for delivery to the addressee.

Naval communication activities authorized to receive and commercially refile class E messages with Western Union are—

- NavSta Charleston
- NavCommSta Key West
- NavCommSta Newport
- NavCommSta Norfolk
- Commandant, THIRD Naval Dist, New York, N.Y.
- NavCommSta San Diego
- NavCommSta San Francisco, Stockton, Calif.
- NavCommSta Washington, D.C.

All of the activities listed are authorized to refile class E messages from ships. Only the last two, San Francisco and Washington, can refile from overseas bases.

Abstracting Class E Messages

All ships and stations originating class E messages involving toll charges must submit monthly reports under report symbol NavCompt 2101-1. All reports are mailed to the Commanding Officer, U.S. Navy Regional Finance Center, Washington, D.C. 20390. Ships must mail their class E traffic report by the 5th of the month after handling; shore stations, by the 10th.

Class E message reports consist of three items. They are—

1. Abstract, NavCompt Form 2067.
2. One copy of each class E message handled, showing complete transmission data.
3. Remittance necessary to cover commercial tolls of all class E messages reported. Remittance must be in the form of exchange-for-cash U. S. Treasury check, U. S. postal money order, or American Express money order. (Cash, postage stamps, or personal checks are not allowed.)

Remittance covering class E messages addressed to the continental United States, and refiled for final delivery by Western Union Telegraph Company, must be made payable to Western Union Telegraph Company, Washington, D.C. 20390. Make sure that only those funds due Western Union Telegraph Company are included in the check or money order made payable to that company.

Details for Preparation

When filling in the class E abstract form, messages are arranged in groups according to shore stations to which messages were addressed for refile with Western Union. If there was a considerable volume of messages, a separate sheet must be used for each refile station. For reporting only a few messages, a single sheet will suffice, but be sure to leave a blank space of at least three lines to separate the groups of refile stations.

Copies of class E messages must be arranged and attached to the abstract form in the exact order of listing on the abstract. This requirement will probably cause SRS numbers to appear out of order, but cannot be avoided.

In listing messages on the abstract, use only the last name of addressees. City of destination can be abbreviated.

Be sure that only class E messages destined for refile with and final delivery by Western Union Telegraph Company are included in the class E message report.

Class E Rates

FEB 74 RM2 Rate tables for class E messages list toll charges applicable from each refile station to each state (except Alaska and Hawaii) and the District of Columbia. Rate tables are given in DNC 26; they are not repeated here.

In determining rates to be charged for class E messages, the following procedures are observed.

1. Count number of words to be charged. This count includes all words in text and all matter in the signature except name and rank of sender.
2. Consult schedule of rates for city at which message will be refiled with Western Union.
3. Dependent upon the destination, determine the applicable rate for the class of message refiled with the Western Union Telegraph Company.
4. The Telegram or Overnight Telegram charge for the number of chargeable words in the message is then computed. It should be noted that the minimum number or words charged for a Telegram is 15 and an Overnight Telegram is 100. Additional words in excess of that minimum are charged for on a per word basis.
5. When a rate involves a fraction of a cent, the fraction is carried through the entire computation of the charge for the service. When the total charge so computed includes a fraction of one-half cent, the fraction is treated as one cent.

COASTAL HARBOR RADIOTELEPHONE SERVICE

Coastal harbor radiotelephone service is a two-way telephone communication service through a commercial land radiotelephone station between a naval vessel and any telephone on land. This service is provided to meet the needs of ships operating within a few hundred miles of the shore, and is known commercially as the coastal harbor service. Except for USNS contract operated vessels, naval vessels using this service are limited to calls originating on the ship. Calls normally are made collect in order to keep shipboard abstracting to a minimum. Incoming calls to the ship (except those necessary to complete shore-ship connection that involve some delay) are not accepted.

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The coastal harbor radiotelephone service is authorized for passing official message when appropriate. Any official message passed via this circuit requires release by an authorized releasing officer.

All U.S. Navy ships are authorized to use this service in peacetime unless otherwise directed by appropriate authority.

ARRANGEMENTS WITH TELEPHONE COMPANY FOR INITIATION OF SERVICE

No prior arrangements are necessary to use this service for collect calls, toll credit card calls, or for calls "billed to third number," (i.e., other than calling or called party.)

If the service is to be used for calls paid aboard ship (as may be the case of USNS contact vessels) the ship or aircraft squadron commander must establish an account with the telephone company representative nearest the home port assigned to the unit. The form letter as shown in fig. 5-4, when filled out, contains all the necessary data to establish a coastal harbor service billing account. Ships desiring to use the Hawaiian coastal ship-to-shore service must first make local arrangements with the Commercial Manager, Hawaiian Telephone Company, Honolulu, Hawaii.

After the account is established (except those established in the Hawaiian area) it covers service through all the coastal harbor stations in the continental United States.

In the event the ship is assigned to a new home port, a new form letter is sent to the telephone company representative nearest the new home port. A copy also is forwarded to the former representative handling the billing account; one letter to establish an account and one to discontinue the old account.

Shipboard Arrangements

Shipboard arrangements for use of telephone service are handled by the communication officer. The communication officer or a person designated by him serves as the shipboard technical operator. He is responsible for all technical details incident to shipboard operation of equipment.

Rates for Service

The charge for service depends upon the location of the ship as well as the land telephone. The coastal waters are divided into rate areas, which are defined by latitude and longitude as shown in figure 5-5. Calls normally are made collect. Charges (toll plus tax) on all calls must be collected when it is impractical to make the call collect. The marine operator will finish the charges upon request.

Equipment

Transmitters: All standard Navy MF/HF transmitters designed for A3 (voice) emission are, if properly tuned and adjusted, adaptable to this service.

Receivers: All standard Navy MF/HF receivers designed for A3 reception are suitable for this service. Accurate tuning to the correct frequency is essential to ensure good service.

Microphones and remote radiotelephone units: Standard Navy model handsets, such as type CRV 51008A and 2592X, used in connection with remote radiophone units type CANG 23500 and CANU 23423, are satisfactory.

Push-to-talk, release-to-listen operation: This method is considered to be the most practical and satisfactory type of operation. However, this method offers difficulties to unpracticed users. It is anticipated that some instruction will be necessary.

Frequencies, station locations, and call signs are listed in the current edition of DNC 26.

How to Place a Call

Assuming that the person desiring to place a call has made necessary arrangements with the communication officer, and that transmitting and receiving equipment has been properly adjusted and tuned to the desired shore station frequency, the following procedure is observed for placing and completing a call. The ship's technical operator will—

1. Listen to make certain that the circuit is not in use.

2. If the circuit is clear, call the marine operator by voice. If there is no immediate response, repeat the call after a short interval. Excessive testing, calling, and transmission of signals without identification are forbidden.

_______________ (Date)

From: Commanding Officer, USS_______________
To: _______________

Subj: Coastal Harbor (and High Seas) Radiotelephone Service; request for establishment of account

1. It is desired that this vessel be registered as a subscriber to the Coastal Harbor (and High Seas) Radiotelephone Service.

2. The following data is submitted:

Name of Vessel: USS_______________

International Call Sign: _______________

Assigned Home Port: _______________

Billing Address: Communication Officer,

USS_______________

3. It is expected that calls will be placed within the next two weeks through the following coastal harbor stations (and/or high seas radiotelephone station) _______________.

4. Previous account with representative for coastal harbor (and/or high seas radiotelephone) station at_______________to be terminated effective _______________ 19_______.

____
(The letter will be signed by Commanding Officer or his duly authorized representative by direction.)

Copy to:
(Type commander)

50.181

Figure 5-4.—Form letter for requesting establishment of coastal harbor and high seas radiotelephone service account.

Example:

"Norfolk Marine Operator, this is the USS Goodship."

3. When the telephone company marine operator responds, give the name of the ship, coastal rate area in which the ship is located, and the city and land telephone number desired. The marine operator should be requested to provide the time and charges when non-collect calls are made. Example:

"This is USS Goodship, rate area 2A, calling Minneapolis, Minnesota 336-1095 collect."

4. When the telephone company marine operator has recorded call details and made necessary connections, the circuit is ready for the person making the call. For best results, speak

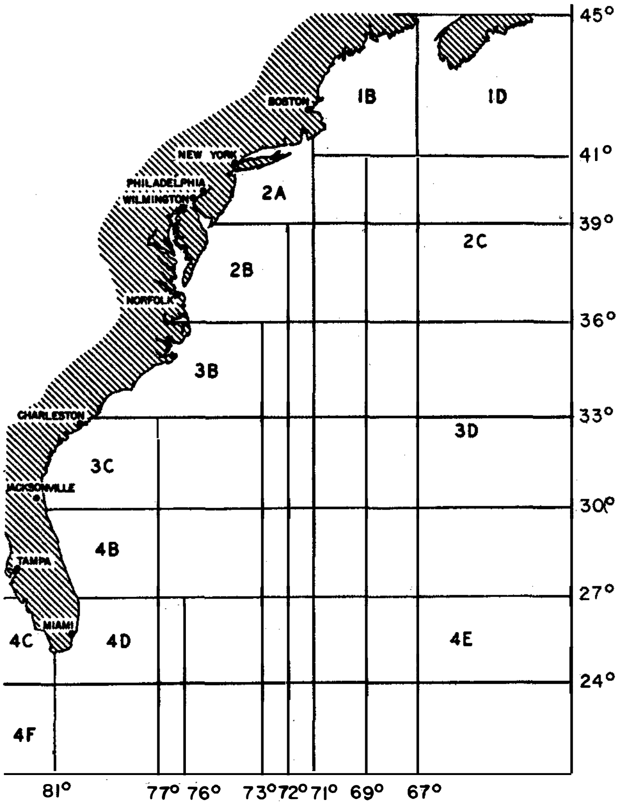

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Figure 5-5.—Coastal harbor stations and ocean rate areas, Atlantic Coast.

naturally and not too loudly. Also, wait until the other party has finished speaking before starting to talk.

5. Upon completion of the conversation, immediately advise the telephone company marine operator that the call is completed. Example:

"This is USS Goodship. Call completed."

HIGH SEAS RADIOTELEPHONE SERVICE

Ship radiotelephone service through high seas radiotelephone stations provides communication between a ship and a land telephone. Service is furnished through land radiotelephone stations WOO, New York, N.Y.; KMI, Oakland, Calif.; WOM, Miami, Fla.; and KQM, Kahuku, Oahu, Hawaii.

Authorization and availability of this service remain the same as for coastal harbor radiotelephone service. Because of the distance involved, however, the provision of service through these stations is subject to transmission, atmospheric, and other limitations.

Ordinarily, service to ships operating near the coast of the United States is furnished through coastal harbor radiotelephone stations established to provide radio communications over relatively short distances. It is contemplated that, in general, ship radiotelephone service through high seas radiotelephone stations will be used by ships operating beyond the normal range of these coastal harbor stations.

CONDITIONS UNDER WHICH SERVICE IS FURNISHED

The conditions under which high seas radiotelephone service is furnished are essentially the same as for coastal harbor stations. An exception is furnishing the station with a general approximation of the ships bearing on the shore station, in order to assist with selection of antenna.

Service Charge

Determination of service charge depends upon location of both the ship and the land telephone. The United States is divided into land rate areas by groups of states; the oceans are divided into ocean rate areas defined by latitude and longitude. Land and ocean rate areas are illustrated in DNC 26.

Billing of Service Charges

Normally, all calls are made collect. If it is impossible for all calls to be made collect, then the charges will be billed against the coastal harbor telephone service account of the ship.

Difference in Operating Procedures

The traffic procedures to be followed by ships in handling calls through high seas radiotelephone stations differ but slightly from handling calls through a coastal harbor station. The essential differences in dealing with calls are as follows:

1. After the radio circuit is established between the ship and the shore traffic operators, the details of all calls on hand are passed, together with any reports pertaining to calls carried forward from a previous contact period.

2. In dealing with a number of active calls, a definite order of precedence of one call over another should be followed. The basic order in the use of the circuits is that a call on which both parties are immediately available is completed before proceeding with new calls; otherwise, calls are dealt with in the order in which they were booked.

3. To facilitate identification of a particular call, where more than one call is active at the same time, the shore traffic operator assigns a serial number to each call.

4. In passing to the ship operator a call, report, or order that necessitates mention of a time of day, the shore traffic operator gives the time in terms of the shore station in all instances.

Frequencies

Operating frequencies for high seas radiotelephone stations are contained in DNC 26.

DISTRESS COMMUNICATIONS

To increase safety at sea and in the air, methods of communication have been developed for use in times of emergency and distress. A list of emergency and distress frequencies adopted for use at such times follows.

- 500 kHz — International calling and distress.
- 2182 kHz — International calling and distress for maritime mobile radiotelephone.
- 8364 kHz — International lifeboat, liferaft, and survival craft frequency.
- 121.5 MHz — International aeronautical emergency frequency for VHF band.
- 243.0 MHz — Aeronautical emergency frequency for UHF band.

Note that 500 kHz is used in times of distress, and it also is the international calling frequency. In routine radiotelegraph communications, merchant ships contact each other on 500 kHz, then shift to a "working" frequency. To make sure that other uses of 500 kHz will not interfere with distress traffic, two silent periods are designated. These periods are for 3 minutes each, and begin at X:15 and X:45 o'clock. That is, a silent period begins 15 minutes before each hour and 15 minutes after each hour. Ship clocks in radio spaces usually have these 3-minute segments of the clock face painted red to remind operators of silent periods. Except for actual distress messages, all traffic ceases at these times on frequencies between 480 and 520 kHz.

Guarding distress frequencies is an important function of Coast Guard shore radio stations. Some naval shore stations stand continuous distress watches. Others maintain only a "loudspeaker" watch.

When a Navy ship is operating singly at sea, a continuous watch is stood on 500 kHz and 8364 kHz if operators and equipment are available. In all instances a receiver watch is always stood and a log is kept covering at least the silent periods. When ships are operating in a group, the officer in tactical command (OTC) arranges for the distress guard. Usually, one ship guards for the group. Under certain conditions, the OTC may request a shore radio station to handle the guard for his ships when in the area of the shore station.

Information concerning international regulations for distress, emergency, and safety traffic can be found in Distress and Rescue Procedure (ACP 135), and in Radio Navigational Aids (N.O. 117A and 117B).

DISTRESS SIGNAL

In radiotelegraph, the distress signal SOS is transmitted as a single character. When sent on 500 kHz, the dashes must be emphasized in order to operate an automatic alarm apparatus with which most merchant ships are equipped. The International Telecommunications Union also adopted an alarm signal for use on 500 kHz. The ITU system consists of twelve 4-second dashes with a 1-second interval between dashes. Thus, there are two possible methods of actuating the alarm. For this reason the distress call should be preceded by the 12-dash alarm signal, followed immediately by $\overline{\text{SOS}}$ sent 3 times.

The answer to a distress message takes this international form: Call sign of the distress ship (3 times), prosign DE, call sign of own ship (3 times), followed by RRR $\overline{\text{SOS}}$. Assume that SS Blank, whose call sign is WUBN, is in distress. The call sign of own ship is NTAA, whose answer to the distress message would be:

WUBN WUBN WUBN DE NTAA NTAA NTAA
RRR $\overline{\text{SOS}}$ $\overline{\text{AR}}$

Usually, the answer to a distress message is followed by the name of own ship, position, and maximum speed at which she is proceeding toward the vessel in distress. This answer, of course, must be originated by the commanding officer.

If own ship is not in position to give assistance to SS Blank, own ship may help by relaying the distress message. In the relay, the distress message is repeated word for word on the distress frequency, with full transmitter power, followed by DE and own ship's call sign repeated 3 times. Authority to relay the message must come from own ship's commanding officer. He may include the distress message in the text of a naval message to be transmitted to a shore station for possible action or broadcast to the fleet.

To handle rescue operations successfully, distress traffic must be controlled. The vessel making the distesss call is the control station for distress traffic. Control may be exercised by another ship at the scene, however. Any ship can impose silence on any radio stations in the zone, or on a particular station interfering with the distress traffic. To impose silence, the signal QRT is sent, followed by the word DISTRESS. This message may be addressed to all stations (CQ) or to a specific station.

When distress traffic is ended, or radio silence no longer is necessary, a message is sent to inform all ships. This message is originated by the control vessel. Assume own ship (NTAA) was control vessel for WUBN. At the end of the distress traffic, your commanding officer would originate the following message.

SOS CQ CQ CQ DE NTAA SS BLANK
WUBN QUM AR

Note that DE is followed by the call sign of the ship transmitting. This call sign, in turn, is followed by the name and call of the ship that originated the distress call. The signal QUM means "Normal working may be resumed."

A naval vessel in distress ordinarily does not use the international distress signal SOS. Instead, Navy communication channels and cryptoaids are utilized.

Although SOS is the international distress signal sent by radiotelegraph, the signal in radiotelephone is the spoken word MAYDAY. Pronunciation of this distress signal is the same as the French word m'aider ("Help me"), from which it derives. MAYDAY also is used by aircraft in distress.

URGENCY SIGNAL

In addition to the distress signal SOS, there is an urgency signal for use on distress frequencies. It consists of the group XXX sent 3 times before the call. The urgency signal indicates that the calling ship has an urgent message to transmit concerning the safety or the ship or of a person on board or within sight. It has priority over all other communications except distress signals.

SAFETY SIGNAL

The safety signal, transmitted on any of the distress frequencies, consists of the group TTT sent 3 times before the call. It indicates that the ship is about to transmit a message concerning the safety of navigation or giving important meteorological (weather) warnings.

DISTRESS DUE TO ENEMY ACTION

Merchant ships use SOS in distress messages to summon assistance only in instances of distress due to normal marine causes such as fire, collision, storm, and the like, not the result of enemy action.

In wartime, five signals are used by merchant ships to indicate distress due to enemy action. These distress signals are given in the accompanying list.

Class of Distress	Distress Signal	When Used
Warship radier	WWWW	On sighting or when attacked by enemy warship.
Armed merchant ship raids	QQQQ	On sighting or when attacked by armed merchant ship raider.
Submarine	SSSS	On sighting or when attacked by enemy submarine.
Aircraft	AAAA	On sighting or when attacked by enemy aircraft.
Mine	MMMM	On striking a mine.

CHAPTER 6
TELETYPEWRITER PROCEDURES

Teletype is the primary means of communication now in use by the Navy. This chapter will outline the operating procedures and practices applicable to the Defense Communications System (DCS) Automatic Digital Network (AUTODIN). The DCS AUTODIN system is a world-wide computerized, general-purpose communications system which provides for the transmission of narrative and data pattern traffic on a store-and-forward (message switching) basis.

ROUTING INDICATORS

In order to move relay message traffic efficiently from one point to another, each station in the DCS AUTODIN teletypewriter network is designated by a routing indicator. A routing indicator is made up of a group of seven letters, according to a specific pattern.

CONSTRUCTION

Routing indicators are distinguished easily from call signs and address groups because the first letter of a routing indicator is always the letter R. Routing indicators are not encrypted for transmission security purposes. The second letter identifies the nation, service of international alliance to which the routing indicator is alloted. Those of the United States and Allied Nations are as follows: A—Australia, B—British Commonwealth (less Canada), C—Canada, H and U—United States, and X—NATO. The third letter normally indicated the geographical area in which a station is located or from which it is served. Within the United States communications networks, the third letter does not necessarily reflect the geographical area. Due to the shortage of routing indicators in some areas and abundance in other areas, assignments are made irrespective of geographical area, particularly for dedicated network major relay stations, etc. The fourth letter identifies major relay stations. In normal operation, major relay station routing indicators are modified by the use of prescribed suffixes to form seven letter routing indicators. The fifth, sixth and seventh letters identify minor relay or tributary stations.

PUBLICATIONS

Publications of principal importance to teletype operators are the effective editions of JANAP 128, ACP 127 (with U.S. Supplement), ACP 117 (with Canadian and U.S. Supplements), and ACP 126.

Supplements actually are separate publications, issued by individual Allied countries, that amplify (or expand) the basic publication for the individual needs of that country.

MACHINE FUNCTIONS

Machine functions are of the utmost importance in teletype operation. Because some functions do not show up on the printed page copy of the message, one may wonder why it is necessary to use them at all. Remember that teletype messages are relayed in various forms; machine functions play an important part in the efficient operation of the AUTODIN system. An explanation of machine functions and rules for their use are given in the ensuing six topics.

SHIFT (FIGS) AND UNSHIFT (LTRS)

Teletype machines, owned or leased for use in naval communications, shift from uppercase characters (figures) to lowercase characters (letters) only when the LTRS key is pressed. Many naval messages, however, are delivered to some addressees by commercial teletypewriter exchange service (TWX). The TWX machines shift automatically from uppercase to lowercase characters whenever the SPACE BAR is pressed, in addition to shifting when the LTRS key is pressed. To ensure that this UNSHIFT-ON-SPACE feature does not result in errors, the following rules should be followed when transmitting by tape on either a TWX or Navy-owned or leased teletype.

1. Always press the LTRS key to shift from uppercase to lowercase of TWX or Navy machines (disregarding the unshift-on-space feature of the TWX machine). Example: 35784 (space) (ltrs) TRY MAKE. This procedure has no adverse effect on either a TWX or Navy machine. Failure to follow this procedure would result in the following error:
   a. Transmitted on a TWX machine without insertion of (ltrs) after the space would be: 35784 TRY MAKE.
   b. As received on a Navy machine however: 35784 546 .-3.

2. Always press the FIGS key to shift from lowercase to uppercase, and also after the space before each group of figures or uppercase characters in a series. Example: 35784 (space) (figs) 27896...The procedure in step two has no adverse effect on either a TWX machine or on a Navy machine. This rule applies whether direct keyboard transmission or tape perforation is used. Failure to follow this practice would result in the following error:
   a. Transmitted on Navy machine: 35784 (space) 27896.
   b. As received on TWX machine: 35784 (space) WUIOY.

CARRIAGE RETURN (CR)

The carriage return function resets the machine to the left margin of the paper. As a special precaution to make sure that the carriages return on all machines properly, the operator presses the CR key twice at the end of each line. Regardless of typing speed during punching of a message tape, the message is transmitted on circuits generally at 100 words per minute. At these high speeds, the carriage does not have enough time to return to the left margin on a single CR function. As a result, the next character prints while the carriage still is moving toward the left. Always remember to press the CR key twice at the end of each line in the message as shown in the message examples in this chapter.

LINE FEED (LF)

The line feed function advances the paper on the page. Note that the normal end-of-line functions include only one LF. At the end of the message, however, eight line feed functions are used to provide space between messages on the printed page.

BELL SIGNAL

The bell signal is used to attract the attention of the receiving operator. One use of the signal bell is when handling flash messages. In the AUTODIN network, the bell signal is not inserted on originated FLASH messages. The AUTODIN Switching Center (ASC) will generate the bell signal on FLASH messages transmitted to Modes II, IV and V terminals (described later in this chapter.) If transmitted to a station operating a Mode I or III terminal, a different type of high-precedence alarm will be generated.

On most teletypewriters the bell signal rings when the uppercase S key is pressed. Some equipments, particularly those used in the Canadian tape relay network, have the bell signal on the uppercase J key.

SPACE (SP)

The space function advances the carriage (typebox) without printing any character on the page. It is used throughout the message for spacing between routing information, prosigns, words or groups, and the like.

BLANK (BL)

Pressing the blank key has no effect on the page copy of a message, but is used to advance blank tape through the punch block of the teletype perforator. The blank function is required in operating certain cryptosystems, but is generally used for tape feed out on typing perforators and reperforators. Do not substitute BLs for LTRS.

SYSTEM OPERATIONAL MODES

At the present time there are five methods of channel operation available in AUTODIN.

MODE I

This is a duplex operation with automatic error and channel controls allowing independent and simultaneous two-way operation. This is accomplished by means of control characters which are used to acknowledge receipt of valid line blocks and messages or to return error information. The terminal (or switching center) responds automatically to these characters by continuing or stopping transmission and/or displaying action information to the operator. Examples of terminal equipments used in this mode of operation are described in chapter eleven of this manual.

MODE II

This is a duplex operation, normally associated with teletypewriter equipments allowing independent and simultaneous two-way operation. There are no automatic error or channel controls; message accountability is maintained through channel sequence numbers and service messages.

MODE III

This is a duplex operation with automatic error and channel controls, but utilizing only one-way transmission. The return direction is used exclusively for error control and channel coordination responses. The Mode III channel is reversible on a message basis. Control characters are used in the same manner as described in Mode I above. Compound terminals and magnetic tape terminals operating in the circuit switching mode (without manual lockup) utilize Mode III.

MODE IV

This is a unidirectional operation (send only or receive only) without error control and channel coordination. The Mode IV channel is non-reversible, and is equivalent to half duplex operation of Mode II.

MODE V

Mode V is duplex operation, normally associated with teletypewriter equipments, allowing independent and simultaneous two-way transmission. Control characters are used to acknowledge receipt of messages and to display limited information to the operator. Message accountability is maintained through the use of channel sequence numbers with automatic response through use of control characters by the distant terminal/switching center.

MESSAGE TYPES AND ELEMENTS

Chapter four of this manual spent a great deal of time on the Naval message. You have learned message types (Single Address, Multiple Address, and General Message) and three different message formats (Plaindress, Abbreviated Plaindress, and Codress). The AUTODIN network will accept the three message formats already outlined and a fourth message format called Data Pattern. It is not always necessary to use all sixteen format lines of the naval message. The basic message format being used governs which format lines are needed.

Plaindress

In message preparation we have learned message preparation using all sixteen format lines. A Plaindress message must have in its construction format lines 2, 4, 5, 6, 7 (and/or 8), 11, 12, 13, 15 and 16. Other format lines may be used when required.

Example of a PLAINDRESS message:

FORMAT LINE	CONTENTS	END OF LINE FUNCTIONS
2	RTTUZYUW RUEBABA1234 1Ø814ØØ-UUUU—RUKKLAA.	(2CR)(1LF)
4	ZNR UUUUU	(2CR)(1LF)
5	R 18123ØZ APR 71	(2CR)(1LF)
6	FM AFSC	(2CR)(1LF)
7	TO ELMENDORF AFB ALASKA	(2CR)(1LF)
11	BT	(2CR)(1LF)
12	UNCLAS (TEXT)	(2CR)(1LF)
13	BT	(2CR)(1LF)
15	#1234	
16	(2CR)(8LF) NNNN	(12 LTRS)

Abbreviated Plaindress

An Abbreviated Plaindress message omits certain format lines for message brevity. The format lines which must be included in an Abbreviated Plaindress message are lines 2, 4, 11, 12, 13, 15 and 16.

Example of an ABBREVIATED PLAINDRESS message:

FORMAT LINE	CONTENTS	END OF LINE FUNCTIONS
2	RTTUZYUW RUEOLGAØØ25 1Ø814ØØ-UUUU—RUCIABA.	(2CR)(1LF)
4	ZNR UUUUU	(2CR)(1LF)
11	BT	(2CR)(1LF)
12	UNCLAS (TEXT)	(2CR)(1LF)
13	BT	(2CR)(1LF)
15	#ØØ25	
16	(2CR)(8LF) NNNN	(12 LTRS)

Codress

A Codress message discloses the originator and all action/information addressee designations only within the encrypted text. Format lines 6, 7, 8, and 9 are never shown externally. The heading of a Codress message contains only the information essential for routing the message to the receiving station. Plain language transmission instructions are prohibited. The classification designator "U" (Unclassified) is used in format lines 2 and 4 on all Codress message traffic.

Example of a CODRESS message:

FORMAT LINE	CONTENTS	END OF LINE FUNCTIONS
2	RTTUZYUW RUEOLGAØØ25 1Ø814ØØ-UUUU—RUCIABA.	(2CR)(1LF)
4	ZNR UUUUU	(2CR)(1LF)
5	R 18132ØZ APR 71	(2CR)(1LF)
10	GR55	(2CR)(1LF)
11	BT	(2CR)(1LF)
12	XXXXX XXXXX XXXXX XXXXX (TEXT)	(2CR)(1LF)
13	BT	(2CR)(1LF)
15	#ØØ25	
16	(2CR)(8LF) NNNN	(12 LTRS)

Data Pattern

A message format that you have not been previously introduced to is the Data Pattern message format. This format is for use between facilities subscribing to the AUTODIN system. Data Pattern format utilizes the high speed computers and card readers (described in chapter eleven of this manual) to transmit and receive large volume message traffic in short periods of time. Due to the extensive use of the Data Pattern message format, we will discuss the construction and handling later in this chapter. Data Pattern message format uses format lines 2, 12, and 16. Other format lines may be employed depending upon the needs of the subscriber.

Example of a DATA PATTERN message:

FORMAT LINE	CONTENTS
2	RCCUDAA RUDOFDAØ123 1Ø814ØØ ØØ5Ø-UUUU-RUFTDBA.
12	TEXT - 48 CARDS
16	RUCCUDAA RUDOFDAØ123 1Ø814ØØ ØØ5Ø-UUUU NNNN

TELETYPE MESSAGE ALIGNMENT

Message alignment is essential so that the AUTODIN system will not reject the message tape and cause unnecessary delay in delivery of the message. The alignment procedure given here is for guidance when preparing message tapes for transmission. When preparing a message tape for submission into the AUTODIN system there are certain tape-cutting procedures that must be adhered to to prevent the message from being rejected by the ASC.

MESSAGE HEADER

The originating station is responsible for preparing the message for submission into the AUTODIN system. The Message Header is the starting point for the operator preparing the message tape. Modes I and III do not require format line one. On terminals of which format line one is required (Modes II, IV and V) the ASC validates these elements. The message header is format line two, and the operator must remember when preparing his header that it must be letter perfect or his message will be rejected when it is introduced into the AUTODIN system. The teletypewriter message header is a basic 34 position header (fig. 6-1).

Leader

To insure acceptance and transmission of the first character of the message header, it is preceded by at least six blanks and six letters functions with five level baudot code (most common) or at least six nulls and six delete functions with ASCII (eight level baudot code).

Position One

There are four categories of precedence which are presently authorized for use. The precedence is assigned by the originator, and must not be altered by operating personnel. The following prosigns are used in position one and the appropriate prosign (depending upon message precedence) is only entered once. Z-FLASH, O-IMMEDIATE, P-PRIORITY, and R-ROUTINE.

Positions Two and Three

There are two teletype transmission codes available in the AUTODIN system. The most common code in use is the five baudot code, which is explained in detail in chapter eleven of this manual. There is, however, an eight level baudot code employed between ASCs. The Navy is going through a transition process to the eight level baudot code (ASCII) which should give the AUDODIN system more versatility. In the teletypewriter header format, the Language Media and Format (LMF) consists of two alphabetical characters. Position two of the message header uses the LMF (alphabetical character) which indicates the method being used to insert the message into the AUTODIN system. The character A is used if the device used for insertion is the ASCII and the character T for the five level baudot code. The LMF used in position three is the character indicating the preferred output device of the addressee of the message.

TELETYPEWRITER HEADER FORMAT

LEADER

PRECEDENCE

LANGUAGE MEDIA AND FORMAT

CLASSIFICATION, AS APPROPRIATE

CONTENT INDICATOR/COMMUNICATION ACTION IDENTIFIER

SEPARATOR

ORIGINATOR

STATION SERIAL NUMBER

SEPARATOR

JULIAN DATE

TIME FILED

CLASSIFICATION REDUNDANCY

START OF ROUTING SIGNAL

ADDRESSEE

END OF ROUTING SIGNAL

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43

RTTUZYUW RUWTAAA1234 22Ø1915-UUUU--RUWJAAA

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Figure 6-1.—Teletypewriter Message Header (Format line 2).

Position Four

As you know, the classification of a message is determined by the originator and cannot be changed by operating personnel. A single character is used in position four to indicate in the message header what classification is being used in the message. The letters authorized for use to indicate degrees of classification for use in message headers are:

A	SPECIAL CATEGORY (SPECAT)
T	TOP SECRET
S	SECRET
C	CONFIDENTIAL
E	UNCLASSIFIED EFTO
U	UNCLASSIFIED

Positions Five through Eight

Positions five through eight of the message header is a combination of letters or three letters and one number which are used to indicate message content and provide identification for communications handling. These code letters or letters/number are called Content Indicator/Communications Action Identifiers; samples of each are illustrated in figures 6-2 and 6-3. JANAP 128( ) ANNEX B provides a complete list of codes for use by communications personnel.

Position Nine

The message header has a space in position nine and it requires the operator to depress his space bar and insert the teletype code equivalent for space in this position on his message tape.

Positions Ten through Sixteen

As you learned earlier, a routing indicator is a combination of letters used to address each station. Positions ten through sixteen (seven positions) of the message header are used to insert the routing indicator of the originating station.

Positions Seventeen through Twenty

The message header uses positions seventeen through twenty (four positions) for the sending station to insert his station serial number (SSN). This station serial number (SSN) serves two specific purposes. In combination with the originators routing indicator, it provides positive identification for each transmission. In the End of Message validation (EOM), discussed later in this chapter, this number appearing in format line fifteen provides a means by which the ASCs can check for the existence of straggler messages. The station serial numbers are expressed in four numeric characters beginning with ØØØ1 and continuing consecutively through ØØØØ, which represents 1Ø,ØØØ. Upon completion of each series, a new series begins. Operating stations may use the SSNs to identify local activities, channels, or positions within a station by assigning each desired activity a specific block of numbers. For example: One station may be assigned numbers from ØØØ1 to 2ØØØ, the next station assigned numbers from 2ØØ1 to 4ØØØ, etc.

Position Twenty One

Again the message header uses a space for a separator which requires the operator to repeat the procedures of position nine.

Positions Twenty Two through Twenty Four

Each calendar day of the year is assigned a Julian date, and the Julian dates begin with ØØ1 on January 1st of the year and run consecutively through 365 on December 31st. Positions twenty two

FIRST POSITION	SECOND & THIRD POSITION	FOURTH POSITION	MEANING
Z	DG	W	ACCURACY OF FOLLOWING MESSAGE IS DOUBTFUL. CORRECTION OR CONFIRMATION WILL BE FORTH-COMING.
Z	DK	W	FOLLOWING REPETITION IS MADE IN ACCORDANCE WITH YOUR REQUEST.
Z	EL	X	THIS MESSAGE IS A CORRECTED COPY. (NOTE: MAY ONLY BE USED WITH (AS FOLLOW-UP) ZDG.)
Z	EX	W	THIS MESSAGE IS A BOOK MESSAGE AND MAY BE DE-LIVERED AS A SINGLE-ADDRESS MESSAGE TO AD-DRESSEES FOR WHOM YOU ARE RESPONSIBLE.
Z	FD	Y	THIS MESSAGE IS A SUSPECTED DUPLICATE.
Z	FG	Y	THIS MESSAGE IS AN EXACT DUPLICATE OF A MESSAGE PREVIOUSLY TRANSMITTED.
Z	FH	1, 2, OR 3	THIS MESSAGE IS BEING PASSED TO YOU FOR (1. ACTION; 2. INFORMATION; 3. COMMENT).
Z	IA	W	THIS MESSAGE IS BEING PASSED OUT OF PROPER SE-QUENCE OF STATION SERIAL NUMBER.
Z	OV	W	THIS MESSAGE IS BEING REROUTED TO YOUR STATION.
Z	YQ	W	THIS IS A BOOK MESSAGE AND MUST BE DELIVERED AS A SINGLE ADDRESS MESSAGE TO ADDRESSEE(S) FOR WHOM YOU ARE RESPONSIBLE.
Z	YU	W	THIS IS A NARRATIVE MESSAGE.
Z	YV	W	THIS IS A SERVICE MESSAGE.
Z	ZD	Z	THIS IS A COMPOSITE MESSAGE, FORMED BY COMBINING SEVERAL SHORT MESSAGES, ALL FOR THE SAME AD-DRESSEE, UNDER THIS SINGLE AUTODIN HEADER.
Z	ZE	Z	NO MAJOR CATEGORY OF AUTODIN CONTENT INDICATOR CODE HAS BEEN ASSIGNED TO COVER THE CONTENTS OF THIS MESSAGE.
Z	ZG	W	THIS MESSAGE IS AN ALTERNATIVELY ROUTED COL-LECTIVE CALL MESSAGE; DELIVER A COPY TO AD-DRESSEE(S) FOR WHOM YOU ARE RESPONSIBLE; DO NOT REINTRODUCE INTO THE SYSTEM AS A COLLECTIVE CALL MESSAGE.
Z	ZL	W	THIS MESSAGE IS FORWARDED UNDER THE PROVISION OF EFTO POLICY. DISREGARD THE CONFLICTING SECURITY WARNING OPERATING SIGNALS.

NOTE: WHERE DIGITS (NUMERICS) APPEAR IN THE THIRD COLUMN OF THIS TABLE (FOURTH POSITION OF THE CODE), EACH SUCH DIGIT MUST BE USED ONLY IN ACCORDANCE WITH THE EXPLANATION GIVEN IN THE MEANING COLUMN. IF NONE OF THE ASSIGNED MEANINGS APPLY, THEN USE THE LETTER Z OR W.

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Figure 6-2.—Communication Action Identifier Codes.

COLUMN 1		COLUMN 2		COLUMN 3		COLUMN 4	COLUMN 5
SECOND POSITION		THIRD POSITION		FOURTH POSITION		MONITORING ACTIVITY	REMARKS
CODE LETTER	MAJOR CATEGORY	CODE LETTER	PRIME SUBCATEGORY	CODE LETTER	MINOR SUBCATEGORY		
D	PERSONNEL	A B C D E F–Y	OFFICER ENLISTED CIVILIAN SUMMARY ORGANIZATION NOT ASSIGNED	A B C–T	REPORTS ACTIONS NOT ASSIGNED	DCA	
E	MEDICAL	A B C D E–Y	OFFICER ENLISTED CIVILIAN SUMMARY NOT ASSIGNED	A B C D–T	REPORTS ACTIONS RECORDS NOT ASSIGNED	DCA	
F	FINANCE AND BUDGET	A B C D E F G H–Y	COMPTROLLER FUNDS PAYROLL BUDGETARY ACCOUNTING ALLOTMENTS UNIFORMED SERVICES SAVINGS DEPOSIT ALLOTMENTS NOT ASSIGNED	A B C D E F G H I–T	REPORTS COLLECTIONS DISBURSEMENTS MILITARY CIVILIAN ESTIMATE EQUIPMENT SUMMARIES NOT ASSIGNED	DCA	
G	OPERATIONS	A B C D E F G H–Y	ATOMIC AIRCRAFT SHIP VEHICULAR ORGANIZATIONS MISSILE COMMAND & CONTROL NOT ASSIGNED	A B C D E–T	REPORTS ACTIONS CONTROL DAMAGE NOT ASSIGNED	DCA	

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Figure 6-3.—Content Indicator Code.

through twenty four of the message header are used to insert the Julian date the message center received the message from the originator for transmission.

Positions Twenty Five through Twenty Eight

When a message is delivered from an originating activity to the communications center for transmission, it is usually stamped by a time clock set to record the actual time the message has been delivered to communications. This clock is set to record the time based on GMT and indicates the day, hour, and minute. The time, in hours and minutes, that this message has been filed with communications is placed in positions twenty five through twenty eight (four positions) of the message header. Each filing time must contain four numerals.

Positions Twenty Nine through Thirty Three

In position four of the message header, we have already inserted the code letter for the classification of the message. In position twenty nine, we insert a hyphen which acts as a sentinel to let AUTODIN system know that a classification verification is following which is required for security reasons. Positions thirty through thirty three (four positions) require the single classification code letter to be duplicated four times.

Position Thirty Four

Position thirty four begins the actual routing of the message and the routing indicators of the addressees are inserted at this point. The positions reserved for routing are comprised of two sections:

a. Start-of-Routing Signal. The start-of-routing signal consists of two consecutive hyphens and will always precede the first addressee's routing indicator.

b. Addressees. Addressee routing indicators are listed immediately following the start-of-routing signal. A maximum of 50 routing indicators can be listed in these positions. In multiple call messages, routing indicators must appear as sequential character groups with a space between each routing indicator. Individual routing indicators will not be split between two lines.

End-of-Routing Signal

The end-of-routing signal is a period (.) and is inserted in the position immediately following the last character of the last addressees routing indicator.

SECURITY WARNING

In torn tape procedure, outlined in ACP 127, format line three is utilized. The United States uses torn tape procedure between some U.S. facilities and allied countries. This method is being replaced by AUTODIN within the U.S. Format line three begins with the prosign DE (meaning: THIS IS) followed by the routing indicator of the originating station and the Station Serial Number (SSN) of the message. In AUTODIN format all of this information is included in the message header (format line two) and, therefore, is not repeated. Immediately following the message header (format line two) a security warning is inserted in format line four. Format line four must be prepared correctly. This means the operator must again insure that this format line is prepared error free or the AUTODIN system will reject his message. Immediately following the end-of-routing signal, the operator must down shift his teletype (LTRS) and follow with 2CR and 1LF. No extraneous functions, such as a LTRS, may be inserted between the 2CR 1LF end-of-line functions of format line two. Format line four then begins with the operating signal ZNY or ZNR. If the message being prepared is unclassified, off-line encrypted, or a classified message being transmitted in the clear, the operating signal ZNR followed by the code letter "U" repeated five times is sent. If the message being prepared is Unclassified EFTO, Confidential, Secret, Top Secret, or Special Category (SPECAT), the operating signal ZNY followed by the appropriate code character, repeated five times, is sent. Figure 6-4A provides a schematic breakdown of format lines one through four.

THE MESSAGE

Construction of the naval message and its components and elements, has been discussed in detail in chapter four of this manual and will not be repeated here. The operator, in preparing his message for transmission, is allowed to correct tape cutting mistakes by back-spacing and lettering out his errors in tape preparation beginning with format line five (Message Preamble). Format lines six through nine (figure 6-4B) comprise the message address. Delivery responsibility to each addressee is indicated by preceding each address designation with the routing indicator of the station responsible for delivery to that addressee. An exception to this procedure is when addressees are designated by a collective address designator or an address indicating group. Then, it is unnecessary to precede the designator with routing indicators. When a single station is responsible for delivery to all addressees represented by a collective address designator, however, that station's routing indicator should precede the designator. When delivery to an addressee is accomplished by other means the operating signal ZEN is used in place of a routing indicator. A slant sign separates the routing indicator (or ZEN) from the address designator. In addition, it is not necessary to precede the originator with his routing indicator since it has already been identified in the message header. In the case of single address messages, it is also not necessary to precede

PARTS	COMPONENTS	FORMAT LINE	ELEMENTS	CONTENTS	EXPLANATION
HEADING	PROCEDURE	1	HANDLING INSTRUCTIONS	TRANSMISSION IDENTIFICATION FOR MODES II, IV, AND V STATIONS ONLY, AND PILOTS.	CONTAINS START OF MESSAGE INDICATORS AND TRANSMISSION IDENTIFICATION, WHEN NECESSARY (PARA. 403); CONTAINS PILOTS AS REQUIRED (PARA. 328 AND 504).
		2	HEADER	PRECEDENCE, LMF, CLASSIFICATION, CIC/CAI, OSRI, SSN, DATE-TIME FILED, RECORD COUNT (AS REQUIRED), CLASSIFICATION REDUNDANCY, CALLED STATION(S), END-OF-ROUTING SIGNAL.	IF MESSAGE IS DUAL PRECEDENCE, ONLY THE HIGHER PRECEDENCE IS SHOWN IN THIS LINE.
		3	CALLING STATION AND FILING TIME	PROSIGN DE; ROUTING INDICATOR OF STATION PREPARING MESSAGE FOR TRANSMISSION; STATION SERIAL NUMBER; FILING TIME.	FILING TIME IS THE DATE AND TIME THE MESSAGE WAS FILED WITH THE COMMUNICATIONS CENTER. NOT USED IN AUTODIN ORIGINATED MESSAGE. WILL BE RECEIVED IN MESSAGES FROM OTHER TELETYPEWRITER NETWORKS.
		4	TRANSMISSION INSTRUCTIONS	SECURITY WARNING OPERATING SIGNAL; CLASSIFICATION DESIGNATORS; PROSIGN T; OTHER OPERATING SIGNALS; SPECIAL OPERATING GROUP(S) (SOGS); ADDRESS DESIGNATOR(S) ROUTING INDICATOR(S).	OPERATING SIGNALS ZNR/ZNY, AS APPROPRIATE AND CLASSIFICATION DESIGNATORS WILL BE USED. INDICATES SPECIFIC TRANSMISSION RESPONSIBILITY NOT APPARENT IN OTHER COMPONENTS OF THE MESSAGE HEADING. PLAIN LANGUAGE ADDRESS DESIGNATORS ARE NOT PERMITTED IN CODRESS MESSAGES.

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Figure 6-4A.—Schematic Diagram of Message Content.

PARTS	COMPONENTS	FORMAT LINE	ELEMENTS	CONTENTS	EXPLANATION
	PREAMBLE	5	PRECEDENCE: DATE-TIME GROUP; MESSAGE INSTRUCTIONS.	PRECEDENCE PROSIGN, DATE, ZULU TIME, ABBREVIATED MONTH, AND YEAR OPERATING SIGNALS.	IN THE CASE OF DUAL PRECEDENCE, BOTH PROSIGNS ARE SHOWN SEPARATED BY A SPACE. OPERATING SIGNALS ARE USED ONLY WHEN REQUIRED TO CONVEY MESSAGE HANDLING INSTRUCTIONS.
	ADDRESS	6	ORIGINATOR	PROSIGN FM; ORIGINATOR'S DESIGNATION.	MESSAGE ORIGINATOR IS INDICATED BY PLAIN LANGUAGE, ROUTING INDICATOR, ADDRESS GROUP, OR CALL SIGN.
		7	ACTION ADDRESSEE(S)	PROSIGN TO; ROUTING INDICATOR(S); OPERATING SIGNAL; ADDRESS DESIGNATION(S).	ACTION ADDRESSEE(S) IS INDICATED BY PLAIN LANGUAGE, ROUTING INDICATOR(S), ADDRESS GROUP(S) OR CALL SIGN(S). IN THE CASE OF MULTIPLE ADDRESS MESSAGES, WHEN ADDRESSEES ARE LISTED INDIVIDUALLY, EACH ADDRESS DESIGNATION SHALL BE ON A SEPARATE LINE AND MAY BE PRECEDED EITHER BY THE OPERATING SIGNAL ZEN (MEANING DELIVERED BY OTHER MEANS) OR BY THE ROUTING INDICATOR OF THE STATION RESPONSIBLE FOR DELIVERY. SUCH USE IS MANDATORY ON ALL JOINT AND COMBINED MESSAGES.
		8	INFORMATION ADDRESSEE(S)	PROSIGN INFO: ROUTING INDICATOR(S); OPERATING SIGNAL(S); ADDRESS DESIGNATOR(S)	SAME AS FOR LINE 7, EXCEPT THAT LINE 8 PERTAINS TO INFORMATION ADDRESSEE(S).
		9	EXEMPT ADDRESSEE(S).	PROSIGN XMT; ADDRESS DESIGNATOR(S).	USED ONLY WHEN A COLLECTIVE ADDRESS DESIGNATION IS USED IN LINE 7 OR 8, OR AN AIG IN LINE 7, AND AN INDICATION OF THE ADDRESSEE(S) EXEMPTED FROM THE COLLECTIVE ADDRESS OR AIG IS REQUIRED.

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Figure 6-4B.—Schematic Diagram of Message Content—Continued.

PARTS	COMPONENTS	FORMAT LINE	ELEMENTS	CONTENTS	EXPLANATION
	PREFIX	10	ACCOUNTING INFORMATION GROUP COUNT.	ACCOUNTING SYMBOL (WHEN REQUIRED); GROUP COUNT PROSIGN GR; GROUP COUNT.	THE GROUP COUNT PROSIGN AND GROUP COUNT SHALL BE USED ONLY WHEN THE TEXT CONSISTS OF COUNTABLE ENCRYPTED GROUPS.
SEPARATION		11		PROSIGN BT	
TEXT		12	CLASSIFICATION; INTERNAL INSTRUCTIONS; THOUGHT OR IDEA EXPRESSED BY ORIGINATOR (IN THAT ORDER).		SEE ACP 121 SERIES. CLASSIFICATION AND INTERNAL INSTRUCTIONS NOT REQUIRED IN DATA PATTERN MESSAGES.
SEPARATION		13		PROSIGN BT	
ENDING	PROCEDURE	14	CONFIRMATION		NOT USED IN AUTODIN AND TAPE RELAY OPERATIONS.
		15	CORRECTION	PROSIGN C; OTHER PROSIGNS; OPERATING SIGNALS AND PLAIN LANGUAGE AS REQUIRED.	NOT USED IN DATA PATTERN MESSAGES.
			EOM VALIDATION NUMBER.	NUMBER SIGN (#) 4-DIGIT NUMBER.	USED ON ALL DOD ORIGINATED TELETYPEWRITER MESSAGES.
		16	END OF MESSAGE FUNCTIONS (EOM).	2CR, 8LF, 4NS, 12LTRS.	USED ON ALL TELETYPEWRITER MESSAGES UNLESS OTHERWISE PRESCRIBED.
			— OR —		
			END OF TRANSMISSION (EOT)	REPEATS FIRST 33 OR 28 CHARACTERS OF HEADER PLUS 4NS.	USED ONLY WITHIN AUTODIN.

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Figure 6-4C.—Schematic Diagram of Message Content—Continued.

the addressed station with his routing indicator since the message header indicates message delivery responsibility.

Message text preparation is as outlined in chapter four of this manual. The operator preparing his message for transmission must insure that the message classification, which is the first word of the text, is prepared letter perfect. If while preparing the message classification, he makes an error, he must back-space and letter out the entire classification marking and begin again. Each letter of the classification is separated by a space; e.g., S E C R E T. In unclassified EFTO messages, the abbreviation EFTO is spaced; e.g., UNCLAS E F T O. Figure 6-4C illustrates required elements of text preparation.

END-OF-MESSAGE VALIDATION

To prevent straggler messages, the ASC automatically checks and compares, on input, the SSN appearing in format line two of each message against the EOM validation number appearing in format line 15 of teletypewriter messages or format line sixteen of DATA PATTERN (to be covered later in this chapter) messages. Messages containing unlike numbers, or numbers missing in either line will be rejected by the ASC and the input station will be advised by an automatically generated service message of a possible straggler message condition.

End-of-Message validation is the four digit SSN repeated in format line fifteen. The EOM validation must be preceded by the number sign (#).

Example: #Ø123

The EOM validation appearing in format line fifteen and the EOM functions in format line 16 must be prepared in uninterrupted sequence. Again if the operator were to make an error while preparing the EOM functions he would have to back-space and letter out the entire EOM functions and begin again. The EOM functions are as shown in the following example:

FORMAT LINE	CONTENTS	END OF LINE FUNCTIONS
12	END OF TEXT	(2CR)(1LF)
13	BT	(2CR)(1LF)
15	(1FIGS)#Ø123(1LTRS)	
16	(2CR)(8LF)NNNN	(12 LTRS)

Figure 6-4C illustrates the uses of the various format lines in tape relay, ship to ship, and AUTODIN communications. Note that format line 14 is not used in AUTODIN or Tape Relay procedures.

MESSAGE EXAMPLES

Message examples shown in the remainder of this chapter are for illustrative purposes only. They do not necessarily reflect actual routing indicators, call signs, or address group assignments. The format of examples, however, gives the proper sequence of message elements and line functions used. End-of-line and end-of-message functions are in parenthesis. Messages are prepared as they would appear when reproduced on a page printer set for single line feed.

PLAINDRESS MESSAGE

A plaindress message carries originator and addressee designators in the message heading. Message text may be plain language or encrypted. A group count is not required for plain language, but an encrypted message always carries a numerical group count.

Single-Address Message

Following is a plaindress version of a single-address message:

FORMAT LINE	CONTENT	END OF LINE FUNCTIONS
	(6BL)(6LTRS)	
2	PTTUZYUW RUEBABA1234 1191432-UUUU—RUKKLAA.	(1LTR)(2CR)(1LF)
4	ZNR UUUUU	(2CR)(1LF)
5	P Ø114ØØZ APR 71	(2CR)(1LF)
6	FM CINCPACFLT	(2CR)(1LF)
7	TO USS RENSHAW	(2CR)(1LF)
11	BT	(2CR)(1LF)
12	UNCLAS	(2CR)(1LF)
	1. THIS PLAINDRESS SINGLE-ADDRESS	(2CR)(1LF)
	MSG IS PREPARED IN FORMAT PRESCRIBED	(2CR)(1LF)
	FOR DCS AUTODIN MSGS ADDRESSED TO SINGLE ADDRESSES.	(2CR)(1LF)
13	BT	(2CR)(1LF)
15	(1FIGS)#1234(1LTRS)	
16	(2CR)(8LF)NNNN	(12 LTRS)

Multiple Address Message

A multiple address message prepared for entrance into the DCS AUTODIN network appears in the next example. Plain language address designators are employed because all the addressees are capable of reception of this message form.

FORMAT LINE	CONTENT	END OF LINE FUNCTIONS
	(6BL)(6LTRS)	
2	RTTEZYVW RUFTLBA3249 183Ø825-EEEE—RUHPBLA	(2CR)(1LF)
	RUHPCKL RULTALA RUWSPGL	(1LTR)(2CR)(1LF)
4	ZNY EEEEE	(2CR)(1LF)
5	P Ø2Ø75ØZ JUN 71	(2CR)(1LF)
6	FM CNO	(2CR)(1LF)
7	TO RUHPBLA/CINCPACFLT	(2CR)(1LF)
8	INFO RUHPCKL/COMHAWSEAFRON	(2CR)(1LF)
	RULTALA/COMFAIRWESTPAC	(2CR)(1LF)
	RUWSPGL/COMWESTSEAFRON	(2CR)(1LF)
	RUHPBLA/COMCRUDESFLOT FIVE	(2CR)(1LF)
11	BT	(2CR)(1LF)
12	UNCLAS E F T O	(2CR)(1LF)
	1. TEXT OF MESSAGE	(2CR)(1LF)
13	BT	(2CR)(1LF)
15	(1FIGS)#3249(1LTRS)	
16	(2CR)(8LF)NNNN	(12 LTRS)

In the above example notice that the routing indicator RUHPBLA has the delivery responsibility for two of the messages addressees. It is necessary only to place each routing indicator in the message header one time. When the message is received in the communication center of RUHPBLA, the communications personnel will be directed to protect delivery to both addressees by the appearance of their routing indicator before each (CINCPACFLT and COMCRUDESFLOT FIVE) addressee.

Abbreviated Plaindress Messages

Operational requirements for speed of message handling may sometimes require abbreviation of message headings. To speed message handling, any or all of the following elements may be omitted from the message heading: precedence, date, date-time-group, and group count.

Most plaindress messages originated within the DCS AUTODIN system omit the group count (format line 10). In this instance, absence of the group count does not, in itself, place the message in abbreviated plaindress form. (This exception applies to the definition of the abbreviated plaindress form.) Only in encrypted messages are numerical group counts required for messages originated within the system.

Abbreviated plaindress form is employed widely in radiotelephone, radiotelegraph, and manual teletypewriter procedures. It is rarely, if ever, used in DCS AUTODIN network.

Codress Messages

A codress message is an encrypted message that has in the encrypted text the designations of the originator and addressees (and any internal passing instructions). Accordingly, the address components (format lines 6, 7, 8, and 9) are omitted. Codress is a valuable security device; it conceals the identity of units and prevents an enemy from making inferences from originator-addressee patterns.

Transmission instructions are required in the heading of codress messages when the station (or stations) called in line 2 is to deliver or refile the message without decrypting it. If the station is to decrypt the message, as well as refile it, the station's routing indicator must appear after the prosign T in line 4. An example of a codress message follows:

FORMAT LINE	CONTENT	END OF LINE FUNCTIONS
	(6BL)(6LTRS)	
2	RTTUZYUW RUEOLGA6754 2551Ø4Ø-UUUU—RUCKHGR	(2CR)(1LF)
	RUCIABA.	(1LTR)(2CR)(1LF)
4	ZNR UUUUU	(2CR)(1LF)
	RUCIABA T RUCIABA XYPD	(2CR)(1LF)
5	R 121Ø37Z SEP 71	(2CR)(1LF)
10	GR97	(2CR)(1LF)
11	BT	(2CR)(1LF)
12	(NINETY SEVEN ENCRYPTED GROUPS TYPED	(2CR)(1LF)
	FIVE CHARACTERS PER GROUP AND TEN GROUPS	(2CR)(1LF)
	TO THE LINE).	
13	BT	(2CR)(1LF)
15	(1FIG)#6754(1LTRS)	
16	(2CR)(8LF)NNNN	(12 LTRS)

Punctuation

Message drafters try to word their messages clearly without using punctuation. Occasionally, though, punctuation is essential for clarity. In such instances, punctuation marks (or symbols) are used in preference to spelling out the desired punctuation.

All punctuation marks and symbols on U.S. military teletypewriter keyboards are authorized for use in U.S. networks. Only those marks and symbols listed in table 6-1, however, may be used in messages that have other routing indicators besides the United States in format line two.

Tabulated Messages

Ability to handle information in tabulated form is one of the many advantages of teletypewriter equipment. If a message is received for transmission in tabulated form, it normally should be transmitted in that form. In some instances column headings require more space than data in a column. When this inequality happens, use more than one line for headings. (Compare the form of headings in examples of incorrect and correct methods.) Keep columns as close as possible to the left margin, to reduce total transmission time.

In the first of the below examples, each dot represents the transmission of a space, which requires as much circuit time as transmitting a character. In the second example (the correct way), the same information is transmitted at a considerable saving of circuit time.

Table 6-1.—Punctuation Used Allied Messages

PUNCTUATION	ABBREVIATION	SYMBOL
Period	PD	.
Hyphen	---	-
Parentheses	PAREN	( )
Slant sign	SLANT	/
Colon	CLN	:
Comma	CMM	,
Question mark	QUES	?

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1. Example of incorrect method:

```
                    STOCK REPORT AND REQUIREMENTS

                              QUANTITY
  ITEM        CAT NO          ON HAND           ARTICLE            REQUIRED

   1 ...... 268423........1ØØ ........ CYL RINGS ........ 3ØØ
   2 ....... 93846........ 39 ........ MUFFLERS ......... 5Ø
   3 ...... 624364........ 28 ........ MAGNETOS ......... 2Ø
   4 ....... 34256........3ØØ ........ WRIST PINS ....... 3ØØ
   5 ....... 19432........14Ø ......... VALVES ......... 5ØØ
   6 ....... 43264........ 42 ....... CARBURETORS ....... 5Ø
```

2. Example of correct method:

STOCK REPORT AND REQUIREMENTS

ITEM	CAT NO	QTY ON HAND	ARTICLE	RQRD
1	268423	1ØØ	CYL RINGS	3ØØ
2	93846	39	MUFFLERS	5Ø
3	624364	28	MAGNETOS	2Ø
4	34256	3ØØ	WRIST PINS	3ØØ
5	19432	14Ø	VALVES	5ØØ
6	43264	42	CARBURETORS	5Ø

MULTIPLE PAGE MESSAGES

To facilitate reproduction of incoming messages by distribution centers, all messages exceeding a total of 2Ø lines of heading and text, beginning with format line 5, are divided into pages for transmission.

1. Each page consists of not more than 2Ø lines.

2. The first page must begin with format line 5 of the message heading and continue for a total of 2Ø lines, including succeeding lines of the heading.

3. Second and succeeding pages must be identified by the page number, the routing indicator of the station of origin and the station serial number. The number sign (#) is not used preceding the station serial number. When message text is transmitted in plain language, the security classification, special category term (SPECAT) and SPECAT designator, i.e., SPECAT SIOP-ESI, or the abbreviation UNCLAS is included as part of the page identification of second and succeeding pages. One space is inserted following each letter of the security classification and EFTO. Page identification appears on a separate line, and is not included in the line count as in paragraph (1) above, Example: Page 2 RUEDABAØ123 C O N F I D E N T I A L (2CR)(1LF).

4. Machine functions between pages should be (2CR)(4LF).

5. The number of pages of message text in any transmission must not exceed five; a page consisting of part heading and part text does not count as a textual page. Messages that exceed five pages of message text are divided in transmission sections.

In the following example of the proper way to page a message, note that necessary machine functions differ between pages of a message and those at the end of message transmission. The rules regarding paging apply only to the narrative-type messages submitted to the message in page copy form. Paging rules do not apply to statistical and meteorological (weather) messages in which paging information would disrupt processing by the user of the information.

Example of a paged message:

FORMAT LINE	CONTENT	END OF LINE FUNCTIONS
	(6BL)(6LTRS)	
2	RTTUZYUW RUWJABA1234 1542ØØØ/-UUUU–RUEDTFA.	(1LTR)(2CR)(1LF)
4	ZNR UUUUU	(2CR)(1LF)
5	R Ø3193ØZ JUN 71	(1LTR)(2CR)(1LF)
6	FM CNO	(2CR)(1LF)
7	TO COMWESTSEAFRON	(2CR)(1LF)
11	BT	(2CR)(1LF)
12	UNCLAS	(2CR)(1LF)
	(15 Lines of Text)	(2CR)(4LF)
	Page 2 RUWJABA1234 UNCLAS	(2CR)(1LF)
	(2Ø Lines of Text)	(2CR)(4LF)
	Page 3 RUWJABA1234 UNCLAS	(2CR)(1LF)
	(2Ø Lines of Text)	(2CR)(4LF)
	Page 4 RUWJABA1234 UNCLAS	(2CR)(1LF)
	(2Ø Lines of Text)	(2CR)(4LF)
	Page 5 RUWJABA1234 UNCLAS	(2CR)(1LF)
	(2Ø Lines of Text)	(2CR)(4LF)
	Page 6 RUWJABA1234 UNCLAS	(2CR)(1LF)
	Remainder of text must not exceed 2Ø lines)	(2CR)(1LF)
13	BT	(2CR)(1LF)
15	(1FIG)#1234(1LTR)	
16	(2CR)(8LF)NNNN	(12 LTRS)

LONG MESSAGES

Messages that exceed five textual pages are long messages. They must be transmitted in sections. This procedure prevents prolonged circuit tieups that could result in delaying more important traffic.

At a convenient point within the limits of five pages, the text of a long message is separated into sections. Normally, separation is at the end of a sentence or a cryptopart. (Long encrypted messages have cryptoparts.) Each section is numbered and the section number is inserted on the same line as the abbreviation UNCLAS or appropriate security classification. When a message is divided into two sections, the first section is identified as SECTION 1 of 2, and the second is FINAL SECTION of 2. In long encrypted messages, when a transmission section commences with a new cryptopart, identification of the cryptopart follows designation of the transmission section. Transmission sections of a long message have the same heading, except that station serial numbers change with sections. Each section bears the same date-time-group and filing time. A group count, if used, applies only to the section it accompanies. Transmission section and page identification are not included in the group count. The cryptopart identification is included. Following is an example of a message handled in two transmission sections:

FORMAT LINE	CONTENT	END OF LINE FUNCTIONS
	(6BL)(6LTRS)	
2	RTTUZYUW RUWJABA1234 1542ØØØ-UUUU--RUEDTFA	(1LTR)(2CR)(1LF)
4	ZNR UUUUU	(2CR)(1LF)
5	R Ø31930Z JUN 71	(2CR)(1LF)
6	FM CNO	(2CR)(1LF)
7	TO COMWESTSEAFRON	(2CR)(1LF)
11	BT	(2CR)(1LF)
12	UNCLAS SECTION 1 OF 2	(1LTR)(2CR)(1LF)
	(15 lines of text)	(2CR)(4LF)
	PAGE 2 RUWJABA1234 UNCLAS	(2CR)(1LF)
	(2Ø lines of text)	(2CR)(4LF)
	PAGE 3 RUWJABA1234 UNCLAS	(2CR)(1LF)
	(2Ø lines of text)	(2CR)(4LF)
	PAGE 4 RUWJABA1234 UNCLAS	(2CR)(1LF)
	(2Ø lines of text)	(2CR)(4LF)
	PAGE 5 RUWJABA1234 UNCLAS	(2CR)(1LF)
	(2Ø lines of text)	(2CR)(4LF)
	PAGE 6 RUWJABA1234 UNCLAS	(2CR)(1LF)
	(20 Lines of text)	(2CR)(1LF)
13	BT	(2CR)(1LF)
15	(1FIG)#1234(1LTR)	
16	(2CR)(8LF)NNNN	(12 LTRS)
	(6BL)(6LTRS)	
2	RTTUZYUW RUWJABA1235 1542ØØØ-UUUU--RUEDTFA	(1LTR)(2CR)(1LF)
4	ZNR UUUUU	(2CR)(1LF)
5	R Ø13930Z JUN 71	(2CR)(1LF)
6	FM CNO	(2CR)(1LF)
7	TO COMWESTSEAFRON	(2CR)(1LF)
11	BT	(2CR)(1LF)
12	UNCLAS FINAL SECTION OF 2	(1LTR)(2CR)(1LF)
	(REMAINDER OF MESSAGE PAGED AS NECESSARY)	(2CR)(1LF)
13	BT	(2CR)(1LF)
15	(1FIG)#1235(1LTR)	
16	(2CR)(8LF)NNNN	(12 LTRS)

You will note the above messages are virtually identical in construction with the exception of the SSN. In the example shown there is only one digit separating the two SSNs used on the two message sections. In actual practice it is not necessary to transmit message sections back to back.

Transmission of long messages is usually accomplished during slack periods unless the message itself is of unusually high precedence.

CORRECTING ERRORS

Even the best operators sometimes make mistakes. There are definite procedures for correcting mistakes, depending on whether the mistakes occur in tape preparation or during transmission direct from a keyboard.

To erase or letter out errors in tape, back space and strike the LTRS key as many times as necessary to obliterate the error. This method is used to correct errors in tape preparation, except when they occur in format lines two and four. A mistake made in these two lines cannot be corrected and the message tape must be discarded and the operator must begin again. The reason for this rule is because the message tape will be rejected by the AUTODIN system.

Another special rule applies to correcting errors in the security classification and EOM format. When such errors occur, backspace and obliterate the entire classification or EOM. Then, start anew with the first character of the classification, or with the FIGS function if the error is in the EOM format.

When an operator is operating a ship-to-ship circuit and is transmitting from the teletype keyboard, he cannot correct mistakes that occur in the message heading nor in the security classification which is the first word of the text. Cancel the transmission and again send the message from its beginning. To cancel the transmission send 2CR, 1LF, 1LTRs, and prosigns E E E E E E E E AR, followed by 8LF, 4N's. In teletype procedure the error prosign is exactly 8 Es—no more, and no less—with a space after each E.

To correct a mistake in the text of a message (other than one in the security classification), send 1 LTRS, 8 Es, repeat the last word sent correctly, and continue with the correct version of the text. For example, assume that in transmitting IN ACCORDANCE WITH PREVIOUS INSTRUCTIONS a mistake is made in the word "previous." Correct it as follows: IN ACCORDANCE WITH PREVX E E E E E E E E WITH PREVIOUS INSTRUCTIONS. The error prosign is transmitted immediately after the error occurs.

MISROUTED AND MISSENT MESSAGES

Occasionally an operator receives a message that was delivered through error. Whenever this happens, remember that every COMMCEN is responsible for delivering every message received, even though it was transmitted through error. Messages transmitted through error are classed in two groups: misrouted and missent.

MISROUTED MESSAGES

A misrouted message is one which contains an incorrect routing instruction. The misroute condition occurs when the originating station assigns incorrect routing indicators during message header preparation. The AUTODIN system will process a misrouted message until it reaches the communications center of the called routing indicator. A tributary station in receipt of a misrouted message takes the following action:

1. If possible, obtain the correct routing indicator from the applicable ACP 117 series publication.
2. Apply a header change to the misrouted message and retransmit the message to the correct routing indicator.
3. Transmit a service message to the originating station advising of the reroute action and correct routing indicator. The service message will also contain the actual time-of-transmission of the rerouted message (with any reason for delay), which should satisfy any tracer actions for excessive delay.

If the tributary station is unable to determine the correct routing indicator due to insufficient address information in format lines 7 and 8, the originating station will be notified by service message and requested to protect delivery.

The station rerouting a misrouted message will change (substitute) the following information in format line 2 of the original message:

1. Own first position LMF designator, if necessary.
2. Content indicator code/communication action identifier ZOVW (which means this is a misrouted message).
3. Own Routing Indicator.

4. SSN of message being rerouted.
5. Own Julian date and time filed.
6. Correct routing indicator of the station to effect delivery.

After the changes in format line 2 have been made, the following is added to format line 4 of the original message:

1. Operating signal ZOV.
2. Routing indicator of the station preparing the header change.
3. SSN of the station preparing the header change.
4. The words "Reroute of" followed by the Routing Indicator, SSN, and Julian date and time filed as appearing in format line 2 of the original message.
5. In the case of multiple address message, the prosign T preceded by routing indicator(s) (when required) and followed by the addressee(s) address designator(s).

A station receiving a multiple address message bearing a header change containing transmission instructions, must effect delivery to only the addressee(s) whose designator(s) follow the prosign T in the message header change. Delivery responsibility appearing in the message address is ignored.

When messages involving mobile units (ships) require rerouting for delivery on further relay, they are treated as misrouted messages except that the originator need not be advised of the misroute.

The below example shows a message received by RUCLAKA in error:.

RTTUZYUW RUEDABA6724 183133Ø-
UUUU—RUCLAKA.
ZNR UUUUU
R Ø21315Z JUL 71
(Remaining format lines follow)

The below example shows the same message as prepared by station RUCLAKA for rerouting to the correct addressee:

RTTUZOVW RUCLAKA6724 183141Ø-
UUUU—RUEBABA.
ZNR UUUUU ZOV RUCLAKA1294 REROUTE
OF RUEDABA6724 183133Ø
R Ø21315Z JUL 71
(Remaining format lines of original message follow unchanged)

After station RUCLAKA had transmitted the message with the correct routing indicator he would then prepare and transmit a service message to station RUEDABA notifying him of the correct routing indicator and any possible delay his message may have had. Service messages and tracer procedures will be covered later in this chapter.

MISSENT MESSAGES

A missent message is one which contains a correct routing indicator but is transmitted to a station other than the one represented by the routing indicator. Missent messages may be caused by equipment malfunction, incorrect switching, or operator error.

A tributary station receiving a missent message should reintroduce the message as a suspected duplicate. A message header must be applied to the missent message.

Upon completion of re-entry of the message into the AUTODIN system the tributary forwards a routine service message to the connected ASC citing the complete header, time of receipt and advise that the message has been protected.

The following is an example of a missent message to station RUWTAAA:

RTTUZYUW RUEBAAB1349 1811545-
UUUU—RUWJBBB.
ZNR UUUUU
R Ø31520Z JUL 71
(Remaining format lines)

The following is an example of the message above after station RUWJBBB has changed the message header:

RTTUZFDY RUEBAAB1349 1811545-
UUUU—RUWJBBB.
ZNR UUUUU ZFD RUWTAAA
R Ø31520Z JUL 71
(Remaining format lines)

After the above message has been re-entered into the system and the ASC receives the service message, a search to determine the cause of the missent message must be conducted.

SUSPECTED DUPLICATES

When a station has cause to suspect that a message may have been previously transmitted, but definite proof of prior transmission cannot be readily determined, the message should be forwarded as a "suspected duplicate" by applying a header change.

An example of message with a "suspected duplicate" header change is as follows:

PTTSZFDY RUKKAFA1276 1911820-SSSS–RUWMABA.
ZNY SSSSS ZFD RUKKAFA
P 101810Z JUL 71
(Remaining format lines)

Messages are not reintroduced as "suspected duplicates" at the request of the originator because the addressee(s) failed to reply or take action on the message. In such instances, a new message must be generated by the originator.

Messages recovered by an ASC as the result of a retransmission request or when an acknowledgment for an EOM is not received should contain a suspected duplicate pilot.

The following is an example of a message recovered by an ASC and transmitted as suspected duplicate:

RTTUZFDY RUCIABA2405 1911345-RUHHUUUU–RUHHBFA.
RTTUZYUW RUCIABA2405 1911345-UUUU-RUHHBFA.
ZNR UUUUU
R 101330Z JUL 71
(Remaining format lines)

When a station receives a message marked as a suspected duplicate, that station files the message if it was previously received and delivered to the addressee. If the message has not been previously delivered the station must then forward the message, marked as a suspected duplicate, to the addressee.

Messages received without the appropriate marking (ZFDY, ZFGY, ZFD, ZFG) are caused primarily by operator error and in some cases by equipment/ASC operating program malfunctions. Stations receiving unmarked duplicate transmissions should immediately forward a routine service message to the originating station citing the complete header format of the duplicated message including the time of receipt of the original and duplicate transmissions. The receiving station then files the duplicate message if the original has been delivered to the addressee.

Upon receipt of the addressee's service message, the originating station checks transmit records to determine the validity of the duplicate report. If the duplicate report is valid, the originating station should ensure in-station procedures are adequate to guide personnel in retransmission of messages for which confirmed transmission is in doubt. Correct equipment malfunction if this was the cause of the duplicate transmissions. If only one transmission can be accounted for, the originating station should then advise the serving ASC by routing service message that only one transmission has been accounted for. The service message to the ASC should cite the complete header, time of transmission, and the routing indicator of the station reporting the receipt of duplicate transmission.

Upon receipt of a service message indicating duplicate transmissions the ASC should search records to determine if the message was received in duplicate.

If a duplicate message was received, investigate further to determine why ASC records indicate duplication and the connected station's records indicate a single transmission.

If the message was not received in duplicate, trace it on a station-to-station basis to determine the point of duplication.

If the investigation reveals the duplicate transmission was caused by equipment malfunction or program deficiency at the AUTODIN switching center, all details should be documented and forwarded by message to DCA for evaluation and necessary corrective action.

OPEN CHANNEL SEQUENCE NUMBERS

When operating Modes II, IV and V terminals, all traffic from the ASC will contain an automatically assigned format line one. The responsibility for the continuity of received channel sequence numbers rests with the station receiving the traffic. It is the responsibility of the receiving operator to ensure that a transmission is received under each channel number and that numbers are not duplicated or omitted.

When an open number (a sequential number for which no transmission was received) occurs at a tributary station, the connected ASC should be so advised by an Immediate precedence service message. The service message should report the number(s) open, the exact time-of-receipt, if available, of the message preceding the open number, and the time-of-receipt of the message following the open number. The service message should not contain a request for retransmission. After appropriate record is made, the matter is considered closed insofar as the reporting station is concerned.

The station receiving the report of an open number determines whether or not a transmission has been made under that number. If not, no further action is taken. If so, the transmission is retransmitted with a suspected duplicate pilot affixed.

SERVICE MESSAGES

Service messages have been covered in detail in chapter four of this manual. It should be noted that the use of the service message is applicable to all phases of communications. The construction of the service message varies according to the communications media involved. The below examples are service messages prepared for use within the AUTODIN system.

Example 1:

A tributary station has received a message garbled and transmits the following service message to the originator.

```
RTTUZYVW RUMOAFA1234 2691115-
  UUUU—RUEBFDA.
ZNR UUUUU
BT
UNCLAS SVC 147 RUEBFDA1559 269Ø93Ø
  26Ø915Z
SEP 71 ZES2
BT
#1234
NNNN
```

Example 2:

A tributary station requests retransmission of a specific portion of a message:

```
PTTUZYVW RUWJADA1234 273133Ø
  UUUU—RUDOLTA.
ZNR UUUUU
BT
UNCLAS SVC INT ZDK RUDOLTAØ249
  2721115 3Ø11ØØZ SEP 71
PAGE 1 LINES 3 AND 4
BT
#1234
(NNNN)
```

READDRESSING MESSAGES

Circumstances may arise in which it becomes necessary to readdress a message to additional activities not originally included in the message address. Readdressed messages are new messages and are processed accordingly. A request for readdressal is prepared and submitted to the communication center.

If the message being readdressed is held in the communication center files of the Communications Activity serving the additional addressees, the readdressal may be accomplished by a service message containing appropriate operating signals. If the message being readdressed is not held in the Communications Activity of the additional addressees, it must be prepared as follows:

1. A supplementary heading is prepared in cluding format lines one through ten, as appropriate and inserted in front of the original header. All format lines before line 5 are removed from the original heading.
2. Under no circumstances should the original date-time-group be deleted or altered. If the message being readdressed was not originated during the current month or year, the abbreviation of the month and last two digits of the year or origin are inserted following the original date-time-group.
3. The precedence indicated by the readdressing authority is used in the supplementary heading.
4. The originating station routing indicator and station serial number in the supplementary heading are used for identification by the receiving terminal station(s) if retransmission or corrections are required.
5. The filing time (format line 2) appearing on the readdressed message is the time of receipt of the readdressal request in the communications center.
6. A new date-time-group is assigned by the readdressing authority and appears in format line 5 of the supplementary heading.
7. The designator of the readdressing authority (new originator) appears in format line of the supplementary heading.
8. Format lines 7 and/or 8 are used to address the new addressees of the message.

Special attention must be given to applying the EOM validation procedure when performing a readdressal action. As you remember, the station serial number appearing in the message header must always correspond to the EOM validation number appearing in format line 15. This is accomplished by changing the original EOM validation number to the station serial number of the readdressing activity.

If the message being readdressed is a multiple page message, the readdressing activity must change the page identification to conform to their routing indicator and SSN.

Examples of readdressed messages:

The following message was received by LETTERKENNY ARMY DEPOT CHAMBERSBURG PA.

PTTUZYUW RUADLKA1275 2271430-
  UUUU—RUEOFMA
ZNR UUUUU
P 151400Z AUG 71
FM US ARMY JAPAN CAMP ZAMA JAPAN
TO RUEOFMA/LETTERKENNY ARMY DE-
  POT CHAMBERSBURG PA
INFO RUEDEIA/FORT MONROE VA
BT
TEXT
BT
#1275
NNNN

The commanding officer of LETTERKENNY ARMY DEPOT desires to readdress this message to DEFENSE DEPOT TRACY CALIF:

RTTUZYVW RUEOFMA2480 2291130-
  UUUU—RUWJSHA
ZNR UUUUU
R 161100Z AUG 71
FM LETTERKENNY ARMY DEPOT CHAM-
  BERSBURG PA
TO DEFENSE DEPOT TRACY CALIF
P 151400Z AUG 71
FM US ARMY JAPAN CAMP ZAMA JAPAN
TO RUEOFMA/LETTERKENNY ARMY DE-
  POT CHAMBERSBURG PA
INFOR RUEDEIA/FORT MONROE VA
BT
TEXT
BT
#2480
NNNN

Note: Notice how EOM has been changed to conform to the message header of the readdressing activity.

TRACER ACTION

Tracer action is the process by which an investigation is conducted to determine the reason for inordinate delay or nondelivery of a message. Normally, requests for tracer action are initiated by a message originator or addressee. However, should the circumstances so dictate, trace actions may be initiated by an originating communications station, relay station, or addressee communications station. Tracer action should be initiated as soon as the discrepancy is discovered, but not later than 30 days from the original time of transmission. Separate tracer action logs and individual case files are maintained at all communication facilities involved. Case files are retained at least one year. Tracer actions maintain continuity throughout the system beginning with the originating station. The originating station is advised of all transactions as the tracer action progresses through the system. Within the Navy, reports accepting responsibility for delayed or lost messages will receive command attention. Tracer action on FLASH messages will be handled as rapidly as possible.

Tracer action proceedings on messages involving inordinate delay are terminated as soon as station-to-station reporting has accounted for the excessive delay. Plaindress headings are used on tracer messages addressed to Navy afloat and mobile units. Delay or nondelivery of messages which where traced to ASC equipment malfunction should be completely documented and forwarded by message to DCA for evaluation and corrective action.

INORDINATE DELAY

Before initiating tracer action, the communications center serving the addressee carefully examines records, logs, and the message heading to determine if the cause of delay can be ascertained and adequately explained prior to advising the originator to commence tracer action. Consideration must be given to any adverse circuit conditions. After all efforts have been exhausted, the addressee's communications center advises the originator of the delayed message including the exact amount of delay claimed (hours and minutes).

Upon receipt of a tracer action request for excessive delay, the communications center serving the originator carefully examines their logs and records to determine whether the cause for delay can be adequately explained. Special emphasis is placed on in-house backlog conditions, elapsed time between date-time-group and file time, elapsed time between file time and actual time of transmission, circuit or equipment outage, ASC outage, or service action taken on the message being traced (e.g., request for retransmission, invalid routing indicator).

If the cause of delay cannot be locally determined, delay tracer action is normally initiated by routine message to the directly connected relay station, citing the exact amount of delay claimed.

Example: Delay tracer to the first relay point:

```
RTTUZYVW RUEDABA1481 Ø76163Ø-
  UUUU—RUEDCSA
ZNR UUUUU
BT
UNCLAS SVC T-1Ø4 ZUI RUEDABA1127
  Ø711835 121747Z JUL 71
TOR RUDOALA Ø72Ø722 12 HRS 47 MINS
  DELAY
TOT TO RUED Ø711925. 50 MIN DELAY
  FOR NORMAL MESSAGE PROCESSING.
  INT ZDN
BT
#1481
NNNN
```

Upon receipt of an excessive delay tracer, each station examines its records for time of receipt and time of transmission or delivery of the message being traced. This information should be compiled and transmitted to the next station in the transmission path. The originator is included as an information addressee on all service messages pertaining to the message being traced. Any station responsible for any portion of the delay should include the reason for the delay and the corrective action taken to prevent a recurrence.

NONDELIVERED MESSAGE

Upon notification of a nondelivery claim, the originator's communications center retransmits the message as a duplicate to the addressee claiming nonreceipt unless the originator prefers to cancel it. If a duplicate transmission is made, the communications action identifier ZFGY should be substituted in the content indicator field of format line 2 of the original message, and the operating signal ZFG should be added to format line 5. Any message bearing ZFG in format line 5 is delivered to the addressee.

As in an inordinate delay message the originators communication center carefully examines their in-station records to determine if the original transmission of the message was, in fact, properly transmitted to the addressee claiming non-receipt. If the message was properly transmitted, a service message of equal precedence is forwarded to the communication center serving the addressee. The service message should properly identify that particular message, requesting verification of receipt or nonreceipt. If the addressee's communications center advises the message was not received, formal tracer action should be initiated by the communications center serving the originator.

The communications center serving the originator should transmit a service message to the first relay station involved in the original transmission. The service message should contain full identification of the original transmission including the claimants routing indicator.

Example: Nondelivery tracer to the first relay point.

```
RTTUZYVW RUEDBDA1234 Ø77183Ø-
  UUUU—RUEDCSA.
ZNR UUUUU
BT
UNCLAS SVC T-Ø197
RUDOALA CLAIMS NON RECEIPT OF
  RUEDBDAØ99Ø Ø751315R 161236Z MAR
  71
ZDQ RUED CSN BDA143 AT Ø751445Z. INT
  ZDN
BT
#1234
NNNN
```

The tracer action maintains continuity throughout the system, progressing from relay point to relay, until the point of loss or nondelivery of the message occurred. If a nondelivery has occurred, the responsible station conducts an investigation to determine the cause and corrective actions taken to prevent a recurrence and notify the originating station accordingly.

TWX SYSTEM

The teletypewriter exchange service (TWX) is a commercial teletypewriter system owned and operated by various telephone companies. Its services are available to anyone on much the same basis as is the telephone. Any businessman may have TWX installed in his office. Charges are made as for phone service—so much for the use of the equipment and so much for each call, based on time and distance. The TWX serves outlying stations that do not send or receive enough traffic to warrant the cost of circuits and equipment that would make them a part of the regular Navy communication system.

A message to an activity served by TWX is forwarded over DCS circuits to the station nearest its destination, and there it is refiled into the TWX network. This method results in considerable savings because the long-haul portion of such traffic is then handled over DCS-leased lines, and the only extra cost is for the short-distance transmission from the filing station.

TELEX SYSTEM

Dialing, calling, and establishment of the circuit connections between designated refile stations and customers served by Western Union are accomplished by TELEX in accordance with operating instructions contained in the directory furnished by the Western Union Company.

DATA PATTERN

Data pattern message format is another communications media employed by activities equipped with the automatic facilities of the DCS AUTODIN system.

From the example you studied earlier in this chapter, data pattern message format requires only format lines 2, 12, and 16. If the using agency requires more information or control, in addition to that provided by the communications header or end-of-transmission (EOT) record, that agency may prescribe the use of such additional controls by use of the text header card. The additional control information is placed behind the communications header record and included in the record count.

Earlier we covered the preparation of messages for teletypewriter communications. We noted the use of language media and format (LMF) designators in the message header. In data pattern message format, the most common LMF designator is CC (card to card), although, the following LMF's are available and authorized for use in data pattern message format: CT (card to tape), CA (card to ASCII), TC (tape to card), and AC (ASCII to card).

The data pattern message is used by subscribers to the DCS AUTODIN system for the rapid exchange of large volumes of message traffic in short periods of time. Chapter eleven of this manual provides a detailed description of the equipments used to exchange such information. With the use of punch cards, magnetic tape, and high speed computers the subscribing agency are able to exchange large volume message traffic at speeds far beyond the capability of the normal teletypewriter equipments.

DATA PATTERN MESSAGE

Message originators having automatic capabilities may deliver data pattern messages with prepared header (format line 2), message text (format line 12), and EOT formats (format line 16) containing all the necessary information. As outlined in teletypewriter procedures, station serial numbers may be allocated in blocks to identify local activities. The julian date and time entered in format line 2 should be within 30 minutes of the actual time that the message is delivered to the communications facility. If messages are not received by the communications facility within the prescribed 30 minutes, they should be corrected by the communications center and the originator should be advised by DD Form 1503, MESSAGE CORRECTION NOTICE (figure 6-5).

If station serial number allocation is not utilized, the originator may deliver header cards to the communications center with all header information contained on a punched header card format except for the SSN. Blank columns should be filled in by the communications facility.

Message originators who do not prepare the header format for transmission deliver the message text to the communications facility along with a completed DATA MESSAGEFORM (fig. 6-6). Addressees and their geographical location must be entered on this form in plain language. Addressees FPO/APO numbers are not accepted as their geographical address.

The communications personnel are responsible for verifying the message record count provided by the originator except when magnetic

MESSAGE CORRECTION NOTICE (JANAP 128)		DATE: 29 May 1970
TO: Commanding General U.S. Army Strategic Communications Command ATTN: SCC-PO-TCCB Ft. Huachuca, Arizona 85613	FROM: Officer in Charge Data Message Center, USAG Ft. Huachuca, Arizona 85613	
☐ THE ATTACHED MESSAGE HAS BEEN TRANSMITTED. HOWEVER YOUR ATTENTION IS INVITED TO THE DISCREPANCIES INDICATED BELOW.	☒ THE ATTACHED MESSAGE CANNOT BE TRANSMITTED UNTIL THE DISCREPANCIES NOTED BELOW HAVE BEEN CORRECTED.	

	PRECEDENCE OMITTED OR NOT VALID		FILING TIME INCORRECT		IMPROPER SPACING *(field location)* IN HEADER FORMAT
	LANGUAGE AND MEDIA FORMAT NOT VALID		RECORD COUNT OVER		IMPROPER SPACING *(field location)* IN EOT FORMAT
	LANGUAGE AND MEDIA FORMAT NOT AVAILABLE AT: ☐ THE STATION ☐ THE ADDRESSEE	X	RECORD COUNT SHORT		IMPROPER ABBREVIATIONS USED
	CLASSIFICATION INDICATED CANNOT BE TRANSMITTED: ☐ BY THIS STATION ☐ TO THE ADDRESSEE		START OF ROUTING SIGNAL INCORRECT		CARDS BENT OR MUTILATED
	CLASSIFICATION OMITTED OR INCORRECTLY INDICATED		END OF ROUTING SIGNAL OMITTED OR INCORRECT		DROPPED PUNCHES
	CONTENT INDICATOR CODE INCORRECT OR NOT VALID		EOT RECORD OMITTED		OFF-PUNCHED CARDS
	ORIGINATOR ROUTING INDICATOR INCORRECT		EOT RECORD DOES NOT MATCH HEADER INFORMATION		INVALID PUNCHES OR CODES
	STATION SERIAL NUMBER DUPLICATED		*(MAG TAPE ONLY)* EOT RECORD DOES NOT CONTAIN RECORD COUNT		ADDRESSEE UNIDENTIFIABLE
	STATION SERIAL NUMBER INCORRECTLY PREPARED		INCORRECT END-OF-MESSAGE FUNCTIONS		INVALID ADDRESSEE ROUTING INDICATOR(s)
	JULIAN DATE INCORRECT		END OF TRANSMISSION SIGNAL MISSING OR INCORRECT		

REMARKS:

Data Messageform gives card count as 173; actual card count is 176.

MESSAGE (BATCH) IDENTIFICATION	ORIGINATING ROUTING INDICATOR	CONTENT INDICATOR CODE	STA. SERIAL NO.	DATE-TIME FILED
	RUCGHUA	DDBB	4011	1491610

DD FORM 1 NOV 64 1503

76.68

Figure 6-5.—Message Correction Notice.

DATA MESSAGE FORM	PRECEDENCE: PRIORITY	LMF: CC	CLASSIFICATION: UNCLASSIFIED
ADDRESSEE *(Clear Text)*: NAVAL SUPPLY CENTER, OAKLAND, CALIFORNIA			CARD COUNT *(Detail cards)*: 45
ORIGINATOR'S IDENTIFICATION *(RCS, follow-up, status, etc.)*: CGUSASTRATCOM	CONTENT IND: DDBB	RELEASING OFFICER'S SIGNATURE: JOHN J. DOE, LTC, GS	OFFICE SYMBOL & EXT.: SCC-PO-TCCB 5022/2719
REMARKS: Pertains to Bell and family transportation.			
FOR COMMUNICATIONS CENTER USE ONLY			
ORIGINATOR'S ROUTING INDICATOR: RUCGHUA	STATION SERIAL NUMBER: 3792	DATE-TIME *(Time filed)*: 1491610	
TOTAL CARD COUNT: 47	ADDRESSEE ROUTING INDICATOR: RUWMFKA	SUPERVISOR'S SIGNATURE: Joseph C. Miller	
OPERATOR'S SIGNATURE: John E. Smith	TIME TRANSMITTED: 3331616	CLASSIFICATION: UNCLASSIFIED	

DD FORM 1392, 1 AUG 62

76.69

Figure 6-6.—Data Message Form.

tape messages are prepared by computers. When the message header and/or EOT record is provided or prepared by other than the communications personnel, its completeness and accuracy should be verified by communications personnel. Any errors noted in these originator produced elements should be reported to the originator by use of DD Form 1503 (fig. 6-5).

Each data pattern message (complete header and text) should be maintained intact for a period of at least ten days. When storage space or other problems do not permit a ten day record being maintained a minimum of three days can be authorized by the Navy. In the event that the full ten day retention period is not complied with, coordination must be effected with the originator(s) to ensure that a request for retransmission can be honored by the originator again furnishing the message concerned to the communications facility.

After the ten day mandatory period has lapsed, the header and text may be separated. The text may be destroyed or diverted to other uses as dictated by local policy. The header must be retained for a period of not less than 30 days as a communications record. If tracer or other investigative action is pending on a message, that message should then be retained in excess of the minimum retention period.

The receiving activity of data pattern messages addressed to agencies for whom they guard should endorse the header card to indicate the time that the message was received. Time received is defined as the time of receipt of the EOT record. The operator should then verify the record count. If the record count is incorrect, request retransmission from the originating station. The message containing incorrect record count should then be delivered to the addressee and marked "subject to correction." Upon receipt of the corrected version, the addressee should be advised of the discrepancy. The message header card should then be removed and retained as a communications record for a period of not less than 30 days. The text and EOT records are delivered to the addressee and an accountability delivery record maintained according to local policy.

MESSAGE HEADER FORMAT

The message header format for data pattern messages, as you will discover, is very similar to that used in the teletypewriter message header with a few modifications. The operator must again be aware that the message header for data pattern messages must be prepared without error or it will be rejected by the ASC.

Position One

As outlined in teletypewriter procedure, four precedence prosigns are acceptable. Figure 6-7 shows message header format. A single character indicating the precedence degree is used in position one.

Position Two and Three

The LMF consists of two alphabetical characters indicating the LMF of the originator is placed in position two, and the LMF of the preferred output device of the addressee is placed in position three. Annex A of JANAP 128( ) has a complete listing of authorized pairings.

Position Four

As listed earlier in this chapter, the operator must insert a single letter prosign for the correct degree of classification of the message.

Positions Five through Eight

The content indicator code/communication action identifier consists of four alphabetical characters or three characters and one number as described earlier in this chapter for teletypewriter procedure.

Position Nine

Position nine is a separator which requires the operator to insert a SPACE at this point.

Position Ten through Sixteen

Positions ten through sixteen are the seven spaces of the message header which has been allocated for the originators routine indicator.

Positions Seventeen through Twenty

The station serial number of the originator is placed in these positions. The operator must remember that the serial number is always a four digit number with zero's making necessary fills.

DATA PATTERN HEADER FORMAT

Field	Position	Characters
PRECEDENCE	1	P
LANGUAGE AND MEDIA FORMAT	2 3	C C
CLASSIFICATION AS APPROPRIATE	4	U
CONTENT INDICATOR/COMMUNICATION ACTION IDENTIFIER	5 6 7 8	D A A Z
SEPARATOR	9	
ORIGINATOR	10 11 12 13 14 15 16	R U E B A A A
STATION SERIAL NUMBER	17 18 19 20	Ø Ø 4 5
SEPARATOR	21	
JULIAN DATE	22 23 24	1 4 4
TIME FILED	25 26 27 28	Ø 2 3 3
SEPARATOR	29	
RECORD COUNT	30 31 32 33	Ø 2 1 3
CLASSIFICATION REDUNDANCY	34 35 36 37 38	- U U U U
START-OF-ROUTING SIGNAL	39 40	. .
ADDRESSEE	41 42 43 44 45 46 47	R U H J A A A
END-OR-ROUTING SIGNAL	48	
POSITIONS UNUSED IN HEADER ARE FILLED WITH SEPARATORS (SPACE)	49-80	

76.70

Figure 6-7.—Data Pattern Message Header.

Position Twenty-one

A separator (SPACE) is placed in this position.

Positions Twenty-two through Twenty-four

The julian date is the date on which the message was received from an originator by communications personnel for transmission. The three positions, 22 through 24, contain the three numbers indicating this julian date.

Positions Twenty-five through Twenty-eight

The time the message was filed (received from the originator), is inserted here and the operator must recall that the filing time is always expressed in four digits indicating hours and minutes.

Position Twenty-nine

A separator (SPACE) is inserted here.

Position Thirty through Thirty-three

The record count is the total number of 80-character records in the data message, including header and EOT records. Left most positions are filled with zeros when they do not contain other numerals. Magnetic tape messages may use the alphabetical characters MTMS in this field, with the actual record count placed in the record count field of the EOT record. MTMS may also be used in this field to facilitate the processing of messages in batches. However, the actual record count must be placed in the record count field of the EOT.

Positions Thirty-four through Thirty Eight

For security verification, the classification designator inserted in position four is repeated in these positions. Position 34 is filled with a hyphen to alert the system of the classification verification following in the next four positions.

Position Thirty-nine

The positions reserved for routing are comprised of two sections, the start-of-routing signal and the addressee routing indicators.

As in teletypewriter procedures, the start-of-routing signal is two consecutive hyphens and always proceeds the first routing indicator.

The first character of the first routing indicator immediately follows the start-of-routing signal. As in teletypewriter procedure, the message header has a maximum of 50 routing indicators that may be used. The operator should remember that no routing indicator may be split between two lines. Since the ASCs use routing line segregation and the addressee station normally receives only his routing indicator, blank card(s) may be received in a card message when more than the equivalent of five seven-letter routing indicators are contained in the message header. However, the last card of the message received should always contain a period, the end-of-routing signal.

End-of-Routing Signal

The end-of-routing signal consists of a period (.) and is inserted in the position immediately following the last routing indicator.

Separators

Unused positions in the DATA PATTERN headers are filled with separators (SPACES).

MESSAGE TEXT

Data pattern message consist of either 80-character record blocks (card messages) or images of the 80-character record blocks when transmitted via magnetic tape. Messages transmitted via message switching facilities are limited to 500 cards. However, additional cards used to pilot messages constitutes an exception to the maximum message length and will be accepted by the ASCs. Messages containing more than 500 cards are transmitted as two or more transmission sections and each section has a different station serial number assigned.

Single card message can be transmitted by a slight variation of the data pattern message format. Since the entire transmission consists of only one record, a record count indication is not required. Single card messages are limited to a single addressee, and the end-of-routing signal appears immediately following the routing indicator of the addressee. Classified single card messages are not authorized and therefore the classification verification (positions 34-38) are not required. The start-of-routing signal follows the time filed in position 29 and 30. Single card messages are duplicated by the receiving communications facility; one is delivered to the addressee and the duplicate is retained as a communications record. In the single card message, positions 39 through 79 is used for message text. Any portion of these positions not used is filled in with message separators (spaces). The end of transmission signal for a single card message is the single letter N.

MESSAGE BATCHING

Message batching is a method used to increase the operating efficiency and to avoid the retransmission of extremely large groups of cards or records. Certain criteria have been established for segregation of cards or records before transmission. Cards should be separated into batches limited to:

1. One addressee served by any one nonautomatic relay center (NARC) with a total of not more than fifty addressees.
2. One precedence prosign.
3. Five hundred cards or records.
4. One content indicator code.

Each batch of cards or records is preceded by a header and ended by an EOT format. The header provides a standard method of routing and controlling transmissions within and between data transmission terminals. It also serves as a communications record and provides data for traffic analysis. The EOT provides identification of the associated transmission plus end-of-message signaling functions and is forwarded to the addressee. If the receiving activity requires information or control in addition to that provided by the header card or record, that agency may prescribe such additional controls. The additional control information should be placed behind the header and included in the record count.

END-OF-MESSAGE VALIDATION

The end-of-message validation is performed by the ASC upon receipt of each data pattern message. Special attention must be given to applying the EOM validation when performing such actions as message pilots. The SSN used in the heading of these messages with the EOM validation number (SSN) in the end-of-transmission (EOT) record.

END-OF-TRANSMISSION FORMAT

The final record of a data pattern message is used to identify the originating station and other associated transmission information to the addressee after the header is stripped away from the message by the communications facility.

The end-of-transmission (fig. 6-8) is an 80-position record for card and magnetic tape. The EOT consists of a repeat of all header information starting with the precedence, including all intervening elements, and ending with the character before the start-of-routing signal. When MTMS is used in the record count field of format line 2, the actual record count must be placed in the EOT record. The remaining positions are filled with separators (spaces) up to the positions required for the end-of-transmission signal (EOTS).

END-OF-TRANSMISSION SIGNAL

In a series record transmission (three or more records), the EOTS consists of the letter N repeated four times in positions 77 through 80 of the EOT record. The operating personnel must ensure that the unique group of four Ns does not appear anywhere in the text of the message or the ASC will recognize this as a transmission termination. As described earlier, the single letter N in position 80 is the EOT signal used for a single record transmission.

The following examples are data pattern message traffic.

Example using IMFs CT or CA:

RCTUDEAA RUWTFHA1234 3571104 0050-
UUUU-RUFLAFA
ZNR UUUUU
R 231104Z DEC 70
FM SAC
TO 2188 COMMSQ MORON AB SPAIN
BT
TEXT - 42 CARDS
BT
RCTUDEAA RUWTFHA1234 3571104 0050-
UUUU NNNN

Note: The above example illustrates use of additional format lines.

EOT RECORD FORMAT

PRECEDENCE	1	P
LANGUAGE AND MEDIA FORMAT	2 3	CC
CLASSIFICATION, AS APPROPRIATE	4	U
SEPARATOR	5	D
CONTENT INDICATOR/COMMUNICATION ACTION IDENTIFIER	6 7 8 9	A Z
ORIGINATOR	10 11 12 13 14 15 16	R U E B A A A
STATION SERIAL NUMBER	17 18 19 20	Ø Ø 4 5
SEPARATOR	21	
JULIAN DATE	22 23 24	1 4 4
TIME FILED	25 26 27 28	Ø 2 3 3
SEPARATOR	29	
RECORD COUNT	30 31 32 33	Ø 2 1 3
CLASSIFICATION REDUNDANCY	34 35 36 37 38	- U U U U
SEPARATORS	39-76	
END OF TRANSMISSION SIGNAL	77-80	NNNN

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Figure 6-8.—Data Pattern End-of-Transmission Record.

Example: The following example shows the previous message delivered in teletype format.

RCTUDEAA RUWTFHA1234 3571104 0050-
UUUU—RUFLAFA.
ZNR UUUUU
R 231104Z DEC 70
FM SAC
TO 2188 COMMSQ MORON AB SPAIN
BT
TEXT - 42 LINE BLOCKS
BT
NNNN

Note: The ASC, when terminating in teletype procedure, inserts 2CR and 1LF at the end of each format line and replaces the EOT with EOM sequence.

Data pattern, being another communications media, is still subject to basic communications teletypewriter procedures as outlined earlier in this chapter with the exceptions outlined here and in JANAP 128(). Data pattern format is not infallible and is subject to misrouted messages, missent messages, nondelivers, and other irregularities. When such an irregularity occurs, the operator should follow the procedures already outlined for teletypewriter procedure to make the necessary corrections and eliminate the problem.

MAGNETIC TAPE

Magnetic tapes are one of the principal media used in Electronic Data Processing Equipments. There are many different applications of magentic tape, all of which have a direct bearing on the format of the recorded data. Magnetic Tape Terminal Stations (MTTS) in the AUTODIN allow rapid exchange of large volumes of data in a relatively short period of time. Terminals which have compatible speeds, formats, and codes may communicate directly via the CSU (circuit switching unit) if appropriately connected. Other terminals may communicate via the MSU (message switching unit) which automatically performs the necessary speed, format, and code conversions. There are two basic modes of MTTS operation. Message switching MTTS communicate with other AUTODIN tributary stations via the store and forward method provided by the MSU. Circuit switching MTTS can communicate directly with other terminal via the CSU. Message Tape Terminal Stations usually operate full duplex (two way operation) in the MSU mode. They have the capability of operating full duplex in the CSU mode if the operation is coordinated.

OPERATION

All received tape reels must be periodically dismounted and made available for delivery as scheduled by the receiving activity and system manager. A magnetic tape reel accepted by the communications facility for transmission is screened and arranged for transmission according to majority message precedence levels contained on the reel. Establishment of transmission schedules is the responsibility of the commands concerned and prior coordination must be effected to provide for efficient use of the equipment and circuit time. Schedules are limited to 30 minutes per schedule. Most facilities establish their own procedures for maintaining reel accountability and to insure that message transmission has been effected. Message header and EOT printouts are furnished by the message originator with each reel of tape to be transmitted. If a message cannot be transmitted, the MTTS operator returns the reel to the originator, identifying the message(s) that could not be sent and gives the reason for the nontransmission, if known. Terminal equipment should not be used to change message media format for customer convenience. An example is changing from magnetic tape to card, or narrative records.

Operating Precautions

Communications station's master records, such as history tapes and journal records remain within the communications facility until destroyed. History tapes must be appropriately labeled to prevent the possibility of their being inadvertently transmitted along with live traffic. The operator and personnel handling magnetic tape should be aware that the recorded information is very close to the tape edge and rough handling may damage the tape edges and seriously effect the accuracy of the magnetic tape recordings.

MESSAGE PREPARATION

Magnetic tape message preparation is the primary responsibility of the message originator. This type format deals in language media and formats that are generally unfamiliar to the average operator. Magnetic tape LMF's are formats that are acceptable to the computers used (programed) to handle this media. The operator, however, must have the knowledge required to properly handle message reels (magnetic tape) from the originator.

Message Tape Reel Accountability

Each reel of magnetic taped messages presented to the Magnetic Tape Terminal Station operator should bear the following information on the outer label.

1. Reel number
2. Number of messages recorded on tape.
3. Highest transmission precedence used.
4. Highest security classification used.
5. Data and time filed.
6. Tape density
7. LMF in which the message(s) are recorded on the tape.
8. Beginning and ending station serial numbers.
9. Time delivered to the MTTS operator for transmission.

Each reel of blank magnetic tape furnished to the operator for mounting on the receive tape transport should bear a physical tape label on which the following information is recorded (by the operator) in the sequence of handling.

1. A statement that the reel is blank tape.
2. Reel number.
3. The highest classification that is recorded on the tape.
4. Time reel is mounted on the receive tape transport.
5. Time reel is removed from the receive tape transport.
6. Time reel is delivered to the addressee.
7. Number of messages on the reel, type of messages, etc., if known.

All originated tape reels should be retained for a period of not less than ten days to provide retransmission or resubmissions as required. The computer should provide the operator with readouts of the message header and EOT. These readouts are maintained for a period of not less than 30 days as a station record. Other logs and records are recommended to provide the MTTS with accurate accountability of message tapes handled, although these records are generally determined by local policy.

MANUAL TELETYPEWRITER PROCEDURE

Manual teletypewriter procedure is used on teletypewriter circuits that are not part of the tape relay network—on ship-ship and ship-shore RATT circuits, for example. The procedure is contained in the effective edition of ACP 126. Message formats for radioteletype, radiotelegraph, and radiotelephone are essentially the same. Because of this similarity, the message format for manual teletypewriter messages is not given here.

MANUAL TELETYPEWRITER MESSAGES

In the ensuing message examples, you will see the similarities of the manual teletypewriter procedure with tape relay procedures. As in all message examples throughout this text, format lines not needed for the message are omitted. End-of-line and end-of-message machine functions are indicated in parentheses.

Here is a plaindress, single-address message originated by USS Epperson and addressed to USS Renshaw. The originator and the addressee are in direct communication, and the call serves as the address. A preliminary call is made before transmitting the message.

(5 SPACES 2CR LF)	
NWBJ DE NTGT K	(2CR LF)
(5 SPACES 2CR LF)	
NTGT DE NWBJ K	(2CR 8LF)
(5 SPACES 2CR LF)	
NWBJ DE NTGT	(2CR LF)
R 272113Z AUG 71	(2CR LF)
GR3Ø	(2CR LF)
BT	(2CR LF)
UNCLAS	(2CR LF)
1. EXCEPT FOR ABSENCE	(2CR LF)
OF SEPARATIVE SIGNS	(2CR LF)
IN HEADING, FORMAT OF	(2CR LF)
MSG IS IDENTICAL TO	(2CR LF)
RADIOTELEGRAPH	(2CR LF)
2. NOTICE THAT END-OF-	(2CR LF)
MESSAGE FUNCTIONS ARE	(2CR LF)
THE SAME AS IN TAPE	(2CR LF)
RELAY PROCEDURE	(2CR LF)
BT	(2CR LF)
K	(2CR 8LF)
NNNN	(12 LTRS)

Our next example is of a plaindress, multiple-address message. The originator is not in direct communication with the addressees, and sends the message to NAVCOMMSTA Guam for relay. Assume that communications are established by an exchange of calls (as in the preceding example).

(5 SPACES 2CR LF)	
NPN DE NWBJ	(2CR LF)
T	(2CR LF)
P Ø51921Z SEP 71	(2CR LF)
FM UUU RENSHAW	(2CR LF)
TO COMDESDIV 252	(2CR LF)
INFO COMDESRON 25	(2CR LF)
DOMDESFLOT 5	(2CR LF)
GR 29	(2CR LF)
BT	(2CR LF)
UNCLAS	(2CR LF)
1. IF NOT MEMBERS OF TAPE	(2CR LF)
RELAY SYSTEM, MOBILE UNITS	(2CR LF)
TRANSMITTING UNCLAS MSGS	(2CR LF)
TO SHORE STATIONS VIA RATT	(2CR LF)
MUST USE PLAIN LANGUAGE	(2CR LF)
DESIGNATORS IN ADDRESS OF	(2CR LF)
SUCH MSGS	(2CR LF)
BT	(2CR LF)
K	(2CR 8LF)
NNNN	(12 LTRS)

The following exemplifies an abbreviated plaindress message, with the call serving as the address.

(5 SPACES 2 CR LF)	
NLNB DE NREB	(2CR LF)
P	(2CR LF)
BT	(2CR LF)
UNCLAS	(2CR LF)
1. THE DATE AND GROUP	(2CR LF)
COUNT ARE OMITTED FROM	(2CR LF)
THIS MSG. OTHER ELEMENTS	(2CR LF)
THAT COULD BE OMITTED AT	(2CR LF)
THE DISCRETION OF THE ORIG	(2CR LF)
ARE PRECEDENCE	(2CR LF)
AND TIME GROUP IN MSG	(2CR LF)
ENDING	(2CR LF)
BT	(2CR LF)
1421Z	(2CR LF)
K	(2CR 8LF)
NNNN	(12 LTRS)

A radioteletypewriter message prepared in codress form is shown in the next example. The called station, NAVCOMMSTA Honolulu, must decrypt and deliver the message to certain local activities named in the encrypted text. The originator uses an indefinite call.

(5 SPACES 2CR LF)	
NPM DE NA	(2CR LF)
R 2718Ø5Z AUG 71	(2CR LF)
GR 46	(2CR LF)
BT	(2CR LF)
ENCRYPTED GROUPS	(2CR LF)
BT	(2CR LF)
C 12 XYTOP	(2CR LF)
K	(2CR 8LF)
NNNN	(12 LTRS)

TOUCH TELETYPEWRITING TEST

Before you can be recommended to take the fleet servicewide examination for advancement to RM3 you must demonstrate your ability as a teletypist by satisfactorily passing a performance test in touch teletypewriting. This performance test is not a part of the competitive examination. It is administered by your local examining board at least once each quarter, or four times a year. You cannot compete in the servicewide examinations without first passing the performance test and meeting all the other requirements listed in the front of this rate training manual.

The teletypewriting test for advancement to RM3 consists of three messages, totaling approximately 600 characters, which must be transmitted in 9 minutes. Some of the message texts are plain language, others are composed of five-character groups of random mixed letters, or random mixed numerals. The headings contain about 30 percent and the texts about 70 percent of the total number of characters. Only in the event a teletypewriter is unavailable will the examining board let you use a telegraphic typewriter for the typing test.

The time limits for the test include servicing each message by endorsing the time of transmission, the circuit used, and your personal sign. Servicing should not require much time, but be sure to include time for servicing in your practice runs.

Transmission of the touch teletypewriting test must be by direct keyboard method; you are not permitted to cut a tape. A total of five errors (uncorrected or omitted characters) is permitted in the official test. If an error is corrected properly and according to the correct procedure, it does not count as an error. Thus, there is no limit to the number of corrected errors you may have. But correcting errors takes time and, on an examination, if you must stop to correct too many errors, you may disqualify yourself by failing to finish within the time limits.

Just before the official test you will be given a practice test consisting of messages that are different from the official test, though similar in number, length, and general content. The results of the practice test do not affect the score of the official test, but if you try your best on the practice test, it will help you overcome nervousness, and you will be better able to adjust your typing speed within the time limits on the official test.

Be sure to practice your teletypewriting in preparation for the performance test. Strive to improve both your accuracy and your speed. Remember that you may not be able to do your normal best typing on the day of the test. The examining board may hold the test in surroundings unfamiliar to you; besides, most persons are victims of nervousness on examination day. It is well, therefore, to have sufficient speed and accuracy to provide a little "margin" for overcoming your nervousness in unfamiliar surroundings.

CHAPTER 7
TRAFFIC-HANDLING PROCEDURES

The purpose of this chapter is to describe procedures employed by communicators to handle and process messages for delivery by manual, semiautomatic, or fully automatic systems. These procedures are referred to in this chapter collectively as tape relay.

The attainment of reliability, speed, and security depends, to a large extent, upon how well the assigned personnel do their job. It is essential that they be well trained, follow operating procedures, and understand their responsibilities. Adherence to prescribed operating procedure is mandatory. Unauthorized departure from the prescribed operating doctrine invariably creates confusion, reduces reliability and speed, and may lead to a security violation.

ORGANIZATION FOR TRAFFIC HANDLING

To accomplish its assigned mission the Naval Communications System is planned, engineered, and operated so that activities of the system are organized into one or more operational components, which are centrally controlled at any geographical area by the communication center. Figure 7-1 represents a large communication center, with all components illustrated. The operational components of a communication center are—

1. Technical control facility: Operates and maintains the radio and landline facilities to and from the receiver and transmitter sites, patching facilities, terminal equipment; maintains and monitoring equipment to check all lines and circuits; controls the order wire system between the technical control center and the transmitter and receiver sites; operates on-line cryptographic devices and has custody of current keying material; and provides circuit routing and restores circuits and channels in accordance with established priorities and doctrine.
2. Message center: Accepts and prepares messages for transmission, receives and delivers incoming messages, maintains files of all traffic handled, and originates all services required for handling messages in their area of responsibility.
3. Cryptocenter: Handles all classified messages transmitted or received by on-line or off-line means. Makes internal distribution of classified traffic.
4. Fleet center: Delivers messages to mobile units via broadcast methods, receives and relays incoming messages from mobile units, and operates NORATS facilities where installed.
5. DCS relay center: Handles messages via the DCS tape relay network for further relay via automatic or semiautomatic facilities. Maintains a monitor section for the purpose of obtaining and making reruns and retransmissions.
6. Wire room: Operates the unprotected and unclassified circuits, either radio or landline. These circuits may be the commercial circuits or ship-to-shore circuits.
7. Graphics center: Facsimile facilities are located in this area.
8. Visual signal facility: Sends and receive messages by any of the visual means.
9. Transmitter facility: Provides the capabilities for transmitting by radio to distant units and stations.
10. Receiver facility: Provides capabilities to receive incoming signals and maintains patching facilities to deliver the signal to the main distribution frame in the communication center.

PUBLICATIONS

Publications of principal importance to operators are the effective editions of ACP 127 (with United States supplement), ACP 117 (with Canadian and United States supplements), and JANAP 128. Tape relay procedure is dealt with in ACP 127. Autodin procedure is set forth in JANAP 128. Routing indicators employed on tape relay and Autodin networks are listed in ACP 117.

Supplements actually are separate publications, issued by the individual Allied countries, that amplify (or expand) the basic publications. For example, ACP 127 U.S. SUPP-1 prescribes

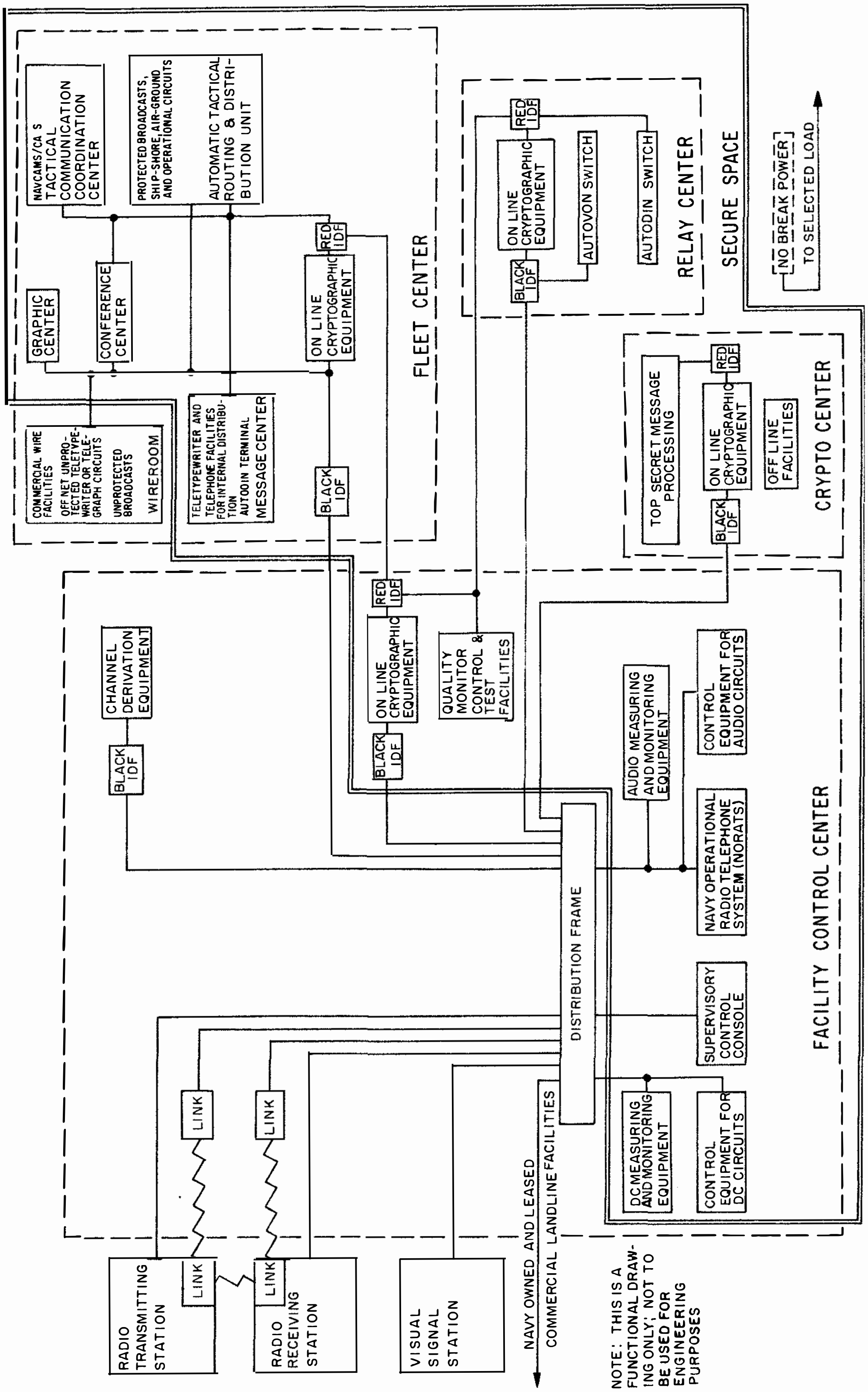

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Figure 7-1.—Typical Communication Center.

operating procedures that are peculiar to the United States tape relay networks. In ACP 117 CAN-U. S. SUPP-1 (a Joint supplement) are listed the routing indicators of the teletypewriter stations belonging to the United States and to Canada. The ACP 117 U. S. SUPP-1 contains instructions for routing U.S.-originated messages to military and nonmilitary activities that are not assigned a routing indicator in the CAN-U. S. SUPP-1.

The information in ACP 117 is utilized in many ways depending on the type of duty station. At the larger shore COMMCENS, the routing indicator book is used to obtain routing for those commands which are permanently based at one location. In order to route messages faster, most COMMCENS transpose those permanent type routing indicators onto strip paper in alphabetical order and then place these strips in either a rotary spindle or a flat index stand. Once these are transposed, it becomes a permanent routing guide. Mobile (ship) routine indicators are not contained in ACP 117, but are published by message. In order for commands to route to units assigned; the "Project Ship's Card" system is utilized. In this system, a daily computer change, in card form, is published by NAVCAMS NORVA and distributed daily to all message centers ashore. These cards indicate any changes to mobile routing indicators which occur within a twenty-four hour period. These cards are usually kept in a cardex file near the out-router. The out-router exchanges new cards for old at the start of the new day.

AUTOMATIC RELAY

The automatic switching equipment installed in relay stations is designed to relay only those message tapes that meet certain requirements. In certain critical portions of an incoming tape, the equipment senses each character (letter and function) to determine the message routes and to guard against nondelivery resulting from garbles or improper character sequence. Any deviation from prescribed procedure, including omission or insertion of machine functions, results in a rejected message.

Messages rejected by the equipment are shunted to a miscellaneous intercept position for service action. When rejections occur, delay is inevitable and, depending upon the traffic load and number of rejects, the delay may amount to hours.

You must bear in mind that automatic relay stations are manned by very few operators. If your message is not punched correctly and the precedence is lower than IMMEDIATE, the relay station does not reprocess and correct it for you. Your station is notified by service message to transmit a correctly prepared tape, and you must retransmit the message. Therefore, you must learn and always use the correct teletypewriter procedure.

Even if a tributary station does not work directly into an automatic relay station, the messages enter the automatic system if there are addressees in the continental United States.

The sequences of letter, numeral, and machine function characters required for automatic system operation are shown in message examples in JANAP 128.

TORN TAPE RELAY

Torn tape relay is a term derived from the manner in which message tapes are processed at a semiautomatic relay station. At such stations, incoming message tapes are received on a reperforator, torn from the reperforator by the operator, and hand-carried to the outgoing circuit. Hence, torn tape relay means that the tape actually is torn at the receiving machine, and is transferred to the outgoing machine by hand.

An operator at a torn tape relay station usually is assigned to operate several circuits in the immediate vicinity of one another. He is responsible for all traffic passed over these circuits; maintains a separate message log for each circuit; screens all messages for obvious errors or garbles; makes certain that messages given him for transmission are transmitted on the circuit indicated; and disposes of incoming messages in accordance with the practices of his particular station.

Except for a slight difference in format line 1, the message format for torn tape relay is identical to the format for automatic relay.

SPECIAL PURPOSE COMMUNICATIONS

Within the Department of Defense, several special purpose communication networks have been established for the transmission of special intelligence. In addition to the normal services provided by the networks, messages may be refiled from one network to another, or from a special purpose network to a general purpose military network.

Depending upon which network a ship or station may be a part of, traffic-handling and circuit operating procedure is set forth in special operating instructions. Normally, messages that are refiled from one system to another undergo minor changes in format.

Traffic-handling procedures, regardless of the system concerned, are similar enough that the examples and procedures discussed in the remainder of this chapter can serve as a basic example for any of the systems. In each example, however, reference must be made to the publication that governs the specific network affected, to ensure compliance with exact procedure.

ROUTING

The Defense Communications System employs the tape relay method of traffic relay. By this method, messages are received and routed to their destination in teletypewriter tape form by means of automatic or semiautomatic relay equipment. Tapes are routed by means of routing indicators, which are directional in character. These indicators are constructed and assigned in compliance with a definite plan. Tapes are routed according to a routing doctrine, whereby the traffic flow over various circuits or channels and the responsibilities of the relay stations concerned are in accord with a specific prearranged plan. The various circuits or channels, equipment, procedures, and routing indicators are engineered and coordinated with the system in such a manner that full benefits may be realized from the advantages, flexibilities, and speed of service of automatic or semiautomatic relay equipment. This method of traffic handling is designed to reduce in-station processing time to a minimum.

Routing may be either predetermined or alternative. Each method is discussed briefly in the following paragraphs.

PREDETERMINED ROUTING

Predetermined routing means that a specific route is selected as the normal path for transmission of messages from one particular station (or geographical area) to another. Regardless of the volume of traffic, permission of the intermediate station(s) is not required to transmit traffic via its normal route.

ALTERNATIVE ROUTING

If a failure occurs in equipment or circuit path, an alternative route for delivery can be selected.

Alternative routing is the transmission of messages via other than the normal route. When available, alternative routes are used to prevent undue delay of high precedence messages, and to reduce or prevent the accumulation of traffic backlogs. For the alternative routing of lower precedence messages, it is usually necessary to determine in advance the relay capabilities of any other relay station, by asking permission to route traffic alternately. Replies normally set specific limitations on either the number or precedence of the messages being routed alternately or the duration of time available for alternate routing.

ROUTING LINE SEGREGATION

The automatic relay system uses a method known as routing line segregation for routing multiple-call tapes (messages having two or more routing indicators in the routing line). This method means that routing indicators in the routing line are segregated or distributed in accordance with the desired transmission channel in the switching process. Under this method, only the routing indicators applicable to a particular transmission appear in the routing line. Messages received at a station that has further relay responsibility contain only the routing indicators for which that station is responsible.

Routing line segregation does not affect tape preparation at the originating station. This function is accomplished at relay stations. At the automatic relay stations, relay equipment segregates routing indicators automatically according to the required transmission path.

In order to make the semiautomatic relay system compatible with the fully automatic system, relay stations that are not connected directly to the automatic system must also perform routing line segregation on all relayed messages. To perform the routing line segregation, semiautomatic relay stations require an operator using special routing segregation equipment. Following are examples of the line segregation method.

Formal lines 2 and 3 of a message as prepared by originating station RUQAC and forwarded to RUQA relay Asmara:

PP RUFRC RUCKO RUWSC RUMFC
DE RUQAC Ø27 2641234
(Etc.)

Station RUQA relay must make two transmissions of this message, one to RUTP, Port Lyautey, and another to RUMF, Philippines. As relayed to RUTP:

VZCZCQAAØ37
PP RUFRC RUCKC RUWSC
DE RUQAC Ø27 2641234
(Etc.)

As relayed to RUMF:

VZCZCQAB137
PP RUMFC
DE RUQAC Ø27 2641234
(Etc.)

The next example is how the message is processed by RUTP. Two transmission are required, one to RUFR, Naples, and the other to RUEC, Washington, for relay to RUCKC and RUWSC. The routing line is altered for the two transmissions as follows:

Transmission to RUFR:

VZCZCTPA296QAAØ37
PP RUFRC
DE RUQAC Ø27 2641234
(Etc.)

Transmission to RUEC:

VZCZCTPC678QAAØ37
PP RUCKC RUWSC
DE RUQAC Ø27 2641234
(Etc.)

Station RUEC is responsible for two transmissions, one to RUCK, Norfolk, the other to RUWS, San Francisco. Each transmission is reduced to a single call in the basic routing line.

As relayed to RUCK:

VZCZCECB311TPC678
PP RUCKC
DE RUQAC Ø27 2641234
(Etc.)

As relayed to RUWS:

VZCZCECD935TPC678
PP RUWSC
DE RUQAC Ø27 2641234
(Etc.)

From the preceding examples, it can be seen that routing indicators are dropped from the routing line when they have served their purpose. The message arrives at each relay with only the routing indicators for which that relay is responsible and at each terminal station with only that station's routing indicator. This procedure enables each relay point to determine its own relay responsibilities, and it eliminates multiple delivery of the same message to a terminal station. One more point should be made: Dropping routing indicators at various relay points along the line increases the possibility of a nondelivery if care is not exercised.

Traffic checkers and personnel operating address segregation equipment (tape factories) must be extremely alert to ensure that all routing indicators received on incoming traffic are protected by outgoing transmissions.

CHANNEL NUMBER SEQUENCES

Channel number sequences may start at 001 on a daily basis, or may be numbered continuously from 001 to 000 (000 representing 1000). Changes to channel number sequences are made at different times, depending upon the various systems and the number of hours of daily operation.

Channel number sequences are changed daily, as near 0001Z as practicable. Because there are many circuits on which numbers must be changed, relay stations usually commence resetting their outgoing channel numbers to 001 at approximately 2330Z daily.

Upon receipt of channel number 001 from the relay station, tributary stations reset their numbers to 001. Then they originate a service message to the relay station, stating the last number received for that day and listing any messages awaiting rerun. This service message is sent under channel number 001 for the new day.

U.S. JOINT PROCEDURE

When only U.S. network stations are participating deviations from the rules set forth in ACP 127 are applied in the situations indicated. Procedures of ACP 127 apply in all other instances. On the transmit side of each circuit or channel, major relay stations must—

1. Start a new sequence daily; or
2. Use a continuing sequence 001 through 1000.

Minor relay and tributary stations follow the numbering system used by their connected relay stations.

In the following example, station RUECD sends the final number comparison for the old day, and informs RUEC that retransmission of a message still is pending.

```
(TI) (5 SPACES 2CR LF)
RR RUEC                      (2CR LF)
DE RUECD 255ØØØ2             (2CR LF)
ZNR UUUUU                    (2CR LF)
UNCLAS SVC ZID ECA164
AWAITING ZUK ECA137          (2CR 8LF)
NNNN                         (12LTRS)
```

The same procedure as just described is observed on circuits between relay stations, except that, on multichannel circuits, one service message usually suffices for reporting all circuits. Example:

```
(TI) (5 SPACES 2CR LF)
RR RUEC                      (2CR LF)
DE RUWS 255ØØØ2              (2CR LF)
ZNR UUUUU                    (2CR LF)
UNCLAS SVC ZID ECA558
  ECB62Ø
ECC459 ECD7ØØ                (2CR 8LF)
NNNN                         (12LTRS)
```

When a station changes transmission identification numbers under the 1000 number sequence, the transmission of number 1000 (represented by 000) indicates the end of the current series. Receipt of a message with channel number 001 indicates that a new series has been instituted. No further notification is required. At the receiving station, traffic records pertaining to the previous series must not be considered complete until every number in the series is accounted for.

COMBINED CIRCUITS

Of the two methods described in the preceding topic, daily sequential channel numbering is used in combined networks.

ENSURING CONTINUITY OF TRAFFIC

Except for FLASH messages, station-to-station receipts are not employed in the tape relay system. Responsibility for continuity of received messages rests with the station receiving the traffic. A receiving station ensures that a tape is received under each channel number and that numbers are not duplicated or omitted.

Channel checks, attention to circuit logs, and quality control are ways of ensuring continuity of traffic.

CHANNEL CHECKS

When no transmission is received over a circuit or channel for a period of 30 minutes (this interval may be increased to 60 minutes at the discretion of the relay station on channels to its tributaries), the receiving station originates a service message (called a channel check) to the transmitting station. A channel check is assigned a precedence of IMMEDIATE, and is in the following form:

```
(TI) (5 SPACES 2CR LF)
OO RUHPB                     (2CR LF)
DE RUHPC 24616Ø5             (2CR LF)
ZNR UUUUU                    (2CR LF)
UNCLAS SVC ZID PBA113        (2CR 8LF)
NNNN                         (12LTRS)
```

(The channel number after operating signal ZID indicates the channel number of the last message received from RUHPB on that channel.)

Station RUHPB checks the channel number of the last message transmitted to RUHPC on the channel indicated, and, if it agrees with the number in the channel check, RUHPB transmits:

```
(TI) (5 SPACES 2CR LF)
OO RUHPC                        (2CR LF)
DE RUHPB 24616Ø7                (2CR LF)
ZNR UUUUU                       (2CR LF)
UNCLAS SVC ZIC PBA113           (2CR 8LF)
NNNN                            (12LTRS)
```

If the message reported as last received does not actually correspond to that sent last, RUHPB takes whatever action is necessary to establish contact with RUHPC, and retransmits the missing message(s).

At tributary stations, if no traffic is received for a period of 30 minutes (or 60 minutes if so directed), the tributary originates and transmits a channel check addresses to its own station. The following example is such a channel check.

```
(TI) (5 SPACES 2CR LF)
CO RUHPB                        (2CR LF)
DE RUHPB                        (2CR LF)
ZNR UUUUU                       (2CR LF)
UNCLAS SVC CHANNEL CHECK
RYRYRYRY                        (2CR LF)
ABCDEFGHIJKLMNOPQRSTUV
  WXYZ
123456789Ø                      (2CR 8LF)
NNNN                            (12LTRS)
```

The preceding message, routed to its own station, indicates to the tributary a satisfactory circuit condition if it is received promptly from the relay station and the channel number agrees with the received message log. If it is not returned over the receive channel within a reasonable length of time, circuit trouble should be suspected, and the condition of the circuit should be investigated by maintenance personnel.

Similarly, self-addressed numbers comparison messages are transmitted over special purpose circuits when a transmission is not received for a period of 30 minutes.

ATTENTION TO CIRCUIT LOGS

In addition to originating channel checks or numbers comparison messages, you must give close attention to circuit logs to ensure the continuity of traffic. Unless each incoming tape is properly examined and logged in (or crossed off a number sheet), a tape may go through unaccounted for, an actual open number might occur, tapes may be received either with or without channel numbers, or any one of several other discrepancies might occur. Ensuring the continuity of traffic is a full-time job, requiring the closest attention to each detail of circuit operation.

QUALITY CONTROL

Another method of achieving continuity of traffic is by the timely page-copy monitoring of incoming circuits in the quality control section. The quality control operator does not relieve the circuit operators of any responsibility for being attentive to circuit conditions. Rather, he assists the circuit operators and prepares most of the necessary service messages required for coordination between stations.

In actual practice, ensuring the continuity of traffic is the responsibility of every man on watch or employed in the communication center. Each message originated or received for relay or for local delivery must be protected to its final destination.

SERVICE MESSAGES

As defined in chapter 4, service messages are brief transmissions between communication personnel for the purpose of expediting the handling of message traffic. The examples of service messages described in this section pertain to discrepancies that occur in transmission identification and in message identification. For a complete discussion of service messages, refer to the publications, listed earlier in this chapter, which pertains to the various teletypewriter networks.

MISROUTE/MISSENT MESSAGES

A misrouted message is one bearing incorrect routing instruction. A missent message contains correct routing instruction but was transmitted to a station other than that indicated. When a message is missent, no alteration is required—it is simply relayed onward. If the message was misrouted, a misroute pilot must be affixed before the message is relayed onward.

After a misrouted message is rerouted, a service message is sent to the station of origin. The service message identifies the particular message, pointing out the incorrect routing, and indicating corrective action taken. Example:

EUAØ24WNAØ17
RR RUFDAE
DE RUEPDA 116B 1351530
ZNR UUUUU
R 141432Z SEP 69
FM HQ DA
TO CGUSARELEVEN
etc.

Misroute pilot applied by RUFDAE:

RR RUFDDO
ZNR UUUUU ZOV RUFDAE
EUAØ24WNAØ17
RR RUFDAE
DE RUEPDA 116B 1351530
ZNR UUUUU
R 141432Z SEP 69
FM HQ DA
TO CGUSARELEVEN
etc.

Service message sent by RUFDAE to RUEPDA:

(TI) (5 SPACES 2CR LF)
RR RUEPDA
DE RUFDAE 117A 1351541
ZNR UUUUU
BT
UNCLAS SVC ZUI RUEPDA 116B 1351530
RUFDDO ZOV RUFDAE
BT
NNNN

MESSAGES WITHOUT A CHANNEL NUMBER

A message received without a sequential channel number—if otherwise correct—must be released for onward transmission, delivery, or refile. A service message must be sent to the transmitting station reporting the pertinent information. Example:

(TI) (5 SPACES 2CR LF)
RR RBDA
DE RBDAGH 1751923
ZFT RBDAC 148C 1751712 DPA125
NNNN

OPEN NUMBERS

When a station discovers an open number, a service message of IMMEDIATE precedence must be sent to the transmitting station advising of the discrepancy. The service message merely reports that the number is open. It does not contain a request for retransmission. After appropriate record is made, the matter is considered closed insofar as the reporting station is concerned.

Upon receipt of a report of an open number, the transmitting station determines whether a transmission was made under that number. If no transmission was accomplished, an appropriate notation is made in station records, and no further action is taken. If records indicate that a transmission was made under the number in question, it must be rerun under a new channel number with no indication of retransmission.

Example (1): RUHPB reports an open number to RUHP:

(TI) (5 SPACES 2CR LF)
OO RUHP
DE RUHPB 131 0111245
ZFX HPAØ63
NNNN

Example (2): RUHPB, after ascertaining that a transmission was made under HPAØ63, retransmits:

HPAØ66WPBØ27PHAØ51
RR RUHPB
DE RUWSPH 151 0111215
etc.

DUPED NUMBERS

When two messages are received at a station bearing duplicate channel numbers, the tapes are examined to determine if duplication of the message occurred. If no duplication is apparent, both messages are released. If duplication is discovered, the duplicate is not released; instead, a service message is transmitted to the responsible station. Example:

(TI) (5 SPACES 2CR LF)
RR RUWG
DE RUWGBS 1732345
ZNR UUUUU
ZFQ WFA145
NNNN(or)
(TI) (5 SPACES 2CR LF)
RR RUWG
DE RUWGBS 1732345
ZNR UUUUU
ZFQ RUCDSQ 194A RUEAFF 167C WFA145
NNNN

In response to a notification of duped numbers—it the message texts are identical—the distant station is advised to disregard one of the tapes. If two different texts were transmitted, a new number is assigned to one or the other tapes.

TAPE RELAY PILOTS

A pilot indicates that, for some reason, a particular message requires special handling over relay circuits. The pilot is considered to be format line 1 of the message. Following are four important types of pilots.

Pilot	Abbreviation	Associated Operating Signal
1. Subject to correction	SUBCOR	ZDG
2. Corrected copy	CORCY	ZEL
3. Suspected duplicate transmission	SUSDUPE	ZFD
4. Rerouted message	- - - -	ZOV

SUBCOR PILOT

When a relay operator finds a garbled or multilated tape of PRIORITY (or lower precedence, the tape usually is not relayed until a good copy is available. If waiting for a good copy would delay the message unreasonably, or if the message is of higher precedence than PRIORITY, it is forwarded immediately, subject to correction. The station releasing a message subject to correction is responsible for seeing that a good tape is transmitted as soon as possible as a corrected copy.

In the following example, a message from the Far East, addressed to Washington, is received garbled at the relay station in Honolulu, and is forwarded SUBCOR.

```
(TI) (5 SPACES 2CR LF)          (2CR LF)
OO RUECN                        (2CR LF)
ZNR UUUUU ZDG RUHP              (2CR LF)
VV (3 SPACES) MGA19ØVV          (2CR LF)
(3 SPACES) ATA1Ø5               (2CR LF)
OO RUECN                        (2CR LF)
DE RUATH 93 31119Ø1             (2CR LF)
ZNR UUUUU                       (2CR LF)
O 18191ØZ SEP 69                (2CR LF)
FM CONMAVFORJAPAN               (2CR LF)
TO RUECN/DIRNAVSECGRU           (2CR LF)
BT                              (2CR LF)
(Text garbled but still useful.) (Etc.)  (Etc.)
```

CORCY PILOT

When a relay station forwards a SUBCOR message, as in the foregoing example, it is that station's responsibility to obtain a good tape and forward it to the station to which the SUBCOR was sent. The next example shows the pilot used by RUHP in forwarding the corrected copy of the preceding message.

```
(TI) (5 SPACES 2CR LF)
OO RUECN                        (2CR LF)
ZNR UUUUU ZEL RUHP              (2CR LF)
VV (3 SPACES) MGA19ØVV          (2CR LF)
(3 SPACES) ATA1Ø5               (2CR LF)
OO RUECN                        (2CR LF)
DE RUATH 93 31119Ø1             (2CR LF)
....Etc.....                      (Etc.)
```

SUSDUPE PILOT

When a station has no conclusive evidence that a tape was transmitted, but suspects that it was, the message is forwarded as a suspected duplicate. In such instances, the station called is responsible for preventing duplicate deliveries to the addressee. Example:

```
(TI) (5 SPACES 2CR LF)
PP RULAGB                       (2CR LF)
ZFD RULA                        (2CR LF)
PP RULAT RULAC RULAGB           (2CR LF)
DE RUECH 48A 2141158            (2CR LF)
P 111213Z SEP 69                (2CR LF)
(Etc.)                            (Etc.)
```

REROUTE PILOT

As you learned in the previous section, a misrouted message bears an incorrect routing indicator. Because a misroute is handled differently, do not confuse this type of message with the missent message, which bears the correct routing indicator but inadvertently is sent to the wrong station. The misrouted message must be forwarded with a pilot, whereas the missent message is forwarded without alteration.

The station detecting a misroute is responsible for taking corrective routing action. (In some instances the station detecting a misroute is a relay station; in others, the tributary station to which the message was misrouted.) Corrective routing action consists of preparing a pilot containing the message precedence (repeated), the correct routing indicator of the station to effect delivery, the operating signal ZNR or ZNY and the repeated classification character, and the operating signal ZOV, followed by the routing indicator of the station preparing the pilot. Transmission instructions are used only in multiple-address messages, and then only when absolutely necessary to effect delivery of the message.

In the following example, assume that relay station RUHP receives a message for further relay, and discovers a misroute in it. An operator at RUHP prepares a reroute pilot tape, prefixes it to the original tape (as received), and relays the message to the correct station.

(TI) (5 SPACES 2CR LF)	
RR RUHPF	(2CR LF)
ZNR UUUUU ZOV RUHP	(2CR LF)
VV (3 SPACES) UATØ96	(2CR LF)
RR RUHPB RUHPE	(2CR LF)
DE RUATA 43 3ØØØ759	(2CR LF)
ZNR UUUUU	(2CR LF)
R Ø8Ø923Z SEP 69	(2CR LF)
FM NAS ATSUGI	(2CR LF)
TO RUHPB/CINCPACFLT	(2CR LF)
INFO RUHPE/COMBARPAC	(2CR LF)
BT	(2CR LF)
(Etc.)	(Etc.)

After rerouting the message, RUHP transmits a service message to RUATA (station originating the misrouted message), pointing out the incorrect routing and indicating the corrective action taken. This procedure is an important part of the reroute process. It brings the routing error to the attention of the station at fault, and helps prevent future misroutes.

TRACER PROCEDURES

Naval communications prides itself on reliability, but no communication system is absolutely perfect. For this reason, some provision must be made for tracing messages that are lost or meet unreasonable delay. Tracers answer three questions: Was the message actually lost? Who lost it? Why was it lost?

Tracers are sent to protect the dependability of communications—not to serve as a basis for disciplinary action. They warn the station at fault that its internal message-handling procedures may need reexamination.

Tracing a message is simply checking from station to station to find where the failure occurred. The procedures leading to transmission of a service message tracer differ, depending upon whether the message in question is a nondelivery, a suspected nondelivery, or an excessively delayed delivery. Detailed procedures for each of these circumstances are prescribed in the effective edition of ACP 127.

For purposes of our discussion of tracer procedures, assume that a known (not suspected) nondelivery occurs. In such instances, tracer procedures start with the originator of the message, either no his own initiative or at the request of the addressee who did not receive the message. Tracer action is not authorized after 30 days from the date of the message being traced.

The first step the originator takes is either to cancel or retransmit the original message to the addressee not receiving it. If the message is retransmitted, the operating signal ZFG is transmitted immediately after the DTG in the original message heading. (Operating signal ZFG means "This message is an exact duplicate of a message previously transmitted.")

After retransmitted the message, a service message tracer is drafted and sent to the first relay station concerned with the original message. The relay station, after assuring that the message was not mishandled at that station, forwards the tracer to the next relay station for action, and to the originating station for information. This procedure continues on a station-to-station basis until the cause for the lost message is determined and reported to the originating station.

To illustrate a message being traced from originator to addressee, assume a message originated by RUEAHQ was lost en route to the addressee at RUFPBW. After retransmitting the original message to RUFPBW as an exact duplicate, RUEAHQ originates and transmits the following tracer to the service desk of the first relay station handling the original message.

(TI) (5 SPACES 2CR LF)	
RR RUEASU	(2CR LF)
DE RUEAHZ 25A Ø5615ØØ	(2CR LF)
ZNR UUUUU	(2CR LF)
UNCLAS SVC RUEAHQ 1Ø4C	(2CR LF)
Ø55Ø8ØØ 24Ø75ØZ	(2CR LF)
ZDE2 RUFPBW/HQ USAFE	(2CR LF)
ZDQRUEA HQB 115	(2CR LF)
24Ø9ØØZ	(2CR 8LF)
NNNNN	(12 LTRS)

(The meaning of the operating signals used in the text of the tracer are: ZDE2—Message undelivered. Advise disposition. ZDQ--Message____was relayed to____by____at____.)

On receipt of the tracer, RUEASU checks its handling of the original message and finds that the message was forwarded to RUFP. Tracer action continues with RUEASU sending the following version to RUFPSU (service desk of relay station RUFP) and RUEAHQ.

(TI) (5 SPACES 2CR LF)	
RR RUFPSU RUEAHQ	(2CR LF)
DE RUEASU 75A Ø561625	(2CR LF)
ZNR UUUUU	(2CR LF)
TO RUFPSU	(2CR LF)
INFO RUEAHQ	(2CR LF)
BT	(2CR LF)
UNCLAS SVC RUEAHQ 104C	(2CR LF)
Ø55Ø8ØØ 24Ø75ØZ	(2CR LF)
ZDE2 RUFPBW/HQ USAFE ZDQ	(2CR LF)
RUFP JNB185	(2CR LF)
240955Z	(2CR LF)
BT	(2CR 8LF)
NNNN	(12 LTRS)

On receipt of the foregoing tracer, RUFPSU checks its station monitors and finds that the questioned message was sent to RUFPBW for delivery to the addressee. Accordingly, RUFPSU sends this tracer:

(TI) (5 SPACES 2CR LF)	
RR RUFPBW RUEAHQ	(2CR LF)
DE RUFPSU 1Ø9 Ø5617Ø5	(2CR LF)
ZNR UUUUU	(2CR LF)
TO RUFPBW	(2CR LF)
INFO RUEAHQ	(2CR LF)
BT	(2CR LF)
UNCLAS SVC RUEAHQ 1Ø4C	(2CR LF)
Ø55Ø8ØØ 24Ø75ØZ	(2CR LF)
ZDE2 RUFPBW/HQ USAFE ZDQ	(2CR LF)
RUFPBW BWA234	(2CR LF)
241ØØØZ	(2CR LF)
BT	(2CR 8LF)
NNNN	(12 LTRS)

As seen in the preceding examples, the original message was traced from the originating station to the station serving the addressee. After a thorough search of its files and records, RUFPBW discovers that the original transmission of the questioned message was received garbled and was filed without a good copy being obtained. That station must accept responsibility for the nondelivery. It does so in the following report to the originator of the message.

(TI) (5 SPACES 2CR LF)	
RR RUEAHQ RUFPSU	(2CR LF)
DE RUFPBW 223B Ø561915	(2CR LF)
ZNR UUUUU	(2CR LF)
TO RUEAHQ	(2CR LF)
INFO RUFPSU	(2CR LF)
BT	(2CR LF)
UNCLAS SVC ZUI RUEAHQ	(2CR LF)
1Ø4C Ø55Ø8ØØ	(2CR LF)
24Ø75ØZ ZDE2 RUFPBW/HQ	(2CR LF)
USAFE RECEIVED	(2CR LF)
ZBK2. THISTA FAILED TO	(2CR LF)
INITIATE ZDK	(2CR LF)
REQUEST. CORRECTIVE	(2CR LF)
ACTION TAKEN	(2CR LF)
BT	(2CR 8LF)
NNNNN	(12 LTRS)

MESSAGES REQUIRING SUPERVISORY HANDLING

Certain messages may, for reasons of sensitivity or privacy, require special handling. Extreme caution must be exercised to preclude the compromise of such messages by transmission on unauthorized circuits. Usually, messages requiring such special handling are identified by special pilots, special handling instructions in the form of a distinct phrase, or by special operating signals. In general, instructions for local handling are incorporated in the communication center's SOP. Both the quality control and the circuit operators should be alert to call such messages to the attention of supervisory personnel.

BASEGRAM SYSTEM

The basegram system of delivery is for general messages of insufficient operational importance to warrant immediate delivery to ships by the fleet broadcast method. Originators of general messages decide which messages may be designated basegrams. The purpose of basegram delivery is to keep the fleet broadcast free for operational traffic. Strategically located shore stations, acting as basegram delivery authorities, furnish copies of basegrams to ships in ports from which U. S. Navy ships normally operate.

Basegrams and all other general messages are delivered by teletypewriter throughout the shore communication system. Broadcast stations, although they receive basegrams by rapid means, ordinarily do not broadcast the actual basegrams. Instead, they originate and broadcast a service message, indicating that the general message is being delivered as a basegram. The operating signal ZFO (Message ________ is being delivered as a basegram) is transmitted, along with the message identification. Example:

```
WR NR 34Ø4
R110254Z
FM NSS
TO NERK
BT
UNCLAS
ZFO ALNAV 1Ø192ØZ/Ø5
BT
AR
```

Broadcast stations are permitted to send basegrams on the fleet broadcast if all other traffic is cleared and free circuit time exists.

All ships are required to keep a general message receipt log. Usually, a standard ledger-type book is used for this purpose, with columns ruled and labeled to indicate the general messages received and the basegrams for which only the procedure messages (ZFOs) were received. The ZFO procedure message is always placed in the appropriate general message file until it is replaced by the actual general message basegrams.

Aboard ship, your communication chief may send you ashore to pick up basegrams as soon as you arrive in port, at frequent intervals while in port, and immediately before getting underway. Be sure to take along the general message logbook, because the basegram office has no other way of knowing which general messages your ship lacks.

When you obtain copies of basegrams from the basegram office, you will notice the word BASEGRAM near the beginning of the text. Additionally, the message heading bears the operating signal ZFP (meaning BASEGRAM) after the DTG.

Upon receipt, basegrams are written up and routed the same as any other general message.

CHAPTER 8

RADIOTELEPHONE PROCEDURES

We learned in chapter 3 that radio is potentially the least secure of all the various means of communication. One way in which Radiomen can improve transmission security is by observing strict circuit discipline.

CIRCUIT DISCIPLINE

Circuit discipline is the part of transmission security that includes the proper use of radio equipment, net control, monitoring and training, adherence to prescribed frequencies and operating procedure, and remedial action. Lack of circuit discipline and lack of operator training, as well as negligence, inaccuracy, and laxity, are responsible for the violations that endanger radio transmission security.

Although circuit discipline is discussed here in connection with radiotelephone procedure, you must understand that the requirement for circuit discipline applies as well to all communication circuits—not just radiotelephone.

Every operator must recognize and avoid the following malpractices that endanger communication security.

1. Linkage or compromise of classified call signs and address groups by plain language or association with unclassified call signs.
2. Linkage or compromise of encrypted call signs and address groups by association with other call signs, address groups, or plain language. For example, use of encrypted call signs in the call and unencrypted call signs in the message address.
3. Misuse and confusion of call signs, routing indicators, address groups, and address indicating groups. This abuse may result in the nondelivery of an important message, a compromise, or the linking of classified and unclassified call signs and address groups.
4. Violation of EMCON conditions of radio silence.
5. Unofficial conversation between operators.
6. Transmitting in a directed net without permission.
7. Transmitting the operator's personal sign.
8. Excessive repetition of prowords.
9. Use of plain language in place of applicable prowords.
10. Use of authorized prowords.
11. Unnecessary transmission.
12. Incorrect and unauthorized procedure.
13. Identification of unit locations.
14. Identification of individuals belonging to an organization.
15. Excessively long calls. When a station is called and does not answer within a reasonable time, presumably because a condition of radio silence prevails, the message may be transmitted blind or by some other method.
16. Failure to maintain radio watches on designated frequencies and at prescribed times.
17. Use of profane, indecent, or obscene language.

MICROPHONE TECHNIQUE

The following guide should be used in developing good microphone technique. Practice the do's and avoid the don'ts. Remember, though, that nothing can take the place of good common sense.

DO's

1. Listen before transmitting. Unauthorized break-in causes confusion and often blocks a transmission in progress to the extent that neither transmission gets through.
2. Speak clearly and distinctly. Both slurred syllables and clipped speech are hard to understand. A widespread error among untrained operators is failure to emphasize vowels sufficiently.
3. Speak slowly. Unless the action officer is listening, he must rely on the copy being typed or written. Give the recorder a chance to get it all down. That way you save time and avoid repetitions.

4. Avoid extremes of pitch. A high voice cuts through interference best, but is shrill and unpleasant if too high. A lower pitch is easier on the ear, but is difficult to understand through background noises if too low.
5. Be natural. Maintain a normal speaking rhythm. Group words in a natural manner. Send your message phrase by phrase instead of word by word.
6. Use standard pronunciation. Speech with sectional peculiarities is difficult for persons from other parts of the country to understand. Talkers who use as a model the almost standard pronunciation of a broadcast network announcer are easiest to understand.
7. Speak in a moderately strong voice in order to override unavoidable background noises and prevent dropouts.
8. Keep correct distance between lips and microphone. A distance of about 2 inches is correct for most microphones. If the distance is too great, speech is inaudible and background noises creep in; if too small, blaring and blasting result.
9. Shield your microphone. Keep your head and body between noise-generating sources and the microphone while transmitting.
10. Keep the volume of a handset earphone low.
11. Keep speaker volumes to a moderate level.
12. Give an accurate evaluation in response to a request for a radio check. A transmission with feedback or a high level of background noise is not "loud and clear," even though the message can be understood.
13. Pause momentarily, after each normal phrase, and interrupt your carrier. This method allows any other station with higher precedence traffic to break in.
14. Adhere strictly to prescribed procedures. Up-to-date radiotelephone procedure is found in the effective edition of ACP 125.
15. Transact your business and get off the air. Preliminary calls waste time when communications are good and the message is short. It is not necessary to blow into a microphone to test it, nor to repeat portions of messages when no repetition is requested.

DON'Ts

1. Transmit while surrounded by other persons loudly discussing the next maneuver or event. It confuses receiving stations, and a serious security violation can result.
2. Hold the microphone button in the push-to-talk position until absolutely ready to transmit. Your carrier will block communications on the net.
3. Hold a handset in such a position while speaking that there is a possibility of having feedback from the earphone added to other background noises.
4. Hold a handset loosely. A firm pressure on the microphone button prevents unintentional release and consequent signal dropout.
5. Tie up a circuit with test signals. Usually 10 seconds is sufficient for testing.

PRONOUNCING NUMERALS

Care must be taken to distinguish numerals from similarly pronounced words. Pronounce numerals as indicated in the accompanying lists.

Numeral	Pronounced
Ø	Ze-ro
1	Wun
2	Too
3	Three
4	Fow-er
5	Fife
6	Six
7	Sev-en
8	Ait
9	Nin-er

The numeral Ø is always spoken as "zero"—never as "oh." Decimal points are spoken as "day-see-mal."

In general, numbers are transmitted digit by digit, except that exact multiples thousands are spoken as such. However, there are special cases when the normal pronounciation is prescribed and this rule does not apply (17 would then be "seventeen"). Examples:

Number	Pronounced
12	Twelve
44	Fow-er Fow-er
90	Nin-er Ze-ro
136	Wun Three Six
500	Fife Ze-ro Ze-ro
1478	Wun Fow-er Sev-en Ait
7000	Sev-en Tou-zand
16,000	Wun Six Tou-zand
812,681	Ait Wun Too Six Ait Wun

PHONETIC ALPHABET

Many letters of the alphabet sound alike. For this reason, the standard phonetic equivalents of the letters of the alphabet are used in radiotelephone communications. Correct pronunciation of the phonetic alphabet is important and should be practiced at every opportunity.

Letter	Phonetic Equivalent	Pronounced
A	ALFA	AL FAH
B	BRAVO	BRAH VOH
C	CHARLIE	CHAR LEE
D	DELTA	DELL TA
E	ECHO	ECK OH
F	FOXTROT	FOKS TROT
G	GOLF	GOLF
H	HOTEL	HOH TELL
I	INDIA	IN DEE AH
J	JULIETT	JEW LEE ETT
K	KILO	KEY LOH
L	LIMA	LEE MAH
M	MIKE	MIKE
N	NOVEMBER	NO VEM BER
O	OSCAR	OSS CAH
P	PAPA	PAH PAH
Q	QUEBEC	KEH BECK
R	ROMEO	ROW ME OH
S	SIERRA	SEE AIR RAH
T	TANGO	TANG GO
U	UNIFORM	YOU NEE FORM
V	VICTOR	VIK TAH

Letter	Phonetic Equipment	Pronounced
W	WHISKEY	WISS KEY
X	XRAY	ECKS RAY
Y	YANKEE	YANG KEY
Z	ZULU	ZOO LOO

PROWORDS

Prowords (procedure words) are the radiotelephone equivalents of prosigns. They are words and phrases that have predetermined meanings, and are used to expedite message handling on radiotelephone circuits. Many prowords and prosigns have exactly the same meaning. They also are used in the same manner.

A list of prowords together with an explanation of each and the corresponding prosign (if one exists), is given in table 8-1. Learn them now, because they will be used often. Precedence of a radiotelephone message is indicated by the actual word(s) of the precedence. (Example: PRIORITY, IMMEDIATE, and so on.)

RADIOTELEPHONE MESSAGES

Radiotelephone uses a 16-line message format that is comparable to formats in teletypewriter communications. It also has the same three military message forms: plaindress, abbreviated plaindress, and codress. By far the most common message form in radiotelephone traffic is the abbreviated plaindress. Often it is so abbreviated that its resemblance to the basic message format is barely detectable. The three major message parts are still there: heading, text, and ending.

Table 8-2 shows the correct arrangement of a radiotelephone message. All the parts, components, elements, or contents are not necessarily included in any one message. When one of them is used, it must be placed in the message in the order in which it appears in the table.

HEADING

The heading of a radiotelephone message may include any or all of the first 10 procedural lines shown in table 8-2. More often than not, though, it includes only the call, preceding the text. One explanation for such general use of the abbreviated form is that radiotelephone

Table 8-1.—Radiotelephone Prowords

Proword	Explanation	Proword Equivalent
ADDRESS GROUP	The group that follows is an address group.	
ALL AFTER	The portion of the message to which I have reference is all which follows ________________.	AA
ALL BEFORE	The portion of the message to which I have reference is all that precedes __________.	AB
AUTHENTICATE	The station called is to reply to the challenge which follows.	
AUTHENTICATION IS	The transmission authentication of this message is ___________.	
BREAK	I hereby indicate the separation of the text from other portions of the message.	BT
CALL SIGN	The group that follows is a call sign.	
CORRECT	You are correct, or what you have transmitted is correct.	C
CORRECTION	An error has been made in this transmission. Transmission will continue with the last word correctly transmitted.	EEEEEEEE
	An error has been made in this transmission (or message indicated). The correct version is ____________.	C
	That which follows is corrected version in answer to your request for verification.	C
DISREGARD THIS TRANSMISSION-OUT	This transmission is in error. Disregard it. This proword shall not be used to cancel any message that has been completely transmitted and for which receipt or acknowledgment has been received.	EEEEEEEE $\overline{\text{AR}}$
DO NOT ANSWER	Stations called are not to answer this call, receipt for this message, or otherwise to transmit in connection with this transmission. When this proword is employed, the transmission shall be ended with the proword "OUT."	F
EXECUTE	Carry out the purport of the message or signal to which this applies. To be used only with the Executive Method.	$\overline{\text{IX}}$ (5 sec dash)
EXECUTE TO FOLLOW	Action on the message or signal which follows is to be carried out upon receipt of the proword "EXECUTE." To be used only with the Delayed Executive Method.	$\overline{\text{IX}}$
EXEMPT	The addressees immediately following are exempted from the collective call.	XMT
FIGURES	Numerals or numbers follow.	
FLASH	Precedence FLASH.	Z
FROM	The originator of this message is indicated by the address designator immediately following.	FM
GROUPS	This message contains the number of groups indicated by the numeral following.	GR
GROUP NO COUNT	The groups in this message have not been counted.	GRNC
I AUTHENTICATE	The group that follows is the reply to your challenge to authenticate.	
IMMEDIATE	Precedence IMMEDIATE.	O
IMMEDIATE EXECUTE	Action on the message or signal following is to be carried out on receipt of the word EXECUTE. To be used only with the Immediate Executive Method.	$\overline{\text{IX}}$
INFO	The addressees immediately following are addressed for information.	INFO
I READ BACK	The following is my response to your instruction to read back.	
I SAY AGAIN	I am repeating transmission or portion indicated.	$\overline{\text{IMI}}$
I SPELL	I shall spell the next word phonetically.	
I VERIFY	That which follows has been verified at your request and is repeated. To be used only as a reply to VERIFY.	
MESSAGE	A message which requires recording is about to follow. Transmitted immediately after the call. (This proword is not used on nets primarily employed for conveying messages. It is intended for use when messages are passed on tactical or reporting nets.)	

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Table 8-1.—Radiotelephone Prowords—Continued

Proword	Explanation	Proword Equivalent
NET NOW	All stations are to net their radios on the unmodulated carrier wave which I am about to transmit.	
NUMBER	Station Serial Number.	NR
OUT	This is the end of my transmission to you and no answer is required or expected.	
OVER	This is the end of my transmission to you and a response is necessary. Go ahead; transmit.	K
PRIORITY	Precedence PRIORITY.	P
READ BACK	Repeat this entire transmission back to me exactly as received.	G
REBROADCAST YOUR NET	Link the two nets under your control for automatic rebroadcast.	
RELAY (TO)	Transmit this message to all addressees immediately following.	T
ROGER	I have received your last transmission satisfactorily.	R
ROUTINE	Precedence ROUTINE.	R
SAY AGAIN	Repeat all of your last transmission. Followed by identification data means "Repeat ___________(portion indicated)."	
SERVICE	The message that follows is a service message.	SVC
SIGNALS	The groups which follow are taken from a signal book. (This proword is not used on nets primarily employed for conveying signals. It is intended for use when tactical signals are passed on nontactical nets.)	
SILENCE (Repeated three or more times)	Cease transmissions on this net immediately. Silence will be maintained until lifted. (When an authentication system is in force the transmission imposing silence is to be authenticated.)	$\overline{\text{HM}}$ $\overline{\text{HM}}$ $\overline{\text{HM}}$
SILENCE LIFTED	Silence is lifted. (When an authentication system is in force the transmission lifting silence is to be authenticated.)	
SPEAK SLOWER	Your transmission is at too fast a speed. Reduce speed of transmission.	
STOP REBROADCASTING	Cut the automatic link between the two nets that are being rebroadcast and revert to normal working.	
THIS IS	This transmission is from the station whose designator immediately follows.	DE
TIME	That which immediately follows is the time or date-time group of the message.	
TO	The addressees immediately following are addressed for action.	TO
UNKNOWN STATION	The identity of the station with whom I am attempting to establish communication is unknown.	$\overline{\text{AA}}$
VERIFY	Verify entire message (or portion indicated) with the originator and send correct version. To be used only at the discretion of or by the addressee to which the questioned message was directed.	J
WAIT	I must pause for a few seconds.	$\overline{\text{AS}}$
WAIT-OUT	I must pause longer than a few seconds.	$\overline{\text{AS}}$ $\overline{\text{AR}}$
WILCO	I have received your signal, understand it, and will comply. To be used only by the addressee. Since the meaning of ROGER is included in that of WILCO, the two prowords are never used together.	
WORD AFTER	The word of the message to which I have reference is that which follows _________.	WA
WORD BEFORE	The word of the message to which I have reference is that which precedes ___________________________.	WB
WORDS TWICE	Communication is difficult. Transmit(ting) each phrase (or each code group) twice. This proword may be used as an order, request, or as information.	
WRONG	Your last transmission was incorrect. The correct version is______.	

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Table 8-2.—Radiotelephone Message Format

Parts	Components	Elements	Format Line	Contents
HEADING	Procedure		1	(Not used in radiotelephone.)
		a. Call	2 and 3	Station(s) called (proword EXEMPT, exempted calls). Proword THIS IS and station calling.
		b. Message follows		Proword MESSAGE.
		c. Transmission identification		Proword NUMBER and station serial number.
		d. Transmission instructions	4	Prowords RELAY TO; READ BACK; DO NOT ANSWER; words twice. Operation signals; call signs; address groups; address indicating groups; plain language designator.
	Preamble	a. Precedence; date-time group; message instructions	5	Precedence designation. Proword TIME; date and time expressed in digits and zone suffix; operating signals.
	Address	a. Originator's sign; originator	6	Proword FROM; originator's address designator.
		b. Action addressee sign; action addressee	7	Proword TO; action addressee designator.
		c. Information addressee sign; information addressee	8	Proword INFO; information addressee designator.
		d. Exempted addressee sign; exempted addressee	9	Proword EXEMPT; exempted addressee designator.
	Prefix	a. Accounting information; group count; SVC	10	Accounting symbol; group count; proword SERVICE.
SEPARATION			11	Proword BREAK.
TEXT	Text	a. Subject matter	12	Internal instructions; thought or idea as expressed by the originator.
SEPARATION			13	Proword BREAK.
ENDING	Procedure	a. Time group	14	Proword TIME. Hours and minutes expressed in digits and zone suffix, when appropriate.
		b. Final instructions	15	Prowords WAIT, CORRECTION, AUTHENTICATION IS; station designators.
		c. Ending sign	16	Prowords OVER; OUT.

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communication nearly always is conducted with the station originating and the station addressed in direct communication.

TEXT

The text of the radiotelephone message is the basic thought or idea the originator wishes to communicate. It may be in the form of plain language, code words, cipher groups, or numerals.

Difficult words or groups within the text of a plain language message are spelled out in the phonetic alphabet. Groups or words to be spelled are preceded by the proword I SPELL. If the operator can pronounce the word, he should do so before and after spelling it.

Abbreviations in the Text

Dates within the text should be spoken digit by digit and the month spoken in full.

Example:

"19 Sep" is spoken as "One niner September."

Initials used alone or in conjunction with short titles shall be spoken phonetically.

Example:

"ACP" shall be spoken phonetically as "Alfa Charlie Papa."

Personal initials shall be spoken phonetically prefixed by the word "INITIALS."

Example:

"G. M. SMITH" shall be spoken as "INITIALS Golf Mike Smith."

Abbreviations frequently used in normal speech may be used in the same manner when transmitted by voice.

Example:

"USS Forrestal" may be spoken as "USS Forrestal."

ENDING

Every radiotelephone message ends with the proword OVER or OUT. With OVER, the sender tells the receiver to go ahead and transmit, or "This is the end of my transmission to you and a response is necessary." With the proword OUT, the sender tells the receiver: "This is the end of my transmission to you, and no response is required." These two ending prowords never are used together.

CODE AND CIPHER MESSAGES

Code words (such as LIBRA in the text EXECUTE PLAN LIBRA) are sent as plain language words. Encrypted groups such as BAXTO are spelled phonetically: BRAVO ALFA XRAY TANGO OSCAR.

The phonetic alphabet is applied not only to letters of the alphabet, but also to the names of the signal flags. Flag A is ALFA, flag B is BRAVO, and so on. Signal flags are combined into code groups that have meanings of their own. ECHO KILO TWO, for example, might mean "anchor is dragging." Meanings of such code groups are given in appropriate signal publications.

It may sound strange to a Radioman that flag signals are sent by radiotelephone, but they are; this procedure happens often. A Radioman must be able to recognize whether he is hearing a flag signal or a word or group spelled phonetically. Here is how to differentiate: If the phonetic alphabet is used, the proword I SPELL precedes it, and each phonetic letter is to be recorded as a letter. If you hear I SPELL, followed by DELTA OSCAR, write it as DO.

On administrative nets the proword "SIGNALS" followed by DELTA OSCAR means the groups have been taken from a signal book and should be recorded as such. On nets primarily employed for conveying signals, no prowords will be used and it may be assumed that alphabet flags are intended.

OPERATIONAL BREVITY CODE

A radiotelephone operator's duties require that he know and use correctly the special "language" developed for tactical maneuvering, air control, anti-air warfare, naval gunfire support, electronic countermeasures, antisubmarine warfare, and other specialized uses. Words, phrases, and abbreviations employed in radiotelephone for these specialized uses are called operational brevity codes.

For a complete list of operational brevity code words, refer to the effective edition of

ACP 165. That publication is divided into sections according to subject area. Major section headings, along with representative code words from each section, are presented here to acquaint RM's with the type of information contained in the publication.

Section 1—General. (Includes surveillance, warning, reporting, aircraft control, airborne early warning, search and rescue, and electronic readiness conditions and duties.)

ABORT(ING): Cancel mission. I am (or contact designated) unable to continue mission.
BOGEY: An air contact that is unidentified but assumed to be enemy.
CHICKS: Friendly fighter aircraft.
SKUNK: A surface contact that is unidentified but assumed to be enemy.
YELLOW JACKET: Survivor in the sea wearing a lifejacket.

Section 2—Anti-air warfare coordination.

GUNS/WEAPONS FREE: Fire may be opened on all aircraft not recognized as friendly.
WARNING RED: Attack by hostile aircraft is imminent.

Section 3—Carrier deck conditions and flight operations.

ASSUME DECK: Carrier prepare deck for possible emergency landing of aircraft as soon as possible.
SLINGSHOT: Launch by catapult.

Section 4—Aircraft conditions of readiness and missions.

AUTOCAT: Automatic relay plane (radio).
SHECAT: Mine-laying plane.

Section 5—Undersea warfare.

BROTHER: Attack ship of surface ASW unit.
COLD: A/S contact has been lost.
SINKER: A radar contact that later disappeared.
SPOOK: Unidentified surface contact that is possibly an enemy submarine.
WOLF: Visually identified enemy submarine.

Section 6—Small surface craft control and direction.

BULLY: Concentrate attack on my target or target designated.

Section 7—Minesweeping operations.

DAISY: Moored mine.

Section 8—Electronic warfare.

CHATTER: Communications jamming.
HOOTER: Jammer.
SCRUB: Erase the contact designated from all plots.

The final section of ACP 165 is an alphabetical decode listing of the code words.

One must understand that words and phrases of the brevity code provide no communication security. The purposes of the codes are to (1) standardize the vocabulary, (2) increase accuracy of transmission, and (3) shorten transmission time.

RADIOTELEPHONE CALL SIGNS

Call signs employed in radiotelephone are more commonly known as voice call signs. They consist of spoken words, which can be transmitted and understood more rapidly and more effectively than actual names of ships and afloat commands, or phonetic equivalents of international radio call signs. Under certain circumstances, however, the phonetically spelled international call sign is used in radiotelephone for station identification. At other times a ship's name serves as the call sign. These usages are explained in later paragraphs. First, consider the voice call signs contained in the JANAP 119 series.

JANAP 119 VOICE CALLS

Voice call signs in JANAP 119 are pronounceable words taken from the English language. They are for tactical use, and are designed to facilitate speed on tactical radio circuits. These voice call signs, when assigned to specific units or activities, do not provide security of address. Secure voice call signs can only be achieved by a conscientiously applied system for changing call signs on a frequent and periodic basis.

CALL SIGNS ON LOCAL HARBOR CIRCUITS

Administrative shore activities are not assigned voice call signs in JANAP 119. Consequently, a ship cannot use her tactical voice call sign on administrative ship-shore circuits. When operating on ship-shore radiotelephone circuits, ships may use their international call signs, spoken phonetically. Example: International call sign NHDY is spoken NOVEMBER HOTEL DELTA YANKEE. They may also use the more simplified procedure as outlined in the next paragraph.

In U. S. ports and U. S.-controlled ports overseas, names of ships and abbreviations of administrative activity titles serve as voice call signs. As a general rule, the USS prefix, hull designations and numbers, and first names or initials of ships need not be included in the voice call unless they are essential for clarity. Even when essential for clarity, it is unnecessary to use the phonetic equivalents for letters and initials.

Port authorities controlling local harbor voice circuits are identified by the word CONTROL. On local harbor circuits established for specific purposes, such as for deguassing, tug, and shipyard services, CONTROL is preceded by the appropriate word describing the service.

The following examples illustrate the simplified voice call procedure. (Words in parenthese in the examples should not be used unless essential for clarity or to avoid confustion. Portions of examples marked with an asterisk (*) are spoken without phonetics.)

(NORFOLK) CONTROL THIS IS (*USS) ROANOKE
COMDESRON TWELVE THIS IS (NORFOLK) DEGAUSSING CONTROL
(NEWPORT) CONTROL THIS IS (*TJ) GARY
(PORTSMOUTH) SHIPYARD CONTROL THIS IS (*USS) FORRESTAL
(FRANKLIN *D) ROOSEVELT THIS IS (CHARLESTON) CONTROL
(NEW YORK) TUG CONTROL THIS IS *LSM ONE SIX ZERO
(NORFOLK) FUEL CONTROL THIS IS (*USNS) PECOS

Remember that the simplified type of call is authorized only in U. S. ports or U. S.-controlled ports. If a ship is in a port that is not under U. S. control, she must conform to the international practice of using phoneticized international call signs on radiotelephone circuits.

RADIOTELEPHONE PROCEDURE

A radiotelephone circuit would soon become confusing if everyone on the circuit failed to follow the same rules and procedures. The remainder of this chapter is devoted to proper operating procedures applicable to radiotelephone communication.

Examples of radiotelephone transmission are assumed to pass over the net shown in figure 8-1. Dashes in the examples indicate natural pauses.

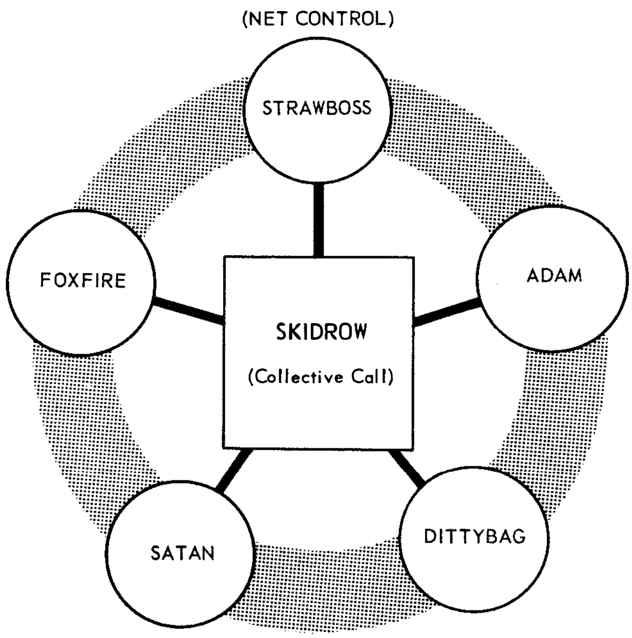

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Figure 8-1.—Radiotelephone net.

CALLING AND ANSWERING

Radiotelephone communication is established by a preliminary call and the answer thereto. A preliminary call may be made to individual station(s) or to a group of stations collectively. A reply to a preliminary call may be abbreviated in certain instances.

Single Call

A single call takes the following form:

FOXFIRE	Call sign of station called.
THIS IS	From.
STRAWBOSS . . .	Call sign of station calling.
OVER	Go ahead: transmit.

The reply is in the same form: STRAWBOSS—THIS IS FOXFIRE—OVER. In this instance a single station was called. If two or more stations were called, they would reply in alphabetical order of call signs.

Collective Call

When stations on the net are assigned a collective call, the collective call is used if all stations are addressed. When necessary, the collective call contains the proword EXEMPT, followed by the call sign of station(s) exempted from the collective call. Example:

SKIDROW	Net call.
EXEMPT	Exempt.
DITTYBAG	Call sign of exempted station.
THIS IS	From.
STRAWBOSS . . .	Call sign of station calling.
OVER	Go ahead; transmit.

ADAM, FOXFIRE, and SATAN now answer in alphabetical order of call signs.

Abbreviated Call

The call sign of the called station may be omitted when the call is part of an exchange of transmissions between stations and when no confusion is likely to result. For example, FOXFIRE and SATAN receive a preliminary call from STRAWBOSS and reply:

THIS IS FOXFIRE — OVER

THIS IS SATAN — OVER

CLEARING TRAFFIC

With communication established, STRAWBOSS commences clearing traffic. Transmission and their meanings are given in the accompanying list.

TRANSMISSION

FOXFIRE	Call signs of receiving stations.
SATAN.	
THIS IS	From.
STRAWBOSS	Call sign of sending station.
MESSAGE.	A message that requires recording is about to follow.
ROUTINE	Precedence.
TIME.	Time of origin is___.
ONE TWO ONE SIX FIVE NINE ZULU	DTG
FROM	Originator of this message is_______.
STRAWBOSS	Call sign of originator.
TO	Action addressee is_______________.
SATAN.	Call sign of action addressee.
INFO	Information addressee is_______.
FOXFIRE	Call sign of information addressee.
GROUPS EIGHT.	Group count.
BREAK	Separation of text from other portions of message.

UNCLASS GO ALONGSIDE FOXFIRE AND EFFECT PERSONNEL

TRANSFER.	Thought or idea conveyed by message.
BREAK	Separation of text from other portions of message.
OVER	Go ahead: transmit.

On hearing the proword OVER, receiving stations check the message to see that it was received fully and correctly. When assured that it was, they receipt by sending the proword ROGER, which means "I received your last transmission satisfactorily." Example:

THIS IS FOXFIRE—ROGER—OUT

THIS IS SATAN—ROGER—OUT

REPETITIONS

When words are missing or are doubtful, repetition is requested by the receiving station. The proword SAY AGAIN (along or with ALL BEFORE, ALL AFTER, WORD BEFORE, WORD AFTER, and TO) is for this purpose. In complying with such requests, the transmitting station identifies the portion to be repeated. EXAMPLES: DITTYBAG sent a message to SATAN. SATAN missed the word after "ship."

SATAN transmits:

DITTYBAG—THIS IS SATAN—SAY AGAIN—WORD AFTER SHIP—OVER

DITTYBAG replies with:

SATAN—THIS IS DITTYBAG—I SAY AGAIN—WORD AFTER SHIP—SIGHTED—OVER

After receiving the doubtful portion,

DITTYBAG receipts for the entire message.

Repetitions may be given in plain language messages by natural phrases or by individual words. In encoded or encrypted messages, they are made by individual characters.

CORRECTING ERRORS

When an error is made by a transmitting operator, the proword CORRECTION is sent. The operator then repeats the last word, group, proword, or phrase correctly sent, corrects the error, and proceeds with the message. Example:

ADAM—THIS IS STRAWBOSS—TIME ONE ZERO ONE TWO ZULU—BREAK—UNCLAS—CONVOY ROMEO THREE—CORRECTION—CONVOY SIERRA ROMEO THREE—SHOULD ARRIVE—ONE SIX THREE ZERO LIMA—OVER

If the error is not discovered until the operator is some distance beyond it, he may make the correction at the end of the message. He must be careful to identify the exact position he is correcting. Example:

ADAM—THIS IS STRAWBOSS—TIME ZERO SIX THREE ZERO ZULU—BREAK—UNCLAS—ARE YOU RIGGED FOR HEAVY WEATHER—BREAK—CORRECTION—TIME ZERO SIX FOUR ZERO ZULU—OVER.

CANCELING MESSAGE DURING TRANSMISSION

During transmission of a message and before transmitting the ending proword OVER or OUT, the message may be canceled by sending the proword DISREGARD THIS TRANSMISSION—OUT. (A message already transmitted can be canceled only by another message.) During transmission of a message, for instance, STRAWBOSS discovers he is giving it to the wrong station:

FOXFIRE—THIS IS STRAWBOSS—ROUTIME—TIME ONE TWO ZERO SIX ZERO TWO ZULU—UNCLAS—COMMENCE UNLOADING AT DAWN SIXTEENTH—PROCEED—DISREGARD THIS TRANSMISSION—OUT

DO NOT ANSWER

When it is imperative that called stations do not answer a transmission, the proword DO NOT ANSWER is transmitted immediately after the call or the proword MESSAGE (if used). The complete transmission is sent twice. Example:

SKIDROW—THIS IS STRAWBOSS—DO NOT ANSWER—

IMMEDIATE—TIME ONE SIX THREE ZERO ZULU—BREAK—NOVEMBER YANKEE DELTA PAPA—I SAY AGAIN—SKIDROW—THIS IS STRAWBOSS—DO NOT ANSWER—IMMEDIATE—TIME ONE SIX THREE ZERO ZULU—BREAK—NOVEMBER YANKEE DELTA PAPA—OUT

VERIFICATIONS

When verification of a message is requested, the originating station verifies the message with the originating person, checks the cryptography (if the message is encrypted), and sends the correct version.

- Example 1:

  STRAWBOSS—THIS IS ADAM—VERIFY YOUR ONE ZERO ZERO EIGHT ZERO ONE ZULU—ALL BEFORE BREAK—OVER

STRAWBOSS transmits:

  THIS IS STRAWBOSS—ROGER—OUT

After checking with the originating officer, STRAWBOSS finds the heading correct as transmitted previously, He then sends:

  ADAM—THIS IS STRAWBOSS—I VERIFY—MY ONE ZERO ZERO EIGHT ZERO ONE ZULU—ALL BEFORE BREAK—PRIORITY—TIME ONE ZERO ZERO EIGHT ZERO ONE ZULU—FROM—STRAWBOSS—TO—ADAM—INFO—DITTYBAG—GROUPS ONE SEVEN—BREAK—OVER

ADAM receipts for the transmission:

  THIS IS ADAM—ROGER—OUT

- Example 2:

  STRAWBOSS—THIS IS SATAN—VERIFY YOUR ZERO EIGHT FOUR FIVE ZULU—WORD AFTER PROCEED—OVER

STRAWBOSS transmits:

  THIS IS STRAWBOSS—ROGER—OUT

After checking with the originating officer, STRAWBOSS finds that he means HONGKONG instead of SHANGHAI as the word after PROCEED. STRAWBOSS transmits:

  SATAN—THIS IS STRAWBOSS—CORRECTION—MY ZERO EIGHT FOUR FIVE ZULU—WORD AFTER PROCEED—HONGKONG—OVER

SATAN receipts:

  THIS IS SATAN—ROGER—OUT

READ BACK AND
WORDS TWICE

Further checks on transmission accuracy can be made by the prowords READ BACK and WORDS TWICE. READ BACK is sent when a sender wants his message (or a portion of it) repeated back to him as received. Remember to identify the message or portion to be read back. Transmit the READ BACK proword immediately after the call or the proword MESSAGE FOLLOWS if used. Example:

  ADAM—THIS IS STRAWBOSS—READ BACK TEXT—TIME ONE SIX THREE ZERO ZULU—BREAK—UNCLAS—CONVOY DELAYED ONE TWO HOURS—BREAK—OVER

ADAM replies:

  THIS IS ADAM—I READ BACK TEXT—UNCLAS—CONVOY DELAYED ONE TWO HOURS—OVER

STRAWBOSS then sends:

  THIS IS STRAWBOSS—THAT IS CORRECT—OUT

  NOTE: When READ BACK is employed, the proword ROGER is not necessary to indicate receipt of the message.

If a message is repeated back incorrectly, it may be corrected by sending the proword WRONG, fellowed by the correct version. In the foregoing example, assume that ADAM made a mistake when he read back the message.

  THIS IS ADAM—I READ BACK TEXT—UNCLAS—CONVOY DELAYED TWO ONE HOURS—OVER

STRAWBOSS CORRECTS ADAM:

  THIS IS STRAWBOSS—WRONG—UNCLAS—CONVOY DELAYED ONE TWO HOURS—OVER

ADAM reads back again:

  THIS IS ADAM—UNCLAS—CONVOY DELAYED ONE TWO HOURS—OVER

STRAWBOSS ends the exchange with:

THIS IS STRAWBOSS—THAT IS CORRECT—OUT

WORDS TWICE is the proword used when communication is difficult. First, the call signs are transmitted twice. Then phrases, words, or groups are spoken twice. Indicate intentions by transmitting WORDS TWICE after the call or the proword MESSAGE, if used. Do not repeat the proword THIS IS. Example:

FOXFIRE—FOXFIRE—THIS IS STRAWBOSS—STRAWBOSS—OVER

FOXFIRE replies:

STRAWBOSS—STRAWBOSS—THIS IS FOXFIRE—FOXFIRE—OVER

STRAWBOSS sends his message:

FOXFIRE—FOXFIRE—THIS IS STRAWBOSS—STRAWBOSS—WORDS TWICE—WORDS TWICE—ROUTINE—ROUTINE—TIME ONE TWO ONE SIX THREE ZERO ZULU—TIME ONE TWO ONE SIX THREE ZERO ZULU—BREAK—BREAK—UNCLAS—UNCLAS—MAIL FOR YOU—MAIL FOR YOU—RECEIVE AT FIRST LIGHT—RECEIVE AT FIRST LIGHT—BREAK—BREAK--OVER

FOXFIRE receipts:

STRAWBOSS—STRAWBOSS—THIS IS FOXFIRE—FOXFIRE—ROGER—ROGER—OUT

EXECUTIVE METHOD

The executive method of transmitting radiotelephone messages is employed to execute tactical signals when two or more units are to take action at the same time. Executive method messages usually are in abbreviated form and contain the proword EXECUTE TO FOLLOW or IMMEDIATE EXECUTE, whichever is applicable, immediately after the call. The signal to carry out the meaning of the message is the proword EXECUTE. It may be sent shortly after transmission of the message (normal executive method), much later (delayed executive method), or if urgent, as a part of the final instructions of the message itself (immediate executive method). In any event, a warning STANDBY precedes the proword EXECUTE. Three examples of sending executive method messages follow.

1. In the first example the OTC sends a message to the task group by the normal executive method.

SKIDROW—THIS IS STRAWBOSS—

EXECUTE TO FOLLOW—BREAK—CORPEN THREE FIVE SEVEN—OVER

All ships reply in alphabetical order:

THIS IS ADAM—ROGER—OUT

THIS IS DITTYBAG—ROGER—OUT

THIS IS FOXFIRE—ROGER—OUT

THIS IS SATAN—ROGER—OUT

When STRAWBOSS is ready to execute, he sends the executive signal. To save time, only one station (ADAM) is to receipt.

SKIDROW—THIS IS STRAWBOSS—STANDBY—EXECUTE—BREAK—ADAM—OVER

ADAM replies:

THIS IS ADAM—ROGER—OUT

2. A delayed executive method message is handled in exactly the same way as a normal executive method message except that, as a memory refresher, the text of the message is repeated just before giving STANDBY—EXECUTE. Assume that the foregoing message is sent by the delayed executive method. The message is transmitted, and all stations receipt for it as before. But this time STRAWBOSS is not ready to execute until several minutes relapse. When ready, he sends:

SKIDROW—THIS IS STRAWBOSS—CORPEN THREE FIVE SEVEN--STANDBY—EXECUTE—BREAK—ADAM—OVER

ADAM replies:

THIS IS ADAM—ROGER—OUT

In the immediate executive method, the text of the message is transmitted twice, separated by I SAY AGAIN. The warning proword IMMEDIATE EXECUTE replaces the proword EXECUTIVE TO FOLLOW in the message instructions. The executive signal itself is in the final instructions of the message. Because only one transmission is made, the immediate executive method message does not allow stations to obtain verifications, repetitions, acknowledgments, and/or cancellations before the message is executed. Example:

SKIDROW—THIS IS STRAWBOSS—

IMMEDIATE EXECUTE—BREAK—TURN NINE—I SAY AGAIN—TURN NINE—STANDBY-EXECUTE—BREAK-SATAN—OVER

SATAN receipts:

THIS IS SATAN—ROGER—OUT

ACKNOWLEDGMENT

An acknowledgment is a reply from an addressee indicating that he received a certain message, understands it, and can comply with it. Note the difference between an acknowledgment and a receipt. The receipt means only that the message was received satisfactorily. Remember that only the commanding officer or his authorized representative can authorize communications personnel to send an acknowledgment.

A request for acknowledgment is the word acknowledge (not a proword) as the final word of the text. The reply is the proword WILCO. If the commanding officer can acknowledge at once, the operator may receipt for the message with WILCO, because the meaning of ROGER is contained in WILCO. If the acknowledgment cannot be returned immediately, the operator receipts for the message with ROGER, and WILCO is sent later. The return transmission to a request for an acknowledgment is either ROGER or WILCO—never both.

In the following example, the OTC sends a tactical signal. He desires acknowledgment from two ships.

SKIDROW—THIS IS STRAWBOSS

EXECUTE TO FOLLOW—BREAK—TANGO BRAND—TACK—ONE FIVE—TACK—ZERO ZERO ZERO—TACK—ONE TWO—FOXFIRE—DITTYBAG—ACKNOWLEDGE—OVER

The commanding officer of FOXFIRE wishes to consider the message before acknowledging. His operator transmits:

THIS IS FOXFIRE—ROGER—OUT

The commanding officer of DITTYBAG heard the message, understands it, and can comply. He directs his operator to acknowledge:

THIS IS DITTYBAG—WILCO—OUT

When the commanding officer of FOXFIRE is ready to acknowledge, he has two choices of reply.

STRAWBOSS—THIS IS FOXFIRE—WILCO—YOUR LAST TRANSMISSION—OUT

STRAWBOSS—THIS IS FOXFIRE—WILCO—YOUR EXECUTE TO FOLLOW—WILCO—TANGO BRAVO—TACK—ONE FIVE—TACK—ZERO ZERO ZERO—TACK—ONE TWO—OUT

When ready to execute the signals, the OTC transmits:

SKIDROW-THIS IS STRAWBOSS-STANDBY—EXECUTE—ADAM—OVER

ADAM receipts as directed:

THIS IS ADAM—ROGER—OUT

RELAY

The proword RELAY indicates that the station called is to relay the message to all addressees. Example:

FOXFIRE—THIS IS STRAWBOSS—RELAY—PRIORITY—TIME ZERO NINE ONE ZERO ZULU—FROM—STRAWBOSS—TO ADAM—BREAK—UNCLAS—REPORT NUMBER ROUNDS EXPENDED LAST RUN—BREAK—OVER

After FOXFIRE receipts for the message, he relays it to the action addressee:

ADAM—THIS IS FOXFIRE—PRIORITY—TIME ZERO NINE ONE ZERO ZULU—FROM—STRAWBOSS—TO—ADAM—BREAK—UNCLAS—REPORT NUMBER ROUNDS EXPENDED LAST RUN—BREAK—OVER

The proword RELAY TO, followed by an addressee, means that the station called is to relay the message to the station indicated. When more than one station is called, the call sign of the station to relay precedes the proword RELAY TO. Example:

DITTYBAG—SATAN—THIS IS STRAWBOSS—MESSAGE FOLLOWS—SATAN—RELAY TO FOXFIRE—ROUTINE—TIME ZERO ONE TWO TWO ZULU—FROM—STRAWBOSS—TO—FOXFIRE—INFO—DITTYBAG—SATAN—BREAK—UNCLAS—PROCEED ON MISSION ASSIGNED—BREAK—OVER

SATAN receipts and relays as instructed:

FOXFIRE—THIS IS SATAN—MESSAGE ROUTINE—TIME ZERO ONE TWO TWO ZULU—FROM—STRAWBOSS—TO—FOXFIRE—INFO—DITTYBAG—SATAN—BREAK—UNCLAS—PROCEED ON MISSION ASSIGNED—BREAK—OVER

Occasionally, it is necessary to relay by radiotelephone a message received by some other means of communication. In the final example, NOLT (FOXFIRE) receives a radiotelegraph message from NAAT (STRAWBOSS) for relay to NRTK (DITTYBAG):

NOLT DE NAAT-T-P-241632Z AUG 71 FM NAAT-TO NRTK GR4 BT UNCLAS RETURN TO BASE BT K

FOXFIRE places the message in radiotelephone form and relays:

DITTYBAG—THIS IS FOXFIRE—MESSAGE—PRIORITY—TIME TWO FOUR ONE SIX THREE TWO ZULU—FROM—STRAWBOSS—TO—DITTYBAG—GROUPS FOUR—BREAK—UNCLAS—RETURN TO BASE—BREAK—OVER

OPENING A NET

Procedures described here are either for opening a net for the first time or for reopening a net secured temporarily. Procedures for both free and directed nets are described.

Free Net

In the following example, STRAWBOSS opens a free net by transmitting:

SKIDROW (a collective call) answers in alphabetical order of stations:

(STRAWBOSS)—THIS IS ADAM—OVER
(STRAWBOSS)—THIS IS DITTYBAG—OVER
(STRAWBOSS)—THIS IS FOXFIRE—OVER
(STRAWBOSS)—THIS IS SATAN—OVER

STRAWBOSS then calls the net and informs all stations that their transmissions were heard:

(SKIDROW)—THIS IS STRAWBOSS—OUT (or proceeds with message).

NOTE: Words in parentheses may be omitted if communications are good.

If a station does not reply to a toll call within 5 seconds, the next station answers. The delinquent station then answers last, if able to do so. If the station is having difficulty and is unable to answer the call, the operator reports in to the net when he can. In the preceding example, assume FOXFIRE had equipment failure and could not answer. SATAN waits 5 seconds and answers as usual. When FOXFIRE is able to transmit, he calls STRAWBOSS:

STRAWBOSS—THIS IS FOXFIRE—REPORTING IN TO NET—OVER

STRAWBOSS replies:

THIS IS STRAWBOSS—ROGER—OUT

Directed Net

In the next example, STRAWBOSS calls member stations and announces that the net is directed. He requests the precedence and addressees of traffic to be transmitted.

SKIDROW—THIS IS STRAWBOSS—THIS IS A DIRECTED NET—OF WHAT PRECEDENCE—AND FOR WHOM—ARE YOUR MESSAGES—OVER

SKIDROW replies, each station indicating the traffic on hand:

(STRAWBOSS—THIS IS ADAM—I HAVE ONE IMMEDIATE AND ONE ROUTINE FOR YOU—OVER
(STRAWBOSS)—THIS IS DITTYBAG—NO TRAFFIC—OVER
(STRAWBOSS)—THIS IS FOXFIRE—I HAVE ONE PRIORITY FOR DITTYBAG—OVER
(STRAWBOSS)—THIS IS SATAN—NO TRAFFIC—OVER

NOTE: Words in parentheses may be omitted if communications are good.

STRAWBOSS informs all stations that their transmissions were received, and commences to clear traffic in order of precedence:

SKIDROW—THIS IS STRAWBOSS—ROGER—ADAM—SEND YOUR IMMEDIATE—OVER

When ADAM transmits, and obtains a receipt for his message, net control gives the station with next highest precedence message permission to transmit.

FOXFIRE—THIS IS STRAWBOSS—SEND YOUR PRIORITY—OUT. DITTYBAG, hearing the authorization, tells FOXFIRE TO GO AHEAD. This procedure saves FOXFIRE the trouble of making a preliminary call.

THIS IS DITTYBAG—OVER
FOXFIRE goes ahead with his message at once.

DITTYBAG—THIS IS FOXFIRE—MESSAGE—(ETC.)

When STRAWBOSS hears the proword OUT that ends the exchange between DITTYBAG and FOXFIRE, he directs ADAM to send the ROUTINE that still is outstanding.

As operators are handed messages to be sent out, they call net control and request permission to transmit. SATAN, for example, has a ROUTINE for ADAM:

STRAWBOSS—THIS IS SATAN—I HAVE ONE ROUTINE FOR ADAM—OVER

STRAWBOSS replies (assuming no other station wishes to send a message of higher precedence):

THIS IS STRAWBOSS—SEND YOUR MESSAGE—OUT. SATAN then sends his message. If, however, higher precedence traffic awaits transmission, STRAWBOSS sends:

THIS IS STRAWBOSS—WAIT—OUT

When traffic conditions permit, STRAWBOSS then call SATAN and gives him permission to transmit:

SATAN—THIS IS STRAWBOSS—SEND YOUR ROUTINE—OUT

ADAM answers, thereby saving a preliminary call, and SATAN clears his message.

SIGNAL STRENGTH AND READABILITY

A station is understood to have good readability unless otherwise notified. Strength of signals and readability are not exchanged unless for good reason.

When necessary to inform another station of his signal strength and readability, it is done by means of a concise report of actual reception. Examples: "Weak but readable," "Loud but distorted," "Weak with interference," and so on. Reports such as "Five by five," and "Four by four," which are derivatives of numerals used with operating signals QSA and QRK, are forbidden.

The following prowords are for the purpose of exchanging information concerning signal strength and readability. They were not included in the previous list of prowords (table 8-1), because their meanings apply only to signal strength and readability.

ROGER . . . . I have received your last transmission satisfactorily. (The omission of comment on signal strength and readability is understood to mean that reception is loud and clear.)
NOTHING HEARD . . . Used when no reply is received from a called station.
LOUD . . . . Your signal is strong, interference will not bother my copying.

GOOD	Your signal is good.
WEAK	I can hear you only with difficulty.
VERY WEAK	I can hear you only with great difficulty.
FADING	At times your signal strength fades to such an extent that continuous reception cannot be relied upon.
CLEAR	Excellent quality (readability).
READABLE	Quality good—no difficulty reading you.
UNREADABLE	The quality of your transmission is so bad that I cannot read you.
DISTORTED	Having trouble reading you.
WITH INTERFERENCE	Having trouble reading you because of interference.

To illustrate two stations exchanging information on signal strength and readability, a ship (FOXFIRE) and a plane (CATFISH ONE) establish communications as follows:

FOXFIRE—THIS IS CATFISH ONE—OVER

ROGER—OVER

THIS IS CATFISH ONE—ROGER—OUT

Had FOXFIRE not received CATFISH ONE loud and clear, the transmissions could have been:

CATFISH ONE—THIS IS FOXFIRE—WEAK BUT READABLE—OVER

THIS IS CATFISH ONE—ROGER—OUT

With communications established firmly, there is no need for further checks of the foregoing nature unless equipment difficulty or other adverse conditions develop.

Radiotelephone Logs

The radiotelephone log contains a record of all transmissions on tactical nets, command nets, and reporting nets. Modified logs may be maintained on all other radiotelephone circuits and nets. Although manual logs may be kept on certain nets for ready reference, automatic recording devices will be utilized on all radiotelephone nets/circuits requiring complete logs. Time should be automatically or manually recorded at intervals not exceeding five minutes.

AUTHENTICATION

Specific instances when a radiotelephone message must be authenticated are the same as those for a radiotelegraph message. In general, a message must be authenticated when there is any possibility that the message is of enemy origin. Be alert! Sometimes (but not always) an enemy deceptive message can be spotted by the operator's mistakes in procedure or by his mistakes in English grammar or pronunciation. Security reasons for authentication were discussed in chapter 3.

BE SECURITY CONSCIOUS

As pointed out in chapter 3 (Communication Security), radiotelephone is potentially the least secure method of radio communications. Radiomen must ever be alert to avoid disclosure of classified information when transmitting on radiotelephone circuits. This precaution applies to military voice circuits as well as to commercial circuits.

CHAPTER 9

ADMINISTRATION

MESSAGE CENTER FILES

Maintaining accurate records and observing good message-handling procedures contribute to an efficient communication organization. In this chapter you will learn what some of these records are and how they are used. Bear in mind, however, that different stations may do things in different ways. There is no "one" way to log a message, for example, nor is there just "one" message blank form. For the most part this chapter discusses those practices and procedures that have become fairly well standardized.

TYPES AND RETENTION

Every message handled by a ship or station is placed in one or more files. Some files are maintained by all ships and stations, but others are optional and are maintained only to fill the need of a particular ship or station. Figure 9-1 summarizes the types of message files maintained by all ships and stations.

Keep accurate files: The importance of well-kept files and of cooperation by the various watch sections to keep them that way cannot be stressed too much nor to often. You should be able to locate any message in 1 or 2 minutes. If you

File	Contents	Disposition
Communication Center	A copy of every message addressed to or originated by the command. Filed chronologically by DTG. Classified messages are filed by encrypted version, or by filler or dummy.	Messages incident to distress or disaster: destroy when 3 years old. Messages involved in any claim or complaint: destroy when 2 years old, or when complaint or claim is settled, if earlier. Messages of historical or continuing interest: retain. All other messages: destroy when 6 months old.
Cryptocenter	The edited plain language version of each classified message addressed to or originated by the command. Filed by DTG. This file may be subdivided as necessary, in order to comply with stowage requirements for classified matter. In effect, the cryptocenter file is the classified version of the communication center file.	Same as communication center files.
Radio Station	Radio circuit copy of each message received, addressed to, transmitted, or relayed by radio. Filed in DTG order.	Destroy when 1 month old.
Visual Station	Copy of each message received, addressed to, transmitted, or relayed by visual means.	Destroy when 1 month old.
General Message	A copy of each general message addressed to the command, segregated by type (ALNAVs, ALCOMs, NAVOPs, etc). Filed according to serial numbers.	Destroy when canceled or superseded. (Copy must be retained for communication center file.)
Broadcast	Messages received by broadcast method.	Destroy when 1 month old.

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Figure 9-1.—Summary of Message Files.

remove a message from the files temporarily, to use as a reference, return it to the proper file. Don't simply throw it in a box or basket for the "dayworkers" to take care of. Inaccurate files mean delays in processing traffic, some of which may be operational in nature and of high precedence. Large shore stations file thousands of messages monthly. Hence, it is easy to see that a misfiled message usually becomes a lost message.

When it is necessary to remove a message from a file for any reason a FILLER must be inserted in place of the message. The filler should list the TDTG, the originator of the message, information as to where the message may be located, and the personal sign of the person removing the message and completing the filler. Occassionally the subject line or subject matter of the message is indicated on the filler also. Blank fillers prepared on colored paper will reduce preparation time and the colored paper will help when refiling the message. Fillers are also used when cross-referencing the external DTG of Off-line encrypted messages.

COMMUNICATION CENTER AND CRYPTOCENTER FILES

The communication center file contains a copy of every message addressed to or originated by the command. It does not matter whether the messages were sent plain or encrypted, or by radio, visual, mail, or other means. All are filed together in DTG order. Classified messages are filed in either of two ways: in encrypted form, or by dummy or filler. A dummy or filler is a form showing only the heading of the message. The communication center file may be subdivided into incoming and outgoing sections.

Plain language translations of classified messages are stowed in the cryptocenter file. Top Secret messages are stowed separately. Messages of other classifications usually are filed together.

If the file location of a needed message is unknown, check the communication center file. If the message is unclassified, it will be found there. If the message is classified, there will be an encrypted or dummy version, indicating that the message is in the cryptocenter file.

Messages in the communication center and cryptocenter files bear the signatures or initials of the drafter, releasing officer, communication watch officer, operator, persons to whom the message was routed, and such other information as may be required by the local command.

Combined files: All the files listed in figure 9-1, except the general message files and broadcast files, may be combined for convenience of stowage, filing, and referencing. Combining these files eliminates the need for filler or dummy sheets in the communication center file referring to the cryptocenter file. Separate stowage, however, must be provided for Top Secret messages and (in most instances) special category messages.

When any or all of these files are combined, stowage and accounting requirements must conform to regulations for the highest classification of messages held in the files. All classified files must be afforded stowage and accountability in accordance with the current edition of OpNavInst 5510.1.

GENERAL MESSAGE FILE

The general message file is a record of all general messages addressed to the command. Normally, the file is subdivided by type of general message, and each type is filed in serial number order. (Types of general messages are discussed in chapter 4.)

General message files are given the security classification of the highest classified message contained in the files. For convenience of access and stowage, the files may be segregated by security classification, with appropriate cross-references, and the classified portion filed in the cryptocenter or other secure space.

BROADCAST FILE

Ships copying broadcasts are required to have complete broadcast files. Messages actually addressed to the ship are written up on message books for local delivery, and after processing, copies are placed in the communication center and radio station files. As messages are received on the broadcast, they are filed in serial number order in the broadcast file. The broadcast file usually is maintained on a monthly basis because the serial numbers run consecutively and start with number 1 the first day of each month.

When a ship moves from one broadcast area to another, it shifts the broadcast guard accordingly. As a result, more than one broadcast may be guarded during the month. A notation is made in the file showing the station from which each broadcast was received, and the inclusive serial numbers of messages from each station.

STATION FILES

The radio station file contains copies of messages handled by the command via radio. It includes a copy of each nontactical message received, transmitted, or relayed by the radio facilities of the ship or station. The copies must bear the operators' servicing endorsements. They are filed in chronological order by DTG, and the file may be combined with the communication center file.

The visual station file is a chronological record of all nontactical traffic handled by the command by visual means. It is identical in purpose and description to the radio station file.

DISPOSAL OF FILES

Stowage space often is a problem, both ashore and afloat. The larger shore communication centers solve the problem of stowage space for message files by reproducing the files on microfilm. Aboard ship, stowage space for message files nearly always is inadequate. Except for messages pertaining to distress and those of legal or historical interest, the communication center and cryptocenter files are destroyed after 6 months, as indicated in figure 9-1. About the first of July, for example, the files for Janary are destroyed. Methods of destruction, such as burning and pulping, are described in chapter 3.

Station files and Broadcast files are destroyed after 30 days. When destroying the broadcast files, a suitable broadcast circuit numbering log (figure 9-2) will serve as the required record of destruction.

General messages must be retained until they are canceled or superseded. Certain general messages (ALNAV, ALNAVSTA, ALSTACON, ALSTAOUT, NAVACT, and NAVOP) are incorporated into the Navy Directive System and are canceled by a superseding message, by a cancellation date indicated in the message test, or automatically after 90 days. Other general messages are incorporated into Registered Publication Memoranda (RPM) and Communications Security Publication Memoranda (CSPM) are considered canceled when thus published. General messages not incorporated into RPM, CSPM, or the Navy Directives System, and which remain effective at the end of the year, are listed as effective in the first general message of that series for the new calendar year.

Ships deployed on hazardous duty, and other ships specifically designated by CNO, are authorized to modify the prescribed retention periods for communications files. Part III of SECNAVINST 5212.5 refers.

COMMUNICATIONS LOGS AND RECORDS

A communication log is a continuous record of everything that happens on a communication net. There are different logs for each type of net, but basic rules governing logs apply to all types. Similarly, various supervisory logs are maintained to record the events of each watch.

It is never premissible to erase an entry in any communication log. Any necessary changes must be made by drawing a single line through the original entry and indicating the changed version next to the original entry. The operator or supervisor making the change initials all such changes. It is desirable for a log to be as neat as possible. It is absolutely necessary that all logs be complete and accurate.

SUPERVISOR LOG

The supervisors log is normally a typewritten record of all significant events occurring during the watch. The log covers an entire radio day, commencing at ØØØ1 Zulu.

Because of the permanent and official nature of the supervisors log, only standard terminology must be used for entries. The use of prescribed abbreviations in logs is permissible, and allows short concise entries, so long as the abbreviations are commonly understood. Slang expressions and operator jargon shall not be used in log entries.

Entries shall include, but shall not be limited to, statements concerning the muster of the watch, inventories, unusual circuit conditions, traffic backlogs and other significant events or difficulties encountered during the watch.

Depending upon local requirements, entries are usually made in the supervisors log at least once an hour, recapping the over-all traffic and circuit conditions.

BROADCAST CIRCUIT NUMBER LOG AND RECORD OF DESTRUCTION

Retain traffic for a period of 30 days in accordance with SECNAVINST P5212.5B SUBPARA 2100(3). After destruction, retain this sheet as a record of destruction for 2 years in accordance with ALCOMPAC 20P/63

BCST No.	CLASS	BCST No.	CLASS	BCST No.	CLASS	BCST No.	CLASS
__01	U E C S T	26	U E C S T	51	U E C S T	76	U E C S T
02	U E C S T	27	U E C S T	52	U E C S T	77	U E C S T
03	U E C S T	28	U E C S T	53	U E C S T	78	U E C S T
04	U E C S T	29	U E C S T	54	U E C S T	79	U E C S T
05	U E C S T	30	U E C S T	55	U E C S T	80	U E C S T
06	U E C S T	31	U E C S T	56	U E C S T	81	U E C S T
07	U E C S T	32	U E C S T	57	U E C S T	82	U E C S T
08	U E C S T	33	U E C S T	58	U E C S T	83	U E C S T
09	U E C S T	34	U E C S T	59	U E C S T	84	U E C S T
10	U E C S T	35	U E C S T	60	U E C S T	85	U E C S T
11	U E C S T	36	U E C S T	61	U E C S T	86	U E C S T
12	U E C S T	37	U E C S T	62	U E C S T	87	U E C S T
13	U E C S T	38	U E C S T	63	U E C S T	88	U E C S T
14	U E C S T	39	U E C S T	64	U E C S T	89	U E C S T
15	U E C S T	40	U E C S T	65	U E C S T	90	U E C S T
16	U E C S T	41	U E C S T	66	U E C S T	91	U E C S T
17	U E C S T	42	U E C S T	67	U E C S T	92	U E C S T
18	U E C S T	43	U E C S T	68	U E C S T	93	U E C S T
19	U E C S T	44	U E C S T	69	U E C S T	94	U E C S T
20	U E C S T	45	U E C S T	70	U E C S T	95	U E C S T
21	U E C S T	46	U E C S T	71	U E C S T	96	U E C S T
22	U E C S T	47	U E C S T	72	U E C S T	97	U E C S T
23	U E C S T	48	U E C S T	73	U E C S T	98	U E C S T
24	U E C S T	49	U E C S T	74	U E C S T	99	U E C S T
25	U E C S T	50	U E C S T	75	U E C S T	__00	U E C S T

Signature of individual authorizing destruction	Rank	File or Service No.

Signature of Witnessing Official	Signature of Witnessing Official

LEGEND:

U-UNCLASS E-UNCLASS/EFTO C-CONFIDENTIAL S-SECRET T-TOP SECRET

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Figure 9-2.--Broadcast Circuit Number Log and Record of Destruction.

CIRCUIT LOGS AND MONITOR ROLLS

The teletypewriter log may consist either of page copy or perforated tape. Page copy may be wound on a continuous roll, at a quality control position, or it can be cut into pages for insertion into a more accessible file, in the manner that broadcast files are usually maintained. Perforated tape is wound on a reel. The TT309 is a typical reperforator monitor. The reel type of log is inconvenient for reference, however, because of the necessity for unwinding and rewinding the reel each time it is necessary to search for a transmission.

Some stations are equipped with automatic timeclocks, which stamp the time on perforated tape and page copies of messages. At stations not equipped with automatic timeclocks, the operator must enter the time on incoming tapes or page copy at least once every 30 minutes. In addition to the time-stamping of monitor rolls every 30 minutes, many stations will record the precise time-of-receipt of each high precedence or special handling message to be printed on the monitor page copy.

Send and receive message logs are used on circuits to maintain accountability of incoming and outgoing traffic. In addition, the operator can also use the log to double-check the proper operation of the equipment numbering devices. The send and receive circuit logs are also used in the traffic checking processes.

PERSONAL SIGNS

A personal sign is a two or more letter identification, usually the man's initials, which is assigned to each man as he reports in to the division. Normally each man can select any two-letter combination not already assigned, but in the case of two men who each desire the same personal sign, the senior member has his preference.

Your personal sign is your "signature" on all logs and records and thus identifies your work. Personal signs are never transmitted over communication circuits but they are sent at the end of each transmission over order-wire circuits.

When filling out logs and records, it is essential that you BLOCK PRINT your sign—and all other information as well. Entries must be legible. One final reminder: the Commchief maintains a master list of personal signs for the division, so he must be informed whenever changes occur.

INCOMING MESSAGES

With certain exceptions, all communications traffic addressed to a station is processed through the message center. You will recognize an inverse parallel between the processing of outgoing messages and the following typical steps through which an incoming message is processed:

1. On arrival of the message in the message center, one of the communicators translates the call signs and address groups if any in the heading. The CWO checks the message and marks action and information officers. It is given to the communication clerk, who makes a smooth and as many copies as are required. These are passed back to the CWO.
2. The CWO checks the message again and gives it to the messenger, retaining at least one copy until completion of delivery.
3. The messenger delivers the traffic to action and then to information officers, who receipt by initialing the original message. The captain, executive officer, and communication officer receive copies of all messages, and for this reason often maintain file boards on which their copies are placed. At a large activity, handling a great volume of traffic, each office may have its own messenger who makes regular "pickups" at the message center; under such circumstances, initialing information copies is seldom required.
4. After distributing all copies and obtaining initials, the messenger returns the initialed original to the message center. There the CWO checks it for completeness of delivery. This master copy becomes a permanent part of the communication center file, and the circuit copy is placed in the radio station file.

INTERNAL ROUTING AFLOAT

Although the captain has the overall responsibility for taking any action required by a message, he seldom is indicated as the action officer. Customarily, a message is routed for action to the department head who has direct responsibility for the subject matter of the message. The captain (or the executive officer), receiving a copy of all messages, then ensures that the action officer takes the required action.

A message is routed for information to officers who have an indirect interest in its subject matter.

The addressees or heading of a message do not indicate who aboard is to receive the message either for action or for information. The CWO must read the test and decide who is principally responsible and who is officially interested. Some incoming messages are borderline cases; that is, more than one department must take some kind of action. The CWO must decide upon the one action officer, keeping in mind that the officer with the GREATER interest in the subject matter is routed action.

It is important that the proper number of copies of a message be made. An underrouted message may result in delay, overshadowing the inconvenience of making additional copies. The other extreme—preparing a copy for everyone who might have even a remote interest in the message—is just as bad; it would take too much time and often circulate classified information too widely.

An example of internal routing afloat may be helpful. Refer to the incoming message shown in figure 9-3. Routing has been indicated by marking the appropriate blocks on the bottom of the form (either "A" for action, or "I" for information). Table 9-1 explains the internal

NAVAL MESSAGE (SHORT FORM)
OPNAV FORM 2110-29 (10-58)
Reorder from FPSO Cog. "I" Stock Points

SECURITY CLASSIFICATION: UNCLASSIFIED

DRAFTED BY	PRECEDENCE	DATE/TIME GROUP	MESSAGE NR.
	IMMEDIATE	110403Z	31

FROM: FLEAWEACEN WASHDC

TO: ALL SHIPS COPYING THIS BROADCAST

INFO: COMEASTSEAFRON / FLEWEAFAC NORVA / FLT HURRICANE FCSTFAC MIAMI

UNCLAS

110400Z GALE WARNING. BETWEEN FORTY TWO AND FORTY FIVE NORTH FROM THIRTY FIVE WEST TO EUROPEAN COAST. WIND WESTERLY TWENTY FIVE TO THIRTY FIVE KNOTS

WR NR3365 WU/JN

RELEASE	TOR	TOD	CWO	WO	DATE
	11/0417Z		LJ		11 OCT 71

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	DATE/TIME GROUP
I	I	A	I		I	I	I	I	I		I		I										I	110403Z

SECURITY CLASSIFICATION: UNCLASSIFIED

31.47

Figure 9-3.—Incoming message.

Table 9-1.—Example of Internal Routing Afloat

Block	Assigned To	Routing	Explanation
1	Commanding Officer	I	Receives all messages. Responsible for everything that goes on in his command and, therefore, necessarily must be informed of everything.
2	Executive Officer	I	Receives all messages. In charge of administering the ship, hence must also be informed of everything.
3	Operations Officer	A	Acts in matters relating to the ability of the ship to carry out her assigned mission.
4	Communication Officer	I	Receives all messages, for two reasons: to check for errors, and to be informed if questions arise.
6	Navigator	I	Plots storms and gales; must determine bearing and distance of ship from gale; plots diversionary route, if necessary.
7	Weapons Officer	I	Must see that exposed ordnance equipment is covered properly.
8	Engineer Officer	I	Responsible for damage control and ship's stability. Must ballast as necessary and be prepared to strike topside weights below; must take precautions against water damage to engine-room power panels; must see that shaft alleys, workshops, and storerooms are ready for heavy weather.
9	Meteorological Officer	I	Receives all messages concerning weather. Must advise command in matters relating to his speciality: anticipated storm track, probable state of sea, etc.
10	Supply Officer	I	Must see that galley, messhalls, storerooms, and other spaces assigned his division are rigged for heavy weather; may have to revise his menus to provide food that can be served when the seas are high.
12	Medical Officer	I	Must see that bedridden patients are subjected to a minimum of discomfort caused by roll and pitch of the ship, and that the sick bay, medical storerooms, and other spaces are secured from heavy weather damage.
14	First Lieutenant	I	Must see that ground tackle is secured, if not required; that rafts, boats, and other gear on the weather decks are secure from damage.
24	OOD	I	Responsible for safety of the ship during period of his watch. (A message routed "OOD" is seen by all OODs.)

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routing indicated across the bottom of the sample message and the action that will be taken.

INTERNAL ROUTING ASHORE

The principles of internal routing are practically the same everywhere, but routing at a shore station often presents difficulties because of traffic volume and the number and diversity of activities the station may serve. For some activities, the station may not route at all, but only make delivery in accordance with the message address. Actual routing to action and information officers in such an instance is a function of the addressee. For other activities the station makes internal routing; but the messages usually go to offices, divisions, or sections—not to individuals—for action and information.

In addition to the action/information internal routing commonly used everywhere, another routing symbol, COGNIZANCE (abbreviated COG), is in use at many of the large shore message centers. It is used instead of action routing on messages addressed to the command for information. The office that has primary cognizance over the subject matter contained in the message is routed COG. He is responsible for taking any action that may be required within the command, including checking to see that the CWO's routing for information includes distribution of copies to other activities that might need the information.

Many stations, especially the larger ones, maintain a routing file based on subject matter of messages. The file consists of cards showing the activities interested in each subject for action and for information.

Messengers from each activity make several trips daily to the communication center to pick up their activity's incoming traffic and to deliver outgoing messages for transmittal. Delivery to some activities may be made by direct teletypewriter drop rather than by messenger.

Final responsibility for routing rests with the CWO, even though an enlisted assistant performs the work. Some CWOs do the routing themselves, using an operator for clerical assistance. Others delegate the work of routing, but check its accuracy before delivery is made. At small stations, both ashore and afloat, it is not unusual for a First or Chief to act as CWO and to assume responsibility not only for routing but also for supervising the watch.

REFERENCES

Many messages refer directly to a previous incoming or outgoing message. It saves bother for everyone if half a dozen officers do not need to telephone the message center to have previous references taken from the files and read to them. Accordingly, if there is a reference in an incoming message, look up the referenced message and show identifying extracts across the face of the routed copies. It is unnecessary to copy the reference in its entirety, but quote enough so that action and information officers get the gist of it. In the event your station is not an addressee on the referenced message, simply note the DTG and type in "(your command) Not Addee."

There are two additional reasons why you must check references in outgoing messages. First, checking references assures accuracy. Second, it is a security measure; unclassified replies to certain types of classified messages are forbidden.

DELIVERY OF INCOMPLETE TEXT

Urgent incoming messages which are received incomplete or garbled often contain enough information to be of value if routed. At the same time service action is being initiated, the urgent or high precedence traffic should also be brought to the attention of the supervisor or CWO for routing. The garbled or missing portions can be marked and a note can be added on the message form that service action has been initiated.

This procedure can be extremely beneifical since it provides at least partial information, and thus advises the CO and appropriate department heads of pending urgent situations, at the same time the communicator is waiting for a response to service action.

It is essential that all copies of messages being routed show the TOR (time of receipt) in the Commcenter plus the signatures and TOR when persons receive advanced copies. Messages which have been serviced for reruns or corrections must be appropriately marked "Corrected Copy."

OUTGOING MESSAGES

The processing of outgoing messages begins with the acceptance of the message at the main communications center, once the releasing officer has made the determination that electrical transmission of the information is necessary.

VERIFYING FACTS

As soon as the message arrives in the message center, communications personnel must verify certain essentials. First of all the signature of the releasing authority must be verified. Secondly, the communicator will verify and note the following items which are frequently in error or are omitted:

1. Precedence. If dual precedence has been assigned, make sure that the lower precedence is assigned to the info addressees.
2. Security handling designation. Either UNCLAS or appropriate classification with downgrading instructions.
3. Valid and properly assigned address designations.
4. Privacy or special handling instructions.
5. Numbering of paragraphs and pages. An error in paragraph or page numbering may be the result of a simple typing error, or it may indicate actual omission of text.
6. Initialing of minor changes after smooth draft has been typed. Ensure that any lined-out or written-in changes have been initialed by the person making the change.

Any message which requires substantial alternation prior to transmission must be returned to the originator. Communication personnel are only authorized to perform normal communication processing functions that do not change the sense of the message.

Upon verifying the essentials and accepting the message in the message center, outgoing messages are typically processed according to the following steps:

1. The time of file (TOF) is stamped or penciled on it. The CWO then logs the message in the outgoing message log, which contains the same general type of information as the incoming message log. The CWO determines that all addressees hold copies of any referenced messages listed in the message being processed, or that the references are marked with the abbreviation NOTAL, which the originator uses to indicate that the referenced messages were "not to, nor needed by, all addressees." The CWO also must ascertain that the classification of the message is in accord with the requirements for unclassified references to classified messages. Primarily, these checks are the responsibility of the message drafter, but they are doublechecked by the CWO or one of his assistants.

2. The originator's draft is given to the communication clerk, who makes file and routing copies. On some ships, the originator indicates internal routing for an outgoing message. On others, the CWO performs this duty and routes an outgoing message just as he would an incoming message.

3. The message center CWO determines which electrical method will be utilized to process and transmit message traffic. To make the proper selection the CWOs prime consideration is the On-Line/Off-Line capabilities of his own unit as well as the On-Line/Off-Line capabilities of all addressees of the message. You will find that the majority of message traffic will employ On-Line procedures and equipment.

It has already been emphasized, that before you accept any outgoing message for transmission, be certain that it is released properly. You will find the signature of the releasing officer on the face of the message. The authority to release messages is vested in the commanding officer, but for sake of convenience the authority often is delegated.

Shore stations maintain a signature file of releasing officers. This file is used in much the same way as a bank's signature file of depositors. Each local command or activity served by the station submits a signature file of depositors. Each local command or activity served by the station submits a signature card for every officer authorized to release messages. Besides signatures, the cards also carry information regarding any limitations on the officer's releasing authority. An officer may, for example, be authorized to release messages to shore activities, but not those addressed to forces afloat. When an outgoing message is received over the counter, the releasing officer's signature is compared with that on his card. If he is authorized to release messages of that type and classification, the message is accepted. Figure 9-4 is an example of the standard Message Release/Pickup Authorization Form.

TRAFFIC CHECKING

The traffic checker is a station's final safeguard against error. Every message handled

NAME (Last, first, middle initial) | RANK/RATING GRADE | ACTIVITY

TITLE | ALTERNATE TO

OPNAV FORM 2160-5 (REV 10-61) MESSAGE RELEASE/PICKUP AUTHORIZATION

AUTHORITY TO RELEASE MESSAGES TO: ☐ SHORE AND AFLOAT ☐ SHORE ONLY ☐ NONE | OTHER CONDITIONS

PICK UP CLASSIFIED MSGS. UP TO AND INCLUDING | OTHER (Nato, Seato, etc.)

SIGNATURE OF AUTHORIZING OFFICER | RANK/GRADE AND TITLE OF AUTHORIZING OFFICIAL

DATE

THIS AUTHORIZATION ☐ IS NEW FOR THIS POSITION ☐ SUPERSEDES THAT OF | NAME OF PERSON BEING REPLACED

SIGNATURE OF AUTH. INDIVIDUAL | FILE/SERIAL/CIVILIAN I.D. CARD NO. | ROOM | PHONE

NAME (Last, first, middle initial) | RANK/RATING GRADE | ACTIVITY

REMOVE AFTER TYPING GPO 935-511

31.75

Figure 9-4.—Message Release/Pickup Authorization.

by the station passes through his hands for a last thorough check before going into the files. (See Table 9-2.)

Shore stations often have from one to four men checking traffic full time. Usually there is some specialization to meet local needs—one or two men, for instance, may check only classified traffic, whereas the other check plain language traffic. A good checker will do his best to stay "up" with the traffic load. That way he can catch errors before the messages leave the station, thus saving service messages and corrected copies.

A traffic checker must know the station's message-handling procedures inside out. He must be acquainted with in-station memoranda and directives, official publications, and (aboard ship) the communication organization book. He must have a well-rounded knowledge of guard lists, routing indicators, and fleet organization.

Few ships handle enough messages to warrant an assembly line procedure, where one man does nothing but check preceding steps. Messages are checked, of course, but checking ordinarily is done by the CWO and assistants as they go along. The communication officer also checks his personal copy. Many ships hold a daily traffic check before messages handled the previous day go into the files. The checker reads the writeup and circuit copies, noting the heading, text, routing, and so on. If everything is in order, he initials the message to that effect. If he finds an erorr, he brings it to the attention of the CWO. If the error is serious enough to justify corrected copies, they are made up and delivered at once. Incorrect copies are picked up, or the possessor is advised to destroy them.

The effective edition of DNC 5, U.S. Naval Communication Instructions supports and amplified NWP 16, Basic Operational Communication Doctrine. The DNC 5 expends and modifies for intra-U. S. Navy and Marine Corps use, information contained in the JANAP and ACP series. Additionally, it contains procedures and instructions not promulgated elsewhere.

TRAFFIC HANDLING DISCREPANCIES

Traffic checking personnel also periodically analyze random samples of transmissions received from directly connected stations. The purpose of a periodic sampling of traffic is to

Table 9-2.— Checklist for Traffic Checkers

1. Examine heading, text, and ending for garbles and omissions.
2. Determine if the message has been handled in accordance with its precedence.
3. Check routing indicators, if any. Check breakdown of call signs and address groups.
4. Check the group count, if any.
5. Check the continuity of the station serial number. See that the number agrees with the number logged.
6. Compare originator's rough draft against hard copy or circuit copy.
7. If the message contains a ZFF, ensure that it has been answered. (ZFF: an operating signal means, in effect, "When did addressee receive message?")
8. Check operator's sign and servicing.
9. Check internal routing for omissions.
10. In shore stations, watch for duplicate messages. If your station receives the same message twice, someone else may have a nondelivery.
11. Watch for excessive in-station delays; compare the time your station received or accepted the message against the time it was delivered or sent.
12. Always be alert for security violations.

76.52

monitor the accuracy of tape preparation and format.

When discrepancies are noted, a report is compiled and forwarded to the station monitored. Enclosed with each report is a tape or page copy of the discrepancies.

Discrepancy reports serve not only to eliminate typing and format errors, thus improving traffic flow, but can also be incorporated as a useful part of operator training.

STATISTICAL REVIEWS

Records maintained by traffic checking personnel are routinely used to compile statistical reports. Such reports may be addressed to volume of messages handled, speed of service, or even volume of encrypted traffic. The traffic checker will also be responsible for researching all information relating to inordinate delay or non-delivery or messages. The need for diligent and conscientious traffic checking cannot be over emphasized.

WATCH SUPERVISION

As you advance in rating you are expected to assume more responsibility and to become more proficient in your field. As Radioman 2 you are required to take charge of a watch, supervise traffic handling, and act as a minor technician for many equipments. Even though at your present duty station you might not be given a watch to supervise, remember that in time of war Radiomen are scattered throughout the enlarged fleet, and it is quite possible for an RM2 to be the only experienced Radioman aboard.

Communication organizations, afloat and ashore, differ widely in internal message-handling procedures. It is difficult to lay down more than a few specific rules for supervisors because of varying problems, purposes, sizes, and locations of individual stations. If you had an opportunity to serve on the watch before taking it over, you probably are reasonably well indoctrinated in the local way of doing things. If not, you will have to depend on your superiors for guidance. In either case, make a study of the organization and regulations of your duty station, and know the contents of departmental and division notices and directives.

Upon the supervisor of any watch falls responsibility for keeping traffic moving and for running a taut watch. You must know your publications and instructions, and have them at hand for ready reference. At sea you should know and understand the cruising disposition of the fleet. You should be familiar with your own radio equipment and, if possible, the equipment of ships in company. That way you can allow for equipment limitations. You should not have to refer to the equipment technical manual for any of the following data on your transmitters. or, as applicable, receivers: model, location, source of power, frequency range, type of emission, rated power output, and effective day and night ranges, summer and winter.

During exercises you must watch your men closely, with an idea to the correction of any shortcomings that may appear. Keep an eye on the strikers; if they show no interest in self-betterment and in making themselves of more value to the Navy, find out why.

Before taking over each watch, obtain all possible information relating to circuit conditions; special orders; cruising disposition; traffic awaiting transmission, receipt, execution, or acknowledgment; frequencies under guard; gear in use; and guardships.

Before relinquishing the watch, assure yourself that all of your men are relieved, and that your operators surrendered to their reliefs logs that are up to the minute and signed. Pass on all information of interest to your relief, and be satisfied that he understands the current communication situation.

The supervisor's desk is so wired that he can cut in on any of the operating positions and monitor the transmissions. Listen in frequently to both radiotelephone and radiotelegraph nets to check for off-frequency operation, incorrect procedure, and unauthorized use of plain language. Correct offending operators. Ensure that traffic flows smoothly. Do not allow letter-writing while on watch, nor the reading of books and magazines (except official publications). See that files are kept orderly, and that out-of-date sections are burned on time.

When you are given an outgoing message, look it over carefully before passing it to an operator for transmission; after the message is sent, note the operator's servicing. Check the address and group count of an incoming message, and take particular care to see whether relay is necessary. As frequently as possible during the watch, examine the logs and records, and make a final check at the end of the watch. Constant checking and rechecking are the best means of preventing mistakes that can embarrass not only you but the entire chain of command.

Traffic usually is filed on the morning after the day it is handled. After the daily files are complete, a final check should be made for nondeliveries. If at any time a delayed delivery or a nondelivery is discovered, that fact, with the attendant circumstances, should be reported at once the to Radioman in charge, who will inform the CWO or communication officer. Fear of the consequences of a mistake should not be a deterrent to such a report. If an honest mistake was made, punishment seldom is occasioned, and a report and rectification are essential to good communication practice.

The relationship between officers and men of the communication organization must, for the sake of efficiency, be based on mutual confidence and trust. A supervisor can do his part to attain this objective by keeping alert and by conducting his watch in such a manner that the radio officer respects his ability. When mistakes occur, as they do in all offices, the radio officer undoubtedly will recognize that, although the error was avoidable, his supervisor nevertheless is competent. Most mistakes merely require provision for prevention of recurrence.

Constant work, observation, and correction are necessary to make your men efficient and responsible by second nature. It is your prime duty to make them so, and to instill in them the conviction that the success of naval communications depends on them individually.

STATUS BOARDS

Status boards usually are large, thick sheets of plexiglass on which the supervisor maintains a record of frequently changing communication data. For instance, the communication plan normally is transferred to a status board. As changes in equipment or circuit status occur, the supervisor records the changes on the status board, and thereby maintains an up-to-the-minute record of the equipment in use, the circuits that are up, and those that are in standby, and so on.

To be of any value, a status board must be accurate. An inaccurate board can cause a lot of confusion, particularly when relieving the watch. To avoid this disarrangement, the supervisor personally makes all changes to a status board.

COMMUNICATIONS CENTER PUBLICATIONS

Publications used in Naval Communications are issued through two separate and distinct systems:

1. Communication-Tactical Doctrine (COMTAC) System—the communication publications in this system consist of ACP, DNC, JANAP, NWP and other U.S. Allied, and NATO doctrinal publications.
2. Registered Publication System (RPS)—the communication publications in this system consist of some ACPs, NWPs and all cryptographic publications.

ACCOUNTABILITY

The watch supervisor is personally accountable for official publications used by his section. In order to provide effective control, ships and shore stations use publication custody logs for recording the watch-to-watch inventory. Std. Form 0199-450-5000 is one such log. You may however see many different log forms. The publication custody log shown in figure 9-5 can be modified to satisfy any requirement. The log lists all publications in use in a particular space. At the change of watch, the supervisor and his relief sight every publication, and the relief signs the log. By doing so, he says, in effect, that the publications are actually present and that he holds himself responsible for them. Always sight every publication for which you sign. If you fail to do so, you leave open to king-size troubles.

CORRECTIONS

One of your jobs as a RM3 or RM2 is to help keep your communication publications up to date. All communication publications, particularly the call sign, address group, and routing indicator books, frequently undergo necessary changes. The custodian (or COMTAC publications control officer) is responsible for the prompt and accurate entry of all changes and corrections to publications. Usually, he issues the changes and corrections to the Chief for the publications held in communication spaces. The Chief then assigns the work to his men through the watch supervisors. On some ships and stations, each man is assigned his share of the publications to keep up and is responsible only for those assigned to him. Other activities assign the correcting job to any men available at the time the work needs to be done.

Corrections to publications are issued in three ways: changes, memoranda, and messages

A change to a publication is itself a serially numbered publication, and may consist of pen-and-ink corrections, cutout corrections, or new pages to amend or add to the contents of a basic publication. Changes are numbered consecutively (change No. 1, No. 2, etc.).

Memorandum corrections are of two kinds: Registered Publication Memorandum Corrections (RPMC) for corrections to RPS-distributed publications, and Navy Memorandum Corrections (NMC) for publications distributed by the Forms and Publications Supply Office of the Navy supply system. Memorandum corrections are used when time does not permit the preparation of a serially numbered change. The RPMCs and NMCs are numbered serially, using a system of two numbers separated by a slant sign. The figure before the slant sign indicates the number of the NMC (or RPMC), and the numbers run consecutively for the life of the basic publication. The figure after the slant sign indicates the change that will confirm the material contained in the NMC or RPMC. For example, NMC 2/1 to ACP 113 is the second NMC issued to ACP 113 and will be confirmed by a forthcoming change No. 1.

Message corrections to publications are issued by ALCOM, JAFPUB general message (or ALCOMLANT, ALCOMPAC when appropriate). Message corrections are used only when it is absolutely necessary to disseminate the correction by rapid means.

Priority of Corrections

When a correction is received, check the forward or Letter of Promulgation for the effective date of the change or correction and ensure that the publication to be corrected is also effective.

Effective corrections, that is effective upon receipt, which pertain to effective publications shall be entered first. A further distinction is

PUBLICATION CUSTODY LOG

WATCH TO WATCH PUBLICATION INVENTORY FOR COMMCEN

SHORT TITLE	REG. NR.	DAY	EVE	MID	DAY	EVE	MID	DAY	EVE	MID	DAY	EVE	MID	DAY	EVE	MID	DAY	EVE
Day-Month-Year Period of Watch		1 JUL 65	1 JUL 65	2 JUL 65	2 JUL 65	2 JUL 65	3 JUL 65	3 JUL 65	3 JUL 65	4 JUL 65								
ACP 100		✓	✓	✓	✓	✓	✓	✓	✓	✓								
ACP 113		✓	✓	✓	✓	✓	✓	✓	✓	✓								
ACP 121		✓	✓	✓	✓	✓	✓	✓	✓	✓								
ACP 122		✓	✓	✓	✓	✓	✓	✓	✓	✓								
ACP 127		✓	✓	✓	✓	✓	✓	✓	✓	✓								
COI 101		✓	✓	✓	✓	✓	✓	✓	✓	✓								
DNC 5		✓	✓	✓	✓	✓	✓	✓	✓	✓								
KAG 1	5336	✓	✓	✓	✓	✓	✓	✓	✓	✓								
KAO 8	2937	✓	✓	✓	✓	✓	✓	✓	✓	✓								
KAO 51	1738	✓	✓	✓	✓	✓	✓	✓	✓	✓								
(Full) Signature (in ink)		Roy W. Harm	John J. Thomas	Harold R. Marion	Roy W. Harm	John J. Thomas	Harold R. Marion	Roy W. Harm	John J. Thomas	Harold R. Marion								

I certify that I have personally sighted and inventoried each of the above listed publications and/or materials, and have page checked all loose leaf cryptographic publications. By my signature above I acknowledge responsibility for maintaining security precautions and assume custody for all above listed publications and/or material during my watch or until properly relieved of their custody. I will report immediately to the custodian or other competent authority any discrepancy in the inventory.

31.58

Figure 9-5.—Publication Custody Log.

made in that corrections to cryptographic publications normally take precedence over those for non-cryptographic publications.

Method of Entering Corrections

Entering corrections in publications is of such importance that it warrants your most careful attention. Here are some general rules for entering corrections:

1. Read and understand the specific instructions contained in the correction before you begin the actual entry.
2. For pen-and-ink corrections, use green ink or any dark ink except red. Red ink is not visible under the red night lights used aboard ship.
3. Type lengthy pen-and-ink corrections on a separate slip of paper, then paste the paper on the page.
4. When cutouts are provided, use them in preference to pen-and-ink corrections.
5. Cutouts should be cemented flat on the page with rubber cement or mucilage. (Rubber cement or mucilage is more satisfactory than cellophane tape because the tape often sticks pages together or may tear pages if its removal is attempted.) If there is insufficient room on the page to insert cutouts, they may be attached to the inner (binding) edge of the page as flaps.
6. Delete, in ink, all subject matter superseded by a cutout before adding the cutout. This method prevents using the superseded material if the cutout becomes detached.
7. Because a correction entered in one section of a publication often affects another section, such as the index, make certain that the corrections are entered in all applicable sections.
8. After entering pen-and-ink or cutout corrections, note on the margin, opposite the line containing the correction, the identification of the correction, as NMC 1/2, ALCOM 3, etc.
9. Upon completion of the entry of any change affecting page numbers, make a page check of the publication. All residue and superseded pages should be returned to the person who issued the material and your work should be double-checked by a second person.
10. After entering the correction, fill in the information required by the "Record of Changes" page in the front of the publication. This page provides spaces for the correction number and its date, the entry date, your signature and rate, and the name or your ship or station.

FAMILIARITY IN USAGE

To become proficient in communications requires a considerable degree of familiarity with the governing publications. This proficiency is best achieved by a continuous review of material, rather than by relying on rote memory. Changes to routing indicators, for example, are promulgated every week or so. When major printed changes are made to publications, take the time to carefully review the new material. You will find that new material is readily identified by appropriate symbols in the margin of the pages.

Ideally, you should be able to recognize the publication which contains the information you desire and be able to rapidly locate the information within the publication.

It is the responsibility of the communications center to have all clocks set accurately. One of the easiest and most accurate means is to set the clocks with radio station WWV or WWVH.

The primary frequency standard is supplied by the National Bureau of Standards through its radio stations WWV and Boulder, Colorado, and WWVH on the island of Maui, Hawaii. Figure 9-6 show the structure of WWV and WWVH signals.

RADIO STATIONS WWV AND WWVH

Technical radio services broadcast by radio station WWV include—

1. Standard radio frequencies. Six frequencies are broadcast continuously, day and night—2.5, 5, 10, 15, 20, and 25 MHz.
2. Time announcements each minute of the hour.
3. Standard time intervals each second of the hour at a tone of 1000 Hz with the 29th and 59th second omitted.
4. Standard audio frequencies of 440, 500 and 600 Hz are broadcast. Duration of each tone is approximately 45 seconds. A 600 Hz tone during odd minutes and a 500 Hz tone is broadcast during alternate minutes unless voice announcements or silent periods are scheduled. A 440 Hz tone is broadcast beginning at two minutes after the hour. The 440 Hz tone is omitted during the first hour of the UT day.

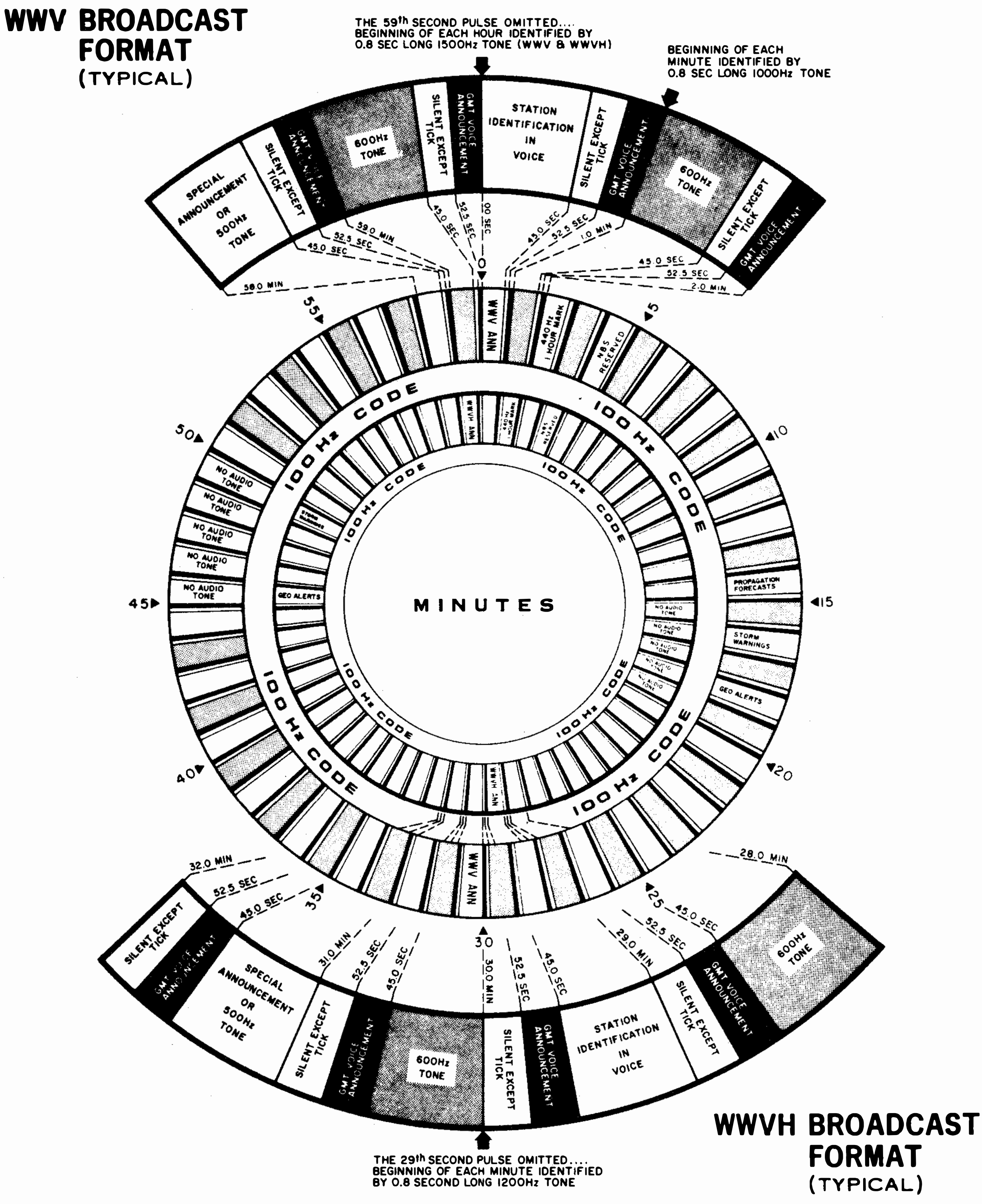

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Figure 9-6.—Structure of WWV and WWVH signals.

5. Official announcement time is set aside on a subscription basis to other agencies of the federal government to disseminate official and public information. This is a 45 second time segment every other minute.

6. Radio propagation conditions is broadcast in voice during part of every 15th minute of each hour.

7. Geophysical alerts as declared by the World Warning Agency and World Days Service are broadcast by voice during the 19th minute of each hour.

Technical radio services broadcast by radio station WWVH include—

1. Standard radio frequencies. Five frequencies are broadcast continuously, day and night—2.5, 5, 10, 15 and 20 MHz.

2. Time announcements each minute of the hour.

3. Standard time intervals each second of the hour at a tone of 1200 Hz with the 29th and 59th seconds omitted.

4. Standard audio frequencies of 440, 500, and 600 Hz are broadcast. Duration of each tone is approximately 45 seconds. A 600 Hz tone during even minutes and a 500 Hz tone is broadcast during alternate minutes unless voice announcements or silent periods are scheduled. A 440 Hz tone is broadcast beginning at 1 minute after the hour. The 440 Hz tone is omitted during the first hour of the UT day.

5. Station WWVH broadcast special announcements under the same format as station WWV.

6. Geophysical alerts are broadcast by station WWVH in the same manner as station WWV except the 46th minute after the hour is used.

Standard Radiofrequencies

Any desired radiofrequency can be measured accurately in terms of standard frequencies, which are accurate to better than 1 part in 100,000,000 Hertz. Any of the six radiofrequencies can be used for checking frequency meters being used.

Time Announcements

The 0 to 24 hour system is used starting with 0000 at midnight at longitude zero. The first two figures give the hour, and the last two figures give the number of minutes past the hour when the tone returns. The time announcement refers to the time when the audio tone occurs.

An example of 1035 GMT, for instance: "At the tone—ten hours, thirty-five minutes Greenwich Mean Time."

LOGISTIC SUPPORT

As an operator, you are vitally concerned that your equipment stays in proper operating condition and that you have sufficient supplies available. While you are less involved with actual material support and spare parts allowance lists, you are specifically involved with logistic support. Logistic support for the communication complex includes the effort to ensure that consumable supplies are available when required.

CONSUMABLE SUPPLIES

Consumable supplies are those items such as paper, pencils, log and record forms, teletype ribbon, and cleaning supplies that are used in daily operation. In order that these supplies will always be available, the communications organization must determine its own stock level requirements and provide this information to the supply department.

STOCK LEVELS

The supply department records stock levels for all items maintained in the command's supply system. These stock levels are based on the rate at which the material is USED and normally indicates a 90-day supply. When the item drops to two-thirds of the 90-day level, it will be reordered in sufficient quantity to raise the supply back to the 90-day level. Accurate past usage is the best guide for establishing these levels. Stock levels must be reviewed at regular intervals to ensure that adequate supplies are on hand when required, and at the same time, to ensure that a surplus does not accumulate. Excessive amounts of supplies for day-to-day use must not be kept in communications spaces.

STANDARD SUPPLY CHIT

In addition to maintaining an accurate count of consumable supplies as they are used, you may also be in a situation where you will be

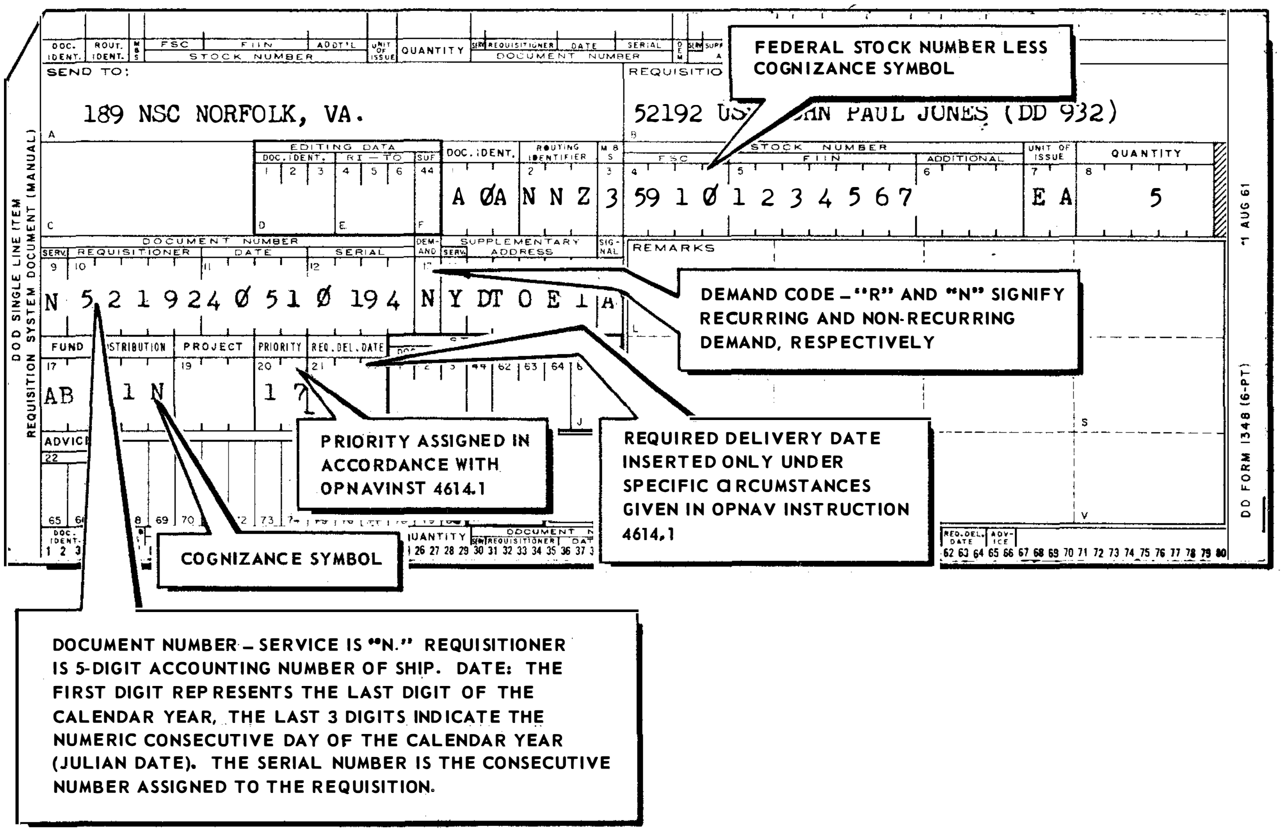

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Figure 9-7.—Sample routine requisition (DD Form 1348).

required to fill out routine requisitions for supplies. Figure 9-7 shows DD Form 1348, the standard supply chit, and illustrates some of the items of information that must be filled in. The Federal Stock Number (FSN) which appears in block 4 and 5 is the uniform identification of the item, as used throughout the Department of Defense. Each item in the supply system is specifically identified by the last seven digits of the FSN. Figure 9-8 is a breakdown of a typical FSN (single ply, canary yellow teletype paper).

CLEANLINESS AND UP-KEEP OF SPACES

Operators should make a conscientious effort to keep the communications spaces squared away at all times. This includes more than just a sweep-down at the end of each watch. Empty paper and tape boxes should be removed from the spaces as they are used. Burn bags should be stapled and stowed properly—not left sitting around full and overflowing.

Paper clips should not be accumulated on equipment cabinets as they might fall into the equipment and short the equipment out. Chad boxes should be emptied periodically, not only after chad starts to spill out of the cabinet. Emptying the chad boxes regularly also will eliminate unnecessary jamming and breakdown of reperforator punch blocks.

Tapes which are being transmitted or are being run off on various positions should be kept off of the deck. This will prevent dirt from being picked up and deposited under the tape lid of the TD and clogging the sensing fingers.

Upkeep of the equipment and spaces also includes keeping coffee cups and cigarettes off of the equipment. Butt kits and racks for coffee cups can be easily mounted on most cabinets. Not only is it easier to operate when the spaces and equipment are clean and neat but fire hazards are being eliminated at the same time. Dust, oil or grease, and carbon dust must not be allowed to accumulate on electronic equipment.

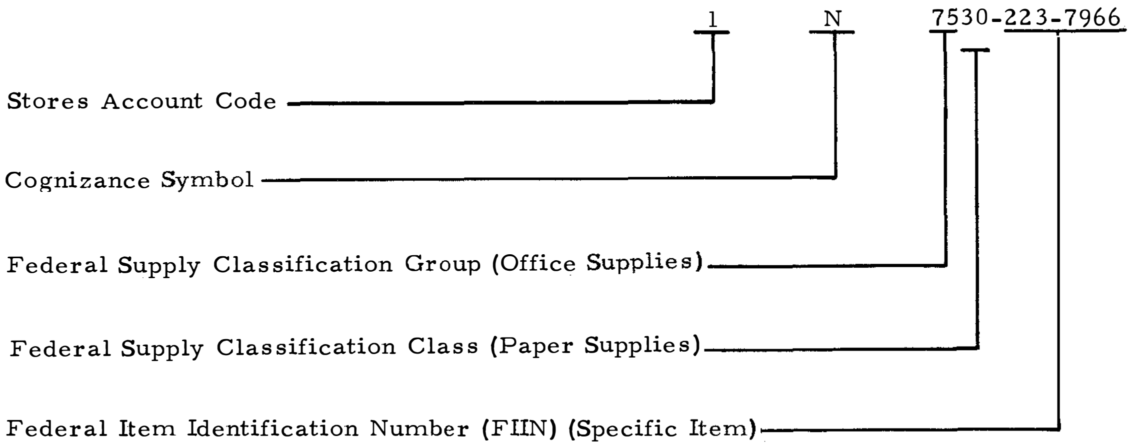

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Figure 9-8.—Breakdown of typical Federal Stock Number.

LOST TAPE HAZARD

Another problem that exists when good housekeeping practices are not followed is the possibility of losing valid traffic tapes. All discarded pieces of tape must be placed in burn bags, not thrown on the deck. But any tapes or papers found on the deck must be examined by supervisory personnel to ensure that they are not valid traffic.

Burn bags or uncovered waste receptacles must not be placed near send or receive positions or near writing surfaces upon which messages are placed.

TRAINING AND QUALIFICATIONS OF COMMUNICATION PERSONNEL

The prime objective in training is to increase the ability of personnel to operate and administer the facilities of the command effectively under all conditions. Training objectives for communication personnel must contain provisions for general training, including examination for advancement in rating, qualification for assigned watches, and basic knowledge in such essentials as damage control, first aid, and fire fighting procedures.

ON-THE-JOB TRAINING

As a supervisor of a watch, it is your responsibility to train your men to become more proficient in their duties. During a normal watch, you are presented with an untold number of opportunities for on-the-job training. Conditions permitting, each shift in frequency or change in equipment can be utilized to train one or more of your men. Many outgoing messages can be used in a similar manner. Take advantage of these opportunities, because both you and your men benefit from them. You benefit by having a sharper watch section that requires less of your time in doublechecking their work. They benefit by increasing their advancement opportunities.

Rotating job assignments is an effective method of training personnel. There is a natural tendency, however, to keep a man in a job that he knows best. This stems from a desire to achieve and maintain a smoothly working unit or section. Such action limits the scope of knowledge of the man and does not make provision for casualty replacement or for advancement to position of greater responsibility. Any plan for rotating personnel must ensure that in addition to providing training, each position remains properly manned.

By the time you advance to the position of a watch supervisor, you should know the value of studying. Encourage your men to study during slack periods. They are not permitted to write letters or read unofficial books or magazines, so why not use this time in bettering themselves? In the ACPs and other publications available, you and your men have at your fingertips all of the doctrinal communication information required for advancement from Seaman to Master Chief Petty Officer. Take advantage of them!

TRAINING FOR ADVANCEMENT

Training for advancement is not separate from the training necessary to become more proficient on watch—it is part of it. However you cannot complete all of your preparations for advancement while on watch. Chapter 1 has outlined the more formal requirements necessary for advancement in rate and suggests how the various training manuals can be put to maximum use.

CHAPTER 10
ANTENNAS AND RADIO WAVE PROPAGATION

The transmission of radio waves through space is known as wave propagation. A study of antennas and wave propagation is essential to an understanding of radio communication.

In any radio system, energy in the form of electromagnetic (radio) waves is generated by a transmitter and fed to an antenna by means of a transmission line. The antenna radiates this energy out into space at the speed of light (approximately 186,000 miles per second). Receiving antennas, placed in the path of a traveling radio wave, absorb part of the radiated energy and send it through a transmission line to a receiver. Thus, components required for successful transmission of intelligence by means or radio waves are a transmitter, a transmission line, a transmitting antenna, a medium through which radio waves travel (for example, the atmosphere surrounding the earth), a receiving antenna, another transmission line, and the receiving equipment. Figure 10-1 is a block diagram showing the arrangement of these components.

Successful communication by means of radio waves depends chiefly on the power of the transmitter, frequency used, distance between transmitter and receiver, and sensitivity (ability to amplify weak signals) of the receiver. The ability of the earth's atmosphere to conduct energy to its destination, together with the nature of the terrain between sending and receiving points, may be responsible for the frequency selected. Interfering signals can make reception impossible at a desired time. Moreover, the amount of noise present and transmission line losses may combine to make unintelligible an otherwise good signal.

TERMS AND DEFINITIONS

In this discussion of antennas and radio wave propagation, a number of technical terms are used. To help you understand the material, the following list of terms and definitions is provided:

ANTENNA. A device used to radiate or receive radio waves.

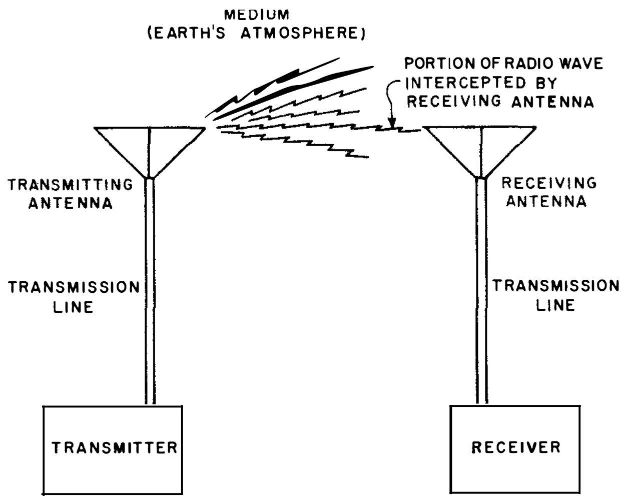

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Figure 10-1.—Simple radio communication network.

ATMOSPHERE. The whole mass of air surrounding the earth, including the troposphere, stratosphere, and the ionosphere.

ATTENUATION. The decrease in signal strength of a radio wave with distance in the direction of propagation.

CONDUCTIVITY. A measure of the ability of a material to act as a path for electron flow. It is the opposite of resistivity and is expressed in mhos per meter.

CRITICAL FREQUENCY. The limiting frequency below which an electromagnetic wave is bent back to earth by, and above which it penetrates through, an ionospheric layer at vertical incidence (straight up).

CYCLE. One complete positive and one complete negative alternation of current or voltage.

DECIBEL (DB). A term meaning one-tenth of a bel. The ratio of a change in power after attenuation or amplification.

DIFFRACTION. The bending of a radio wave into the region behind an obstacle.

DIRECT WAVE. A radio wave that is propagated in a straight line through space from transmitter to receiving antenna.

DISTORTION. An undesired change in waveform.

DECIBEL (db). "In an amplifier, each 3 db of power gain (+3db) will cause the output power to be double the input power. In an attenuator, each 3 db of power loss (-3 db) will cause the output power to be one-half of the input power."

FADING. The variation of radio signal strength at a radio receiver during the time of reception.

FREQUENCY. The number of cycles per seconds (Hertz) existing in any form of wave motion; such as the number of Hertz of alternating current.

GIGAHERTZ (GHz). An expression denoting 10^9 hertz (1000 MHz).

GROUND WAVE. A radio wave that travels close to the earth and reaches the receiving point without being refracted or acted upon by the ionosphere. The ground wave includes all components of a radio wave traveling over the earth except the sky (ionospheric) wave.

HERTZ. The term used to designate a unit of frequency (i.e., radiofrequencies and the operating frequencies of radio equipment) per second; one complete positive and one complete negative alternation of current or voltage.

INCIDENT WAVES. A term denoting that portion of a radio wave which is about to strike a medium of different propagation characteristic which will result in that wave being refracted, reflected, diffracted, or scattered.

IONOSPHERE. The part of the earth's outer atmosphere where ions and electrons are present in quantities sufficient to affect the propagation of radio waves. The portion of the atmosphere above the stratosphere.

ISOTROPIC ANTENNA (UNIPOLE). A hypothetical antenna equally radiating or receiving energy in all directions.

MAXIMUM USABLE FREQUENCY (MUF). The upper limit of the frequencies which can be used at a specified time for radio transmission between two points involving propagation by refraction from the regular ionized layers of the ionosphere. (Frequencies higher than the MUF may be transmitted by sporadic and scattered reflections.)

NOISE. Any extraneous electrical disturbance tending to interfere with the normal reception of a transmitted signal.

FREQUENCY OF OPTIMUM TRAFFIC (FOT). The most reliable frequency at a specified time for ionospheric propagation of a radio wave between two specified points.

LOWEST USABLE FREQUENCY (LUF). The LUF, based on the signal-to-noise ratio, varies as the power or the bandwidth is varied. An increase in power or a decrease in bandwidth will lower the LUF, and a decrease in power or an increase in bandwidth will raise the LUF.

PROPAGATION. The transmission of electromagnetic (radio) waves from one point to another.

REFLECTION. The phenomenon which, when a radio wave strikes a medium of different propagation characteristics (such as the earth or ionosphere), causes the wave to be returned into the original medium with the angles of incidence and of reflection equal and lying in the same plane.

REFRACTION. The phenomenon which, when a radio wave leaves one medium such as the stratosphere and obliquely enters another medium such as the ionosphere, causes the wave to undergo a change of direction. Essentially, refraction is caused by a difference in wave velocity in the two propagation media.

SPACE WAVE. Often called the tropospheric wave. A radio wave that travels entirely through the earth's troposphere.

SKY WAVE. A radio wave that is propagated or acted upon by the ionosphere.

SUNSPOT NUMBERS. The number of dark irregularly shaped areas on the surface of the sun caused by violent solar eruptions. The spots are counted and then averaged over a period of time to obtain values which are expressed as "smooth sunspot numbers." These smooth sunspot numbers are used to predict the average sunspot activity over a period of time.

SURFACE WAVE. A radio wave that travels in contact with the surface of the earth.

STRATOSPHERE. The part of the earth's atmosphere between the troposphere and the ionosphere.

TROPOSPHERE. The lowest part of the earth's atmosphere. In this region, which extends from the surface of the earth to the stratosphere, temperature decreases with altitude, clouds form, and all weather phenomena take place.

GENERAL CHARACTERISTICS OF RADIO WAVES

Any wire or other conductor carrying alternating current produces electromagnetic fields that move outward into surrounding space. As the current increases and decreases, the electromagnetic field alternately grows and collapses about the wire. When the speed of these alternations is increased above a certain point, the collapsing electromagnetic field does not have time to return to the wire before the next alternation begins. Hence, some of the electromagnetic energy is disengaged from the wire and set free in space. The radiated electromagnetic energy, known as the radio wave, moves in free space at the speed of light. (The speed of light is 300,000,000 meters, or about 186,000 miles, a second.) It travels almost—but not quite—that fast in air. Regardless of the frequency of alternation, the velocity of the radio wave is constant.

Table 10-1 shows the entire energy spectrum of which the radio spectrum is only a small part.

It is believed that radio waves travel in a series of crests and troughs, similar to round outward-moving waves created by dropping a stone on the smooth surface of a pond. Although this analogy is not exact, it serves a useful purpose because it compares the movement of the radio waves with a well known physical action. The movement of radio waves is somewhat like the movement of water waves away from a point of disturbance.

Figure 10-2 shows how a falling stone imparts wave motion to a water surface. The action illustrated compares with electromagnetic radiation except that a continuous wave motion is not imparted to the surface of the water by a dropped stone. A study of figure 5-2 should aid in understanding four important aspects of the radio wave: amplitude, cycle, frequency and wavelength.

AMPLITUDE

Amplitude is the maximum instantaneous value of an alternating voltage or current, measured in either the positive or negative direction. The amplitude of the wave in part D of figure 10-2 is the distance from the average water level to the peak (or trough) of the wave. In other words, amplitude is the measure of the wave's energy level. This is the concept in which amplitude is applied to a radio wave—as the measure of energy level.

CYCLE

A cycle is a complete sequence of variation of movement of the wave. Usually a cycle is represented graphically from a point at the average level through a crest and a trough and back again to the corresponding average level. Thus, with the average level as the reference

Table 10-1.—Radio Frequency Spectrum

FREQUENCY	DESCRIPTION	ABBREVIATION
30GHz-300GHz	extremely high frequency	EHF
3GHz-30GHz	super high frequency	SHF
300MHz-3GHz	ultra high frequency	UHF
30MHz-300MHz	very high frequency	VHF
3MHz-30MHz	high frequency	HF
300kHz-3MHz	medium frequency	MF
30kHz-300kHz	low frequency	LF
3kHz-30kHz	very low frequency	VLF

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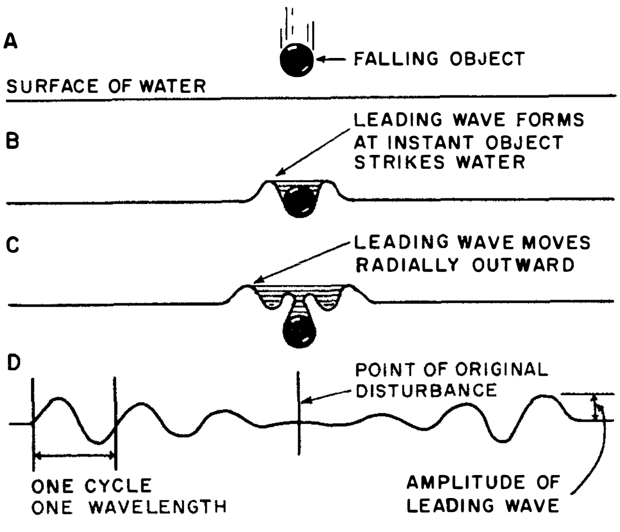

Figure 10-2.—How a falling stone imparts wave motion to a water surface.

point, each cycle is made up of two reversals. In a complete cycle the wave moves first in one direction, then in the other, and returns to the first direction to begin its next cycle (fig. 10-2 part D).

FREQUENCY

The frequency of a wave is the number of cycles that occur in 1 second. In 1967, the U.S. Navy adopted the term Hertz to designate units of frequency per second. If a frequency was formerly 10 cycles per second, it is now referred to as 10 Hertz (Hz.) Unlike the wave illustrated in figure 10-2, which would have a very low frequency, radio waves may have frequencies of a few thousand Hertz or many million Hertz. Because units of radiofrequencies become so large, numerically, they are counted in terms of thousands, millions, billions, and trillions of Hertz, using four appropriate prefixes, from the metric system: kilo, mega, giga, and tera. The latter two, giga and tera, as yet have limited application in naval communications. A kilohertz is 1 thousand Hertz and is abbreviated kHz; a megahertz is 1 million Hertz, abbreviated MHz, and so on. A frequency of 15,000 Hertz, for example is expressed as 15 kHz; 500,000 Hertz is expressed as 500 kHz. When the number of kilohertz becomes too large, megahertz are substituted to simplify the figure. Thus, 82,000 kHz is expressed as 82 MHz and so on.

WAVE LENGTH

Radio waves travel at the same velocity as light waves, which in free space have a speed of approximately 186,000 miles per second or 300,000,000 meters per second. The wavelength of a radio signal is the distance that the wave travels in one Hertz, during which its electromagnetic or electrostatic displacements have a difference in phase of one complete period. Wavelength is also described as the distance from the crest of one wave to the crest of the next. Knowing that radio waves travel at a constant speed, the length of one wavelength (1 Hertz) can be easily determined by dividing the velocity of a wave by its frequency. Although wavelengths are usually measured in meters, the following formulas show how to express wavelengths in both meters and feet.

1. Wavelength (in meters) =

$$\frac{300{,}000{,}000}{\text{Frequency (in Hertz)}}$$

Because there are 3.28 feet in 1 meter and a radio wave travels at 300,000,000 meters per second, 3.28 times 300,000,000 gives 984,000,000 feet; therefore:

2. Wavelength (in feet) =

$$\frac{984{,}000{,}000}{\text{Frequency (in Hertz)}}$$

WAVE POLARIZATION

A radio wave consists of traveling electric and magnetic fields. The lines of force of these fields are perpendicular to each other and at right angles in a plane which is perpendicular to the direction of travel. The polarization of the radio wave is determined by the direction of the electric field of the wave with respect to earth. If the electric field is vertical (perpendicular) to the earth (fig. 10-3) the wave is said to be vertically polarized. If the electric field is horizontal (parallel) to the earth, the wave is said to be horizontally polarized. Vertically positioned transmitting antennas radiate vertically polarized radio waves. Horizontal transmitting antennas radiate horizontally polarized radio waves.

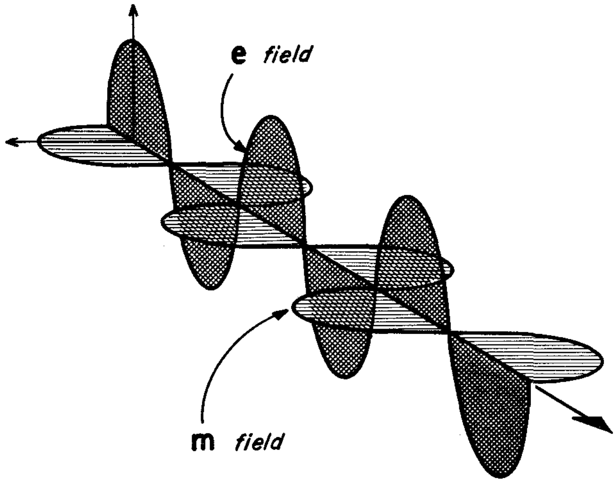

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Figure 10-3.—Instantaneous cross section of a radio wavefront.

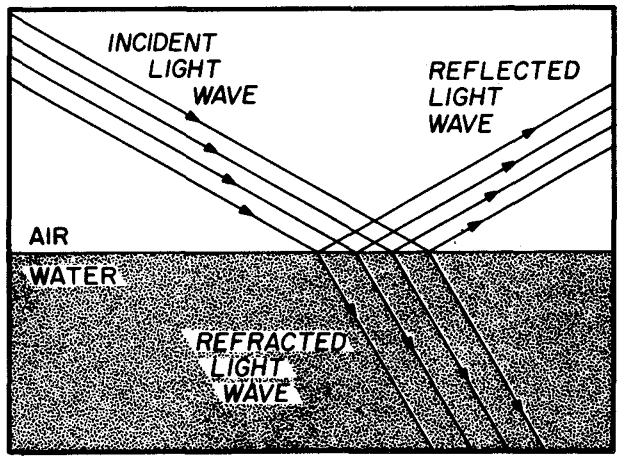

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Figure 10-4.—Reflection and refraction of a light beam.

EFFECTS OF PROPAGATION ON RADIO WAVES

One of the many problems encountered in communications is the changeable propagation conditions of the radio transmission path. Radio waves can be reflected, refracted and diffracted in a manner similar to light and heat waves. As a result it is usually necessary to change frequencies on HF trunks during any operating day, in order to overcome the limitations imposed by varying propagation conditions.

REFLECTION

Radio and light waves alike travel in straight lines but may be reflected from any sharply defined substances or objects of suitable characteristics and dimensions which are encountered in the medium of travel. The wave is not reflected from a single point on the reflector but rather from an area of its surface. The size of the area required for reflection depends on the wavelength and angle of incidence. When a wave is reflected from a plane (flat) surface, a phase shift occurs, as shown in figure 10-4. The amount of the phase shift depends on the polarization of the wave and the angle of incidence.

REFRACTION

As in the case of light, a radio wave is bent when it moves from one medium into another in which the velocity of propagation is different from that of the first medium. The bending, which is called refraction, is always toward that medium in which the velocity is the least. If a wavefront is traveling obliquely from the earth and encounters a medium with a greater velocity of propagation, the part of the wavefront that first enters the new medium travels faster than parts of the wavefront which enter later. The difference in the rate of travel tends to swing the wavefront around or to refract it in such a manner that it is directed back to earth.

DIFFRACTION

A radio wave is also bent when it passes the edge of an object. The bending, called diffraction, results in a change of direction of part of the energy from the line-of-sight path. This change makes it possible to receive energy at some distance below the summit of an obstruction or around its edges. A later section will show how, in the field of ground wave propagation, radio waves are diffracted beyond the earth's horizon. In certain cases, by using high power and very low frequencies, the waves can be made to encircle the earth by diffraction.

TYPES OF RADIO WAVE PROPAGATION

The wave which is transmitted from an antenna can be considered to have two major components. One major component is the ground wave, which consists of two parts. One part travels along the ground and follows the curvature of the earth. This is the surface wave. The second part is the space wave, which is that part of the total radiation that undergoes refraction, reflection, or scattering from regions in the troposphere. The second major component is the sky (ionospheric) wave, which is radiated in an upward direction and may be returned to the earth at some distant location due to refraction or scattering from the ionosphere. The amount of bending of the sky wave by the ionosphere depends upon the frequency of the wave and the amount of ionization in the ionosphere. The higher the frequency of the radio wave, the farther it penetrates the ionosphere, and the less it tends to be bent back toward the earth.

SKY WAVE PROPAGATION

Sky wave transmission falls into two categories, those refracted by the ionosphere and those refracted by the troposphere. Ionospheric refracted sky waves are generally the only usable waves for long range communications. Figure 10-5 illustrates some of the many possible paths that radio waves of various frequencies may take between a transmitter and a receiver by refraction in the ionosphere. Note that some of the waves, which in this case are assumed to be of too high a frequency (30 MHz and higher) for refraction by the ionized layer, pass on through and are lost in space. Other components of the wave, which are assumed to be of the correct frequency (below 30 MHz) for refraction from the ionospheric layers, are returned to the earth; these waves provide communications. Note also that the skip distance is the distance from the transmitter to the nearest point at which the refracted waves return to earth. The skip zone and its relation to the ground wave are shown in Figure 10-5.

Note the distinction between the terms SKIP DISTANCE and SKIP ZONE. For each frequency at which refraction from an ionospheric layer takes place, there is a skip distance that depends on the degree of ionization present. The skip zone, on the other hand, depends on how far the ground wave extends from the transmitter and where the sky wave first returns to earth by refraction from an ionized layer. The skip zone is the zone between the end of the ground wave transmission and the point on the earth where the sky wave first returns from the ionosphere.

As noted previously in the discussion of the ionosphere, the higher the frequency of a wave, the less it is refracted by a given degree of ionization.

GROUNDWAVE PROPAGATION

The ground wave is that part of the total radiated energy which is propagated at a low angle from the transmitting antenna and travels close to the earth. The ground wave includes components traveling in actual contact with the earth as well as components which travel directly from the transmitting antenna to the receiving antenna when the two antennas are high enough from the ground so that they can "see" each other. For purposes of discussion, ground waves are assumed not to be propagated via the ionosphere. The two components of a ground wave are the surface wave and the space wave.

Surface Wave

A surface wave is that part of the groundwave that is affected chiefly by the conductivity of the earth and is able to follow the curvature of the earth's surface. The surface wave is not confined to the earth's surface, however. It extends to considerable heights, diminishing in strength with increased height. Because part of its energy is absorbed by the ground, intensity of the surface wave is attenuated (weakened) in its travel. The amount of attenuation depends on the relative conductivity of the earth's surface. Table 10-2 gives the relative conductivity for various types of surface.

Space Wave

While the characteristics of the surface wave serve to explain propagation, of signals in the VLF to HF frequency ranges, they do not seem to apply to reception of higher frequencies within and slightly beyond the radio horizon. Such signals are considered to be propagated via the space wave. Space waves are composed of two components, direct waves and ground reflected waves. The direct waves travel direct line of sight paths while the ground-reflected waves are reflected from the earth in a similar manner as sky waves are refracted from the ionosphere. Figure 10-6 shows how groundwaves take a direct or reflected course from transmitter to receiver. Although space waves suffer little ground attenuation, they are susceptible to fading.

A direct wave travels close to but not in contact with the earth, directly from transmitting

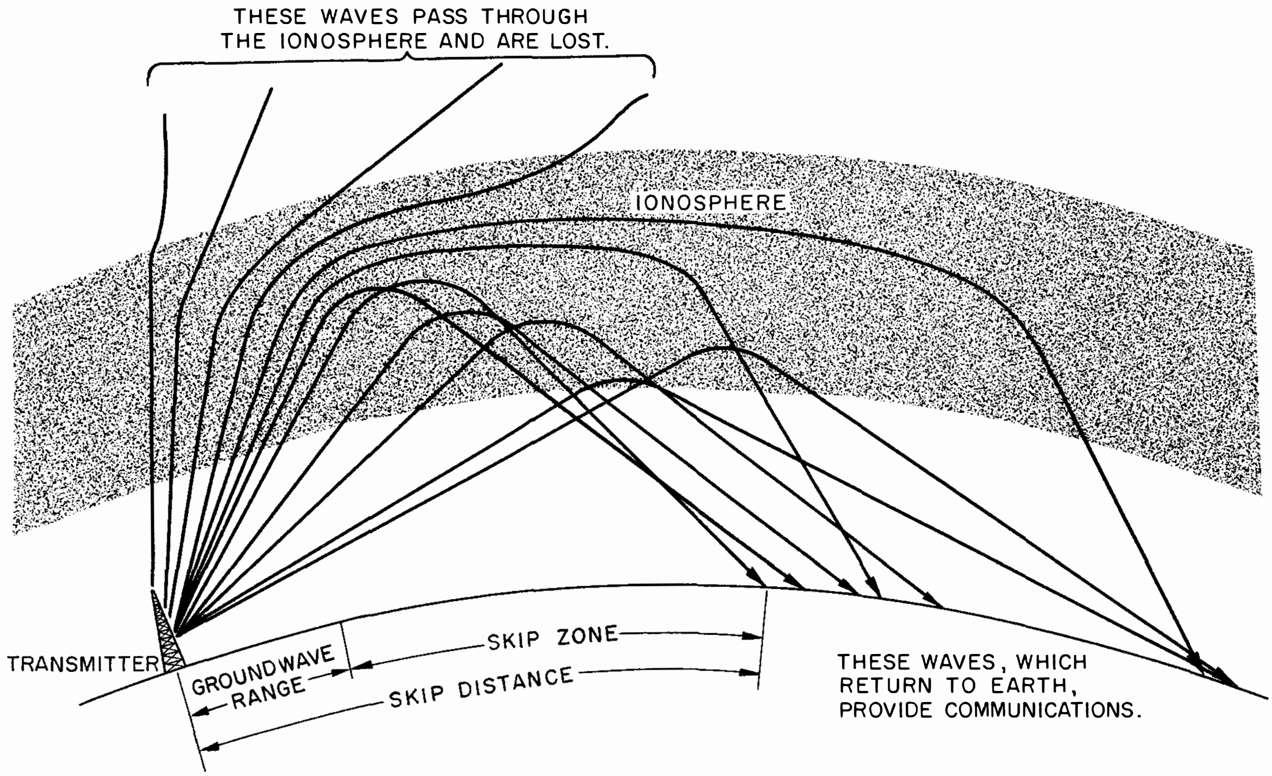

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Figure 10-5.—Various sky-wave transmission paths.

Table 10-2.—Surface Conductivity

Type of surface	Relative conductivity
Sea Water	Good
Large bodies of fresh water	Fair
Wet soil	Fair
Flat, loamy soil	Fair
Dry, rocky terrain	Poor
Desert	Poor
Jungle	Unusable

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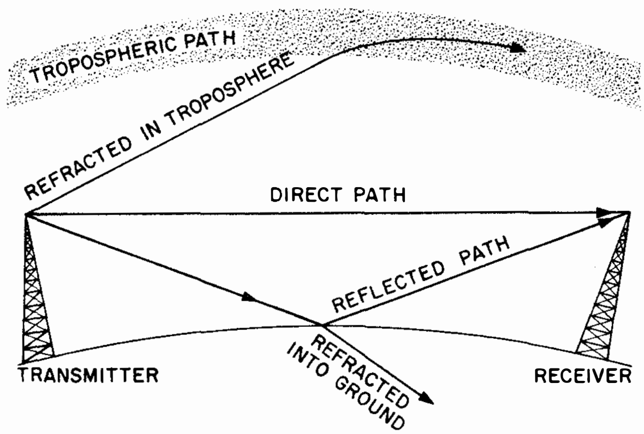

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Figure 10-6.—Possible routes for groundwaves.

to receiving antenna. Consequently, the receiving antenna must be situated within the radio horizon of the transmitting antenna. This distance can be extended by increasing the height of either the transmitting or receiving antenna, effectively extending the horizon. Because radio waves are refracted or bent slightly even when propagated through the troposphere, well below the ionosphere, the radio horizon is actually about four-thirds times the line-of-sight or natural horizon.

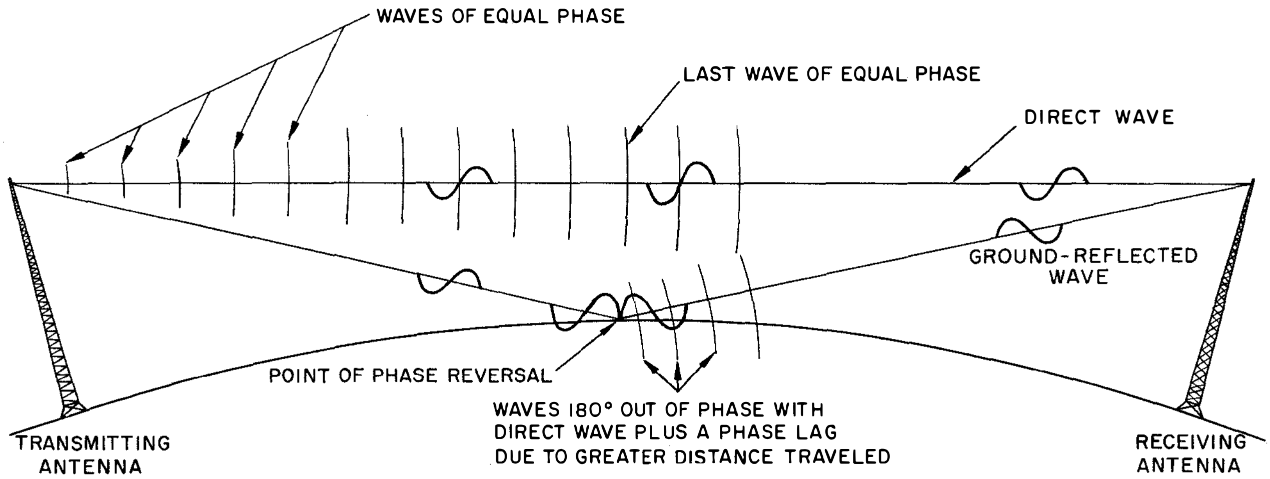

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Figure 10-7.—Comparison of direct and ground-reflected waves.

A ground-reflected wave, as its name indicates, is the part of the space wave that reaches the receiving antenna after it is reflected from ground or sea. Upon reflection from the earth's surface, that ground-reflected component of the space wave will undergo both a phase shift and partial absorption (figure 10-7). Consequently, the signal which is finally received will be a combination of the direct space wave and the weaker, out-of-phase ground-reflected wave. This combination will cause the received signal to fade in varying degrees depending upon the phase difference of the two incoming waves. A phase difference of 180 degrees will produce almost complete fading when the two signals are of equal amplitude.

TRANSMISSION IN FREE SPACE

There is a certain amount of attenuation or loss of energy even for radio signals transmitted in free space. This loss is due to the spreading of energy over a greater area as the transmission distance is increased. The loss is directly related to the frequency and transmission distance. The intensity of energy is the power per unit of area on the spherical wavefront. The relationship between intensity of energy and distance is illustrated in figure 10-8 which shows the pattern of radiated energy spreading directly with the square of the distance which results in the intensity of radiated energy decreasing inversely with the square of the distance from the isotropic antenna in free space. An isotropic antenna uniformly radiates energy in all directions or receives energy in all directions or receives energy equally well from all directions.

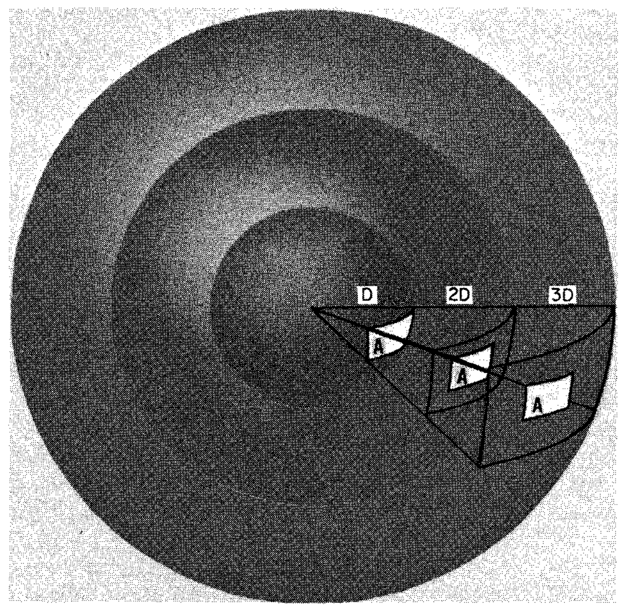

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Figure 10-8.—Free-space pattern of an isotropic antenna showing change in intensity of radiated energy with distance.

Figure 10-8 illustrates the fact that free-space loss introduces a substantial attenuation in the transmitted signal. This is the basic loss which occurs for all types of radio transmissions. For line-of-sight circuits, where the conditions for free-space propagation are closely approximated, the total loss can be considered to be the free-space loss. However, for long distance communications, where either groundwave, sky-wave, or scatter propagation is used, other losses are introduced by the effects of the earth and the atmosphere. Each of these losses must be added to the free-space loss to find the total attenuation of the transmitted signal.

FREQUENCY CLASSIFICATIONS AND CHARACTERISTICS

For practical purposes, it is convenient to classify radio waves into bands of frequencies. Each band of frequencies has similar propagation effects. However, any such classification must be of a general nature only since changes in propagation characteristics with changes in frequency are not sharply defined. Thus when an upper or lower limit of frequency is designated for a certain propagation effect, it does not mean that such an effect stops at those limits, but rather that it becomes negligible beyond such limits.

MF BAND

Only the upper and lower ends of the MF band (0.3 MHz to 3 MHz) have naval use because of the commercial broadcast band extending from about 0.55 MHz to 1.70 MHz. Frequencies in the lower portion of the MF band are used mainly for ground wave transmission for moderate distance over water and moderate to short distances over land. The navy utilizes the upper portion of the MF band (2 MHz to 3 MHz) quite extensively. Range of communication in the upper portion is generally moderate and dependent upon type antenna used and output power of your transmitter. Usually this band, because of the rather long antennas required, utilizes horizontal wire antennas where antenna space is unrestricted. In mobile application, whip antennas are used in this frequency range.

HF BAND

The range of frequencies designated as the HF band (3 to 30 MHz) employs ionospheric propagation for long-range sky wave communication. The frequency characteristics and propagation effects were discussed earlier under ionospheric propagation.

The HF band is the principle frequency range used for Navy ship-to-shore communication circuits. Monthly median frequency predictions for use in this band are distributed quarterly in the DNC-14 (series).

VHF BAND

The VHF band (30 to 300 MHz) is part of the oldest known frequency band of the entire radio spectrum; both Hertz and Marconi conducted their famous experiments in the region from 30 to 3000 MHz. As a rule, ionospheric propagation is negligible in the VHF band and cannot be relied upon for propagation to great distances. However, irregular ionospheric refractions are possible and can cause a signal in the lower part of the band to be propagated several hundred miles by the ionosphere.

The most common path of propagation used at VHF frequencies is through the troposphere and along the surface of the earth. Since the density of the earth's atmosphere normally decreases with altitude, radio waves are propagated by refraction along a curved path to a distance approximating four-thirds the earth's true horizon. In this frequency range, the radio horizon (four-thirds of the true horizon) is governed not only by refraction but by diffraction as well.

Diffraction plays a major role in the VHF band, depending upon the path over which the waves are propagated. The effect of obstacle gain, caused by diffraction of radio waves over a mountain ridge, was first discovered in this frequency range. Diffraction effects are primarily important with regard to irregular terrain which makes possible the reception of signals in the geometric shadow region of a hill or other intervening object. Generally the higher the frequency, the less the diffraction effects.

Atmospheric noise at these frequencies is fairly low and decreases with increasing frequency. One of the more important sources of noise in this range is man-made noise such as that from ignition systems, diathermy machines, and X-ray equipment. In this range, receiver noise and cosmic noise also begins to become prevalent, although considerable improvement in circuit design has made possible its reduction of receiver noise.

UHF BAND

Almost all the energy transmitted from point to point in the UHF band (300 to 3000 MHz) is propagated through the earth's troposphere along a curved path. The refracted path may again be assumed to be a straight line path extending to distances of four-thirds times the true horizon. However, the transmission range may be extended several hundred miles further by means of tropospheric scatter propagation.

Ground reflections are still present at ultra-high frequencies and can cause multipath fading due to destructive interference, although such reflections become of less importance at the higher frequencies of this band. However, a second type of multipath fading can occur when parts of the wave are refracted through other higher layers of the atmosphere and become bent sufficiently to return and combine with the wave received over a lower and more direct path.

At frequencies above 1000 MHz, attenuation of the transmitted signal by trees or other vegetation can range anywhere from 12 to 46 db per mile. However, if the antennas are located to give first Fresnel zone (wave interference zone) clearance above the trees, such attenuation becomes negligible.

Atmospheric and man-made noise in this frequency band is extremely low, with the exception of ignition pulses which can become serious at times. Receiver noise is somewhat greater at these frequencies and increases with increasing frequency, thus calling for special circuit design in the r-f input section of the receiver.

LOWER SHF BAND

At the frequencies of the lower SHF band (3 to 13 GHz), transmission is generally limited to line-of-sight distances based on four-thirds the true horizon. Very little wave reflection will radiate from the earth at these frequencies. Instead, the earth will act as if it were made up of an infinite number of small mirrors, each reflecting the incident wave in a different direction. This phenomenon is sometimes called diffuse reflection. In addition, incident radiation will also be absorbed by the earth's vegetation. The amount of reflected energy from the earth's surface is small; consequently very little wave interference will occur from that source. However, multipath fading and refraction by several propagation paths through the atmosphere is important throughout the entire band. There is also a tendency for buildings and other man-made objects to cast sharp shadows at these frequencies and, if the surface of such objects is smooth, they will reflect the waves in a new direction.

Rain scattering and absorption can cause a serious loss of radiated power at the higher end of this frequency range. If the drop size is comparable to the wavelength of the propagated wave, a very substantial portion of the transmitted energy will be reradiated from the raindrop in a wide range of directions. This phenomenon, known as scattering, has an attenuating effect on radio waves, an effect somewhat like that of diffuse earth reflections. However, not all the energy incident upon a raindrop is reradiated; instead, it is virtually trapped or absorbed and converted into heat. If the drop size is comparatively small in relation to the wavelength, such losses are dependent only upon the volume of water in suspension and therefore are generally negligible.

The use of sharply beamed waves to overcome the losses due to atmospheric attenuation in this band conserves enough power to enable a few watts of directed power to be as effective at a distant receiver as many kilowatts of undirected power.

Receiver noise at these superhigh frequencies has a significant effect on the practical range of a receiving system. Special techniques—such as the use of crystal mixers, MASERS, and high frequency pumps—have been developed to minimize the noise by converting the received signal to a lower frequency before amplification.

FREQUENCY SELECTION

Radio wave propagation conditions have their greatest affect on MF/HF circuits between ships and stations separated by great distances. Frequency selection in the MF/HF range is determined by propagation conditions, frequency authorizations and frequency availabilities. The sky waves of higher frequencies can be used during the daytime, while lower frequencies must be used at night. The key to frequency selection is the condition of the ionosphere midway between the two stations. DNC 14 or other frequency prediction information is used to determine the recommended frequency band, and the selected frequency is monitored to be sure it is not already in service.

In all other frequency ranges, circuits usually operate under semistable propagation conditions, and frequency selection is based on frequency authorization and frequency availability.

FREQUENCY PREDICTIONS

The Institute for Telecommunication Sciences, previously known as the Central Radio Propagation Laboratory of the National Bureau of Standards, receives and analyzes ionospheric data from many stations throughout the world. These ionospheric data, are utilized by the Armed Forces as well as by many other users to produce Monthly Median Frequency Predictions. To assist the Navy communicator, the DNC 14 series, entitled Recommended Frequency Bands and Frequency Guide, is published quarterly, 3 months in advance of its effective data. The publication contains tables of frequency bands recommended for use under normal conditions for communications from various geographic areas to each of the NAVCOMMSTAs. The normal or undisturbed conditions on which these predictions are based exists about 85 percent of the time.

OBLIQUE IONOSPHERIC SOUNDER RECEIVER AN/UPR-2

The Ionospheric Sounder Receiver is a recently designed equipment that will aid the fleet communicator in frequency selection. As previously stated the key to frequency selection is the condition of the ionosphere midway between the two stations that are communicating. Frequency selection with the aid of the Ionospheric Sounder Receiver is accomplished in the following manner. A transmitter stationed ashore sends a series of pulse sequences at precise times specified by its published transmission schedule. The sounder receiver is programmed to automatically tune to each of 80 frequencies in the range from 2 to 32 Mhz. The tuning changes must occur at exactly the right times and allowances must be made for the time taken for the signal to travel from the transmitter to the receiver. Frequencies that propagate are displayed on a cathode-ray oscillograph in the form of an Ionogram. The Ionogram also shows multipath propagation which produces excessive distortion and the effects of solar flares which cause increased absorption of the lower range of frequencies that propagate.

The Technical Manual contains tables that list the operating procedures of the AN/UPR-2 in a logical sequence.

FREQUENCY PLANS

Frequency plans contain information and guidance for intra-service, joint, and combined use, and for operating in specific areas. JANAP 195 contains information and guidance for U.S. Navy and Marine Corps use; supplements to ACP 176 contain information for units operating with NATO and SEATO pact nations.

IONOSPHERIC PROPAGATION

A basic understanding of the ionosphere—what it is and how it is formed—is necessary in order to understand how it affects radio wave propagation. The following paragraphs provide a description of the ionosphere.

STRUCTURE OF THE IONOSPHERE

The ionosphere is the area of the atmosphere in which the gas atoms are charged by xrays or ultraviolet light from the sun and by meteor activity. These charged atoms are called ions; the process by which they are charged is called ionization.

Ionization occurs as follows. When a high-energy electromagnetic wave, such as ultraviolet light, hits an atom, it is capable of knocking an electron free of its parent atom. When this occurs, a positively charged atom, called a positive ion, remains in space along with the negatively charged free electron. The electron absorbs energy from the incident wave which frees it from its parent atom. The rate of ion and free electron formation depends upon the density of the atmosphere and the intensity of the ultraviolet light. As the ultraviolet light wave produces positive ions and negative free electrons, its intensity is decreased because of the absorption of energy by the free electrons. Therefore, the ionized region will tend to form in a layer for a given frequency of ultraviolet light. When the wave first hits the ionosphere, it has high energy, but the ionosphere is not dense at its highest altitudes; therefore, little ionization will occur. As the wave passes through the ionosphere, the density increases, but the energy level of the wave decreases. An ionized layer forms where the combined effect of ionospheric density and wave energy is maximum.

Since there are different ultraviolet wave frequencies, several ionized layers are formed, as shown in figure 10-9. Lower frequency ultraviolet waves tend to produce ionized layers at higher altitudes. The higher frequency ultraviolet waves tend to penetrate deeper into the ionosphere before producing appreciable ionization.

Ionospheric Layers

Figure 10-10 shows that there are four distinct layers of the ionosphere which are designated D, E, F1, and F2. The height, thickness, and intensity of ionization for each of the layers is measured by transmitting r-f pulses vertically into the ionosphere and then receiving the returned pulse. The echo time indicates height of the ionospheric layer. When pulses of various r-f frequencies are transmitted, a frequency will be found above which the vertical wave will not be refracted back to earth. This frequency, called the critical frequency, indicates the extent of ionization. The higher the critical frequency, the greater the ionization. Since the ionospheric layers are caused chiefly by xrays and ultraviolet light emitted from the sun, their height and thickness change with the season and the time of day.

Between heights of 25 to 50 miles above the surface of the earth is the first layer of pronounced ionization, known as the D layer. The amount of ionization in the D layer is not extensive and has little effect in bending the paths of high-frequency radio waves, although it does weaken or attenuate such waves crossing through this layer. At times it may absorb low- and medium-frequency waves completely. Its density follows the variation of the sun, becoming densest at noon, and fading out shortly after sunset. It is chiefly responsible for the intensity of high-frequency waves being lower when the transmission is in sunlit hours than during darkness.

The second layer in order of height, called the E layer, lies at heights between 50 and 80 miles. Its height varies somewhat with seasons. Lower heights occur when the sun is in that latitude, probably because the solar radiation penetrates farther into the atmosphere when the sun is more directly overhead. Ionization of the E layer follows the sun's altitude variations closely. It attains its maximum density at about noon, fading to such a weak level during the night that it is practically useless as an aid to high-frequency radio communication. Ionization in this layer usually is sufficient to bend back to earth radio waves at frequencies as high as 20 MHz. Thus, the E layer is of great importance to radio transmission for distances under approximately 1500 miles. At distances greater than 1500 miles, better transmission can be obtained by means of the F, F1, and F2 layers.

At heights between 85 and 250 miles above the earth's surface is another layer of ionization, known as the F layer. Ionization exists at all hours, usually with two well-defined layers during the daytime (F1 and F2) and one during the night. At night, the single F layer lies at a height of about 170 miles

During daylight hours, especially when the sun is high (as in the tropics), and during the local summer months, the F layer splits into two distinct layers—the F1 and F2. Depending on the seasons and the time of day, maximum ionization occurs in the F1 layer between 135 and 145 miles. The F2 layer maximum ionization occurs between 190 and 230 miles. The F2 layer is the most highly ionized of all layers and is most useful for long-distance radio communication. Intensity of ionization reaches a maximum in the afternoon, gradually decreases throughout the night, with a rapid rise in on density in the morning.

Variations in the Ionosphere

Since the ionosphere exists primarily because of the radiation of the sun, any variation in the strength of this radiation will cause a corresponding change in the ion density of the upper atmosphere. Some of the variations in the ionosphere are periodic and their effects on radiofrequencies can be anticipated. Others are unpredictable, and while their effects are pronounced, there is little that can be done but realize that they may occur. Periodic variations can be divided into daily, seasonal and sunspot cycle variations. Unpredictable variations are usually the result of the sporadic E layer and Short Wave Fadeouts (caused by sudden solar flare-ups).

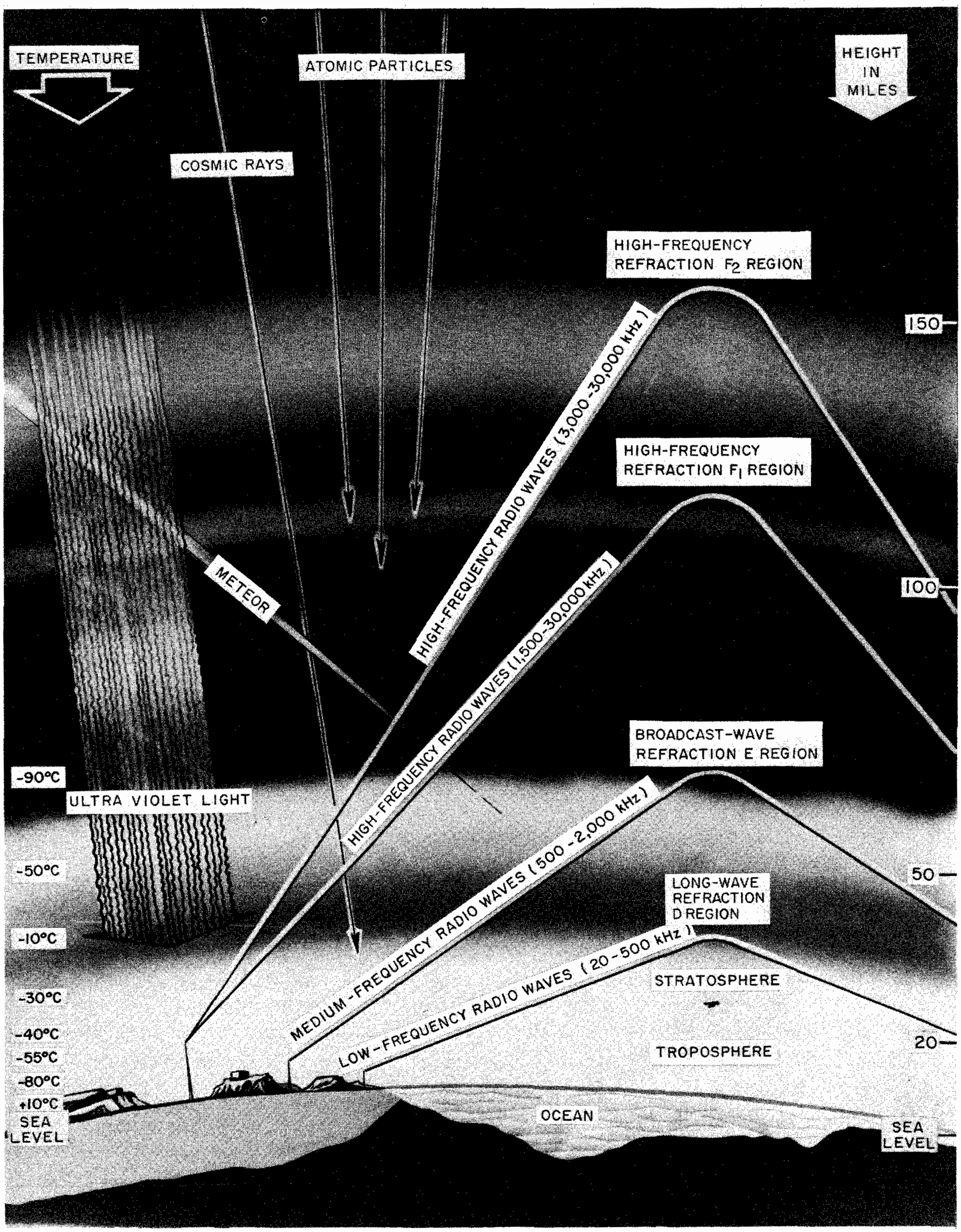

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Figure 10-9.—Composition of the earth's atmosphere.

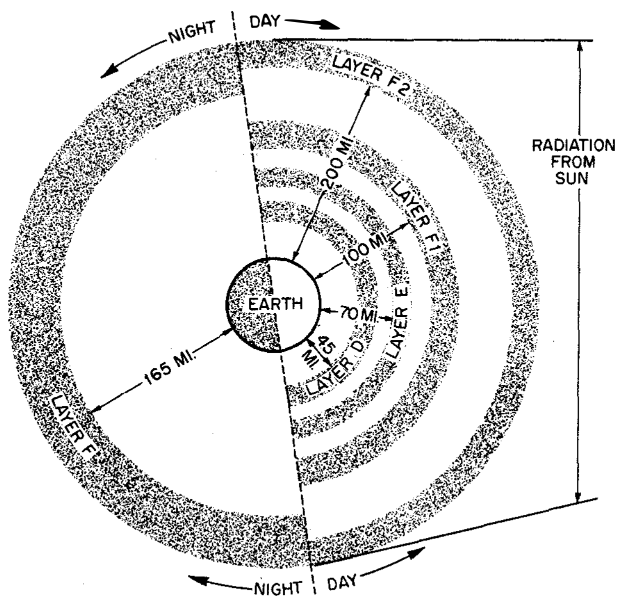

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Figure 10-10.—Ionosphere layers.

PERIODIC VARIATIONS.—Daily variations are caused by the 24-hour rotation of the earth about its axis. In the daytime, the ionosphere consists of the four ionized layers previously mentioned. At night in the F region, only the F2 layer exists insofar as regular HF propagation is concerned. The nighttime F2 layer is formed by a combination of the daytime F1 and F2 layers that merge just inside the night area.

Seasonal variations occur as the intensity of the ultra-violet light which reached any given spot in the earth's asmosphere varies with the position of the earth in its orbit around the sun.

Sunspot activity varies in conformity with an 11-year cycle. Sunspots are proportional to approximate solar radiation and to the total ionization of the atmosphere. During periods of high sunspot activity, ionization of various layers is greater than usual, resulting in higher critical frequencies for the E, F1, and F2 layers, and higher absorption in the D layer. Consequently, higher frequencies can be used for communication over long distances at times of greatest sunspot activity. Increased absorption in the D layer, which has the greatest effect on the lower frequencies, requires higher frequencies. The overall effect is a general improvement in propagation conditions during years of maximum sunspot activity.

Another cycle due to solar activity is the 27-day variation, caused by rotation of the sun on its axis. As the number of sunspots changes from day to day with rotation of the sun, formation of new spots, or disappearance of old ones, absorption by the D layer also changes. Similar changes are observed in the E layer, and cover a wide geographic range. Fluctuations in the F2 layer are greater than for any other layer, but usually are not of a worldwide character.

IRREGULAR VARIATIONS.—In addition to the regular variations of the ionized layers, a number of unpredictable events have an important effect on propagation of the skywave. Several of the more prevalent of these events are sporadic E effects and short wave fadeouts.

Sporadic E is an ionized cloud that appears at indefinite times and at the same height as the normal E layer. Sometimes it is capable of reflecting so much of the radiated wave that reflections from other layers of the ionosphere are blanked out completely. Sporadic E may be so thin at other times that reflections from upper layers can be received through it easily. Although the sporadic E layer is more prevalent in the tropics than in higher latitudes, its occurrence is frequent. It may occur during the night or day.

The most unusual of all irregularities of the ionosphere and of radio wave transmission is the Short Wave Fadeout (SWF), which is due to Sudden Ionospheric Disturbances (SIDs.) SWF comes without warning and may last from a few minutes to several hours. This disturbance, caused by a solar eruption of ultraviolet radiation, affects all stations on the sunlit side of the earth and is characterized by simultaneous fadeouts on a wide range of the HF ban. The solar eruption causes a sudden increase in ionization of the D layer, frequently followed within a few days by disturbances in the earth's magnetic field. The lower frequencies are absorbed first and recover last. During SWF of low intensity, transmission, may continue to be possible on the higher frequencies.

REFRACTION IN THE IONOSPHERE

When a radio wave is transmitted into the ionosphere, the wave is refracted. The refraction, or bending, is caused by a change in velocity of the segments of the wavefront as it strikes the ionized layer at an oblique angle. The portion of the wavefront first striking the ionized layer undergoes bending while other portions of the wavefront which have not yet reached the ionized layer are still traveling in a straight line. The amount of bending depends upon the electron density of the ionized layer and the frequency of the transmitted wave. The effect of each of these factors is discussed in the following paragraphs.

Each ionized layer consists of a central region of relatively dense ionization which tapers off in intensity both above and below the maximum region. As a wave passes into a layer of increasing ionization, the velocity of the upper part of the wave increases, causing the wave to bend back toward the earth. If the wave enters into a layer of decreasing ionization, the velocity of the upper part of the wave decreases, and the wave is bent away from the earth. The amount of bending in both cases depends upon both the variation in ionization and the height of the ionized layer. If the wave enters a thin, very highly ionized layer, the wave will be bent back so rapidly that it will appear to have been "reflected" instead of refracted back to earth. To reflect a radio wave, the highly ionized layer must be approximately no thicker than one wavelength of the incident wave. Since the ionized layers often are several miles thick, ionospheric "reflection" is more likely to occur at long wavelengths (low frequencies). The wave is bent (refracted) more slowly (as shown in figure 10-11) when there is a gradual change in the relationship between ionization density and increased height.

The amount of refraction required to return the wave at a given frequency to earth depends on the angle at which the wave enters the ionized region (incident angle). The relationship is shown in figure 10-11 in which the radio waves of the same frequency are beamed toward the ionosphere at various angles. Because wave A approaches the ionized layer at a small angle, only a slight amount of bending is required to return it to earth. Because wave B approaches at a greater angle and penetrates deeper into the ionized layer, a longer path is required for bending it since the variation in density with height is more gradual. Because wave C approaches at almost vertical incidence, the ionized layer is unable to return it to earth.

If transmission is made at vertical incidence (straight up) and the frequency continues to increase, the lower frequencies will be returned

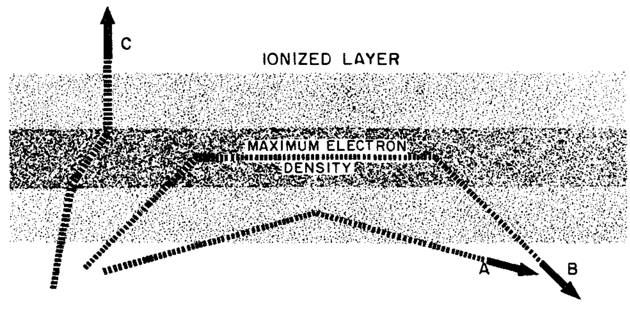

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Figure 10-11.—Change in bending of radio waves in an ionized layer with a change in angle of incidence.

to earth; but eventually a point will be reached where the signals are not returned. The highest frequency that will be returned from vertical incidence is called the critical frequency, which will vary with the seasons, time of day, or any other effects which cause the density of the ionosphere to change. The critical frequency is higher in the daytime than at night.

Maximum Usable Frequency

As the incident angle is lowered from the vertical, there is a corresponding increase in the frequency which will be returned to earth. The factors which determine the actual frequency to be used for a communication circuit are the height of the ionized layer used for refraction and the distance between the two ends of the circuit. The maximum frequency which will be refracted for a given distance of transmission is called the maximum usable frequency (MUF). The MUF is always higher than the critical frequency.

Frequency of Optimum Traffic

Experience has shown that the MUF may increase or decrease significantly, especially during daytime because of changes occurring in the ionosphere. Therefore, the frequency of optimum traffic (FOT), is used so that variations in the ionosphere will have less effect on the communication circuit.

ABSORPTION IN THE IONOSPHERE

As the radio wave passes into the ionosphere, it loses some of its energy to the free electrons and ions. If those high-energy free electrons and ions do not collide with gas molecules of low energy, most of the energy lost by the radio wave is reconverted into electromagnetic energy, and the wave continues to be propagated with little change in intensity. However, if the high-energy free electrons and ions do collide with other particles, they dissipate the energy which they have acquired from the wave, resulting in absorption of the energy from the wave. Since absorption of energy is dependent upon collision of particles, the greater the density of the ionized layer, the greater the probability of collisions; therefore the greater the absorption. The highly dense D and E layers provide the greatest absorption for the ionospheric wave.

Because the amount of attenuation of the sky wave depends upon the density of the ionosphere which varies with seasonal and daily conditions, it is impossible to express a fixed relationship between distance and signal strength for ionospheric propagation. Under favorable conditions, only free-space attenuation will occur. Under certain conditions, the absorption of energy is so great that communicating over any distance beyond the line of sight is difficult. Sky-wave intensity varies from minute to minute, month to month, and year to year because of variations in the ionosphere.

Fading

Fading is the variation of radio signal strength at a radio receiver during the time of reception. Signals received over an ionospheric path may vary in intensity over short periods of time. There are three major reasons for fading. When the radio wave is refracted in the ionosphere or reflected from the earth's surface, random variations in polarization of the wave may occur, causing changes in the received signal level because of the inability of the antenna to receive polarization changes. Fading may also occur if the operating frequency is selected too close to the MUF. If this is the case, any slight change in the ionosphere might cause a change in signal strength. Fading also results from absorption of the signal energy in the ionosphere. Absorption fading occurs for a longer period of time than other types of fading, since absorption changes slowly. However, the major reason for fading on ionospheric circuits is caused by multipath propagation.

Multipath Fading

"Multipath" is the term used to describe types of propagation such as groundwave, reradiation by the ionospheric layers, multireflections from the same layer, and reflection from more than one layer, which cause signals to arrive at the receiving site a short time later than the signal reflected from the ionosphere.

Figure 10-12 shows the various paths a signal can travel between two sites in a typical circuit. One signal from the transmitter may follow the path XYZ, which is the basic ground wave. Another signal, which follows the path XEA, is refracted from the E layer and received at A, but not at Z. Still another path is XFZFA, which results from a greater angle of incidence and two refractions from the F layer. At point Z, the received signal is a combination of the ground wave and the sky wave. If these two waves are received out of phase, they will produce a weak or fading signal. If they are received in phase, they will produce a stronger signal. Small alterations in the transmission path may change the phase relationship of the two signals, causing periodic fading. This same addition of signal components occurs at point A. At this point, the double-hop F layer signal may be in or out of phase with the signal arriving from the E layer.

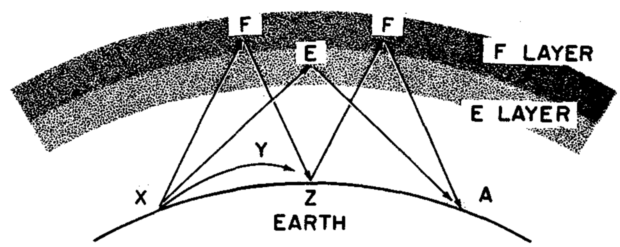

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Figure 10-12.—Multipath transmission.

SELECTIVE FADING.—Fading resulting from multipath propagation is variable with frequency since each frequency arrives at the receiving point via a different radio path. When a wide band of frequencies, such as multichannel single sideband, is transmitted, the frequencies in the sideband will vary in the amount (if any) of fading. This variation is called selective fading. When selective fading occurs, all frequencies within the envelope of the transmitted signal may not retain their original phases and relative amplitudes. This fading may cause severe distortion of the signal and limit the total bandwidth which can be transmitted.

TROPOSPHERIC PROPAGATION

The foregoing sections of this chapter have provided a discussion of that portion of radiated energy which is acted upon by the ionosphere and returned to earth and also that portion of radiated energy which is propagated along the earth's surface. In this section, consideration is given to that part of the total radiated energy which undergoes reflections and refractions in the troposphere.

The troposphere is the lowest region of the atmosphere, extending from the ground to a height of slightly over six miles. Virtually all weather phenomena occur in this region of the atmosphere. There is practically no ionization in the troposphere. Generally, the troposphere is characterized by a steady decrease of temperature and pressure with an increase in height.

Refraction of radio waves in the troposphere is a function of various meteorological variables. Because of the uneven heating of the earth's surface, the air in the troposphere is in constant motion. This motion causes small turbulences, or eddies, to be formed. These turbulence are quite similar to the whirlpools in a rapidly moving stream of water. The turbulence is most intense near the earth's surface and gradually diminishes with altitude.

For frequencies up to about 30 MHz, radio wavelengths are large compared to the size of the turbulences; therefore, the turbulences have little effect on the transmitted signal. However, as the frequency is increased, these local turbulences become increasingly important because they are responsible for tropospheric scatter transmission.

FORWARD SCATTER TECHNIQUES

During the past few years, techniques have been developed in which very high frequencies (VHF) and ultra high frequencies (UHF) can be transmitted over distances far beyond the normal line-of-sight transmission. These new techniques are known as scatter mode propagation.

FORWARD PROPAGATION BY IONOSPHERIC SCATTER (FPIS)

In explaining refraction and describing the ionosphere, it has been assumed that the density variation within a layer is gradual and uniform. This picture of the ionosphere provides a very satisfactory explanation for most radio wave phenomena associated with the ionosphere. However, there are also turbulent and irregular variations in the ion density of the ionosphere. When a wavefront encounters a sudden change in ion density, irregular variations in the wavefront result. These variations result in the scattering of the radio wave. In direct contrast to normal HF circuit propagation, EPIS signal strengths remain relatively stable or even improve during times of magnetic and ionospheric disturbances.

Scattering takes place in the E layer region of the ionosphere. Under suitable conditions, this type of propagation may be used for low transmitting angles with frequencies as high as 100 MHz. However, the scattering process causes some of this energy to be returned from the E layer to the receiving antenna. Only a very small percentage of the total energy is returned. If the scattering region is within visible ranged of the transmitting and receiving antennas, the total loss is free-space loss, plus a scatter loss, which is dependent upon the size and strength of the irregular variation in the medium and the angular change in direction of the wavefront. This scatter loss is large—in the range of 60 to 100 or more db. Since the scatter loss is so large, this form of propagation requires the use of high-power transmitters and highly directional antennas.

Signals received over ionospheric scatter circuits are quite weak, but do not show the extreme changes in signal level (fading) which sometimes occur with other types of propagation. In a daily cycle, the signal level reaches a minimum value at about 2000 local time. There is, however, no nighttime disappearance of the signal as in the case of regular E layer propagation which disappears shortly after sunset. There is also an annual cycle with minimum field strength or signal level during spring and fall. The received signal is also characterized by rapid, punctuated strong bursts of energy evidently associated with ionized meteor trails.

FORWARD PROPAGATION BY PROPOSPHERIC SCATTER

The scatter technique differs from that described above in that it takes place in the troposphere and is independent of the ionosphere. When properly engineered, FPTS is reliable up to distances of 600 miles. The scattering phenomenon in the troposphere is based on the theory that turbulences prevailing in the troposphere cause scattering of the signal beyond the horizon, and takes place primarily when operation is in the UHF range. The scatter effect is the same as if each turbulence received the signal and reradiated it. Thus the effect is similar to the ionospheric scatter already described.

The word "scatter" implies that the spreading of energy is equal in all directions; however, the direction of energy distribution in tropospheric scatter propagation differs only slightly from the direction of the path of the main wavefront. The scattering occurs chiefly in the forward direction; therefore the term "forward scatter" is sometimes used when taling about tropospheric scatter.

The magnitude of the received signal depends on the number of turbulences causing scatter in the desired direction and the direction and gain of the receiving antenna beam. This quantity or magnitude is called the scatter volume. The scatter volume and scatter angle are shown in figure 10-13. As the scatter angle is increased, the amount of received scattered energy decreases very rapidly.

The amount of received energy decreases as the height of the scatter volume is increased. There are two reasons for this: (1) scatter angle increases as height is increased; (2) the amount of turbulence decreases with height. As the circuit distance is increased, the height of the scatter volume must also be increased. Therefore, the received signal level decreases as the circuit distance is increased.

Since tropospheric scatter depends on turbulences in the atmosphere, changes in atmospheric conditions will affect the received signal level. Both daily and seasonal variations are noted. These changes are called long-term fading. In addition to long-term fading, the tropospheric scatter signal often is also characterized by very rapid fading which is caused by multipath propagation. The signals received at any one time are the sum of all the signals received from each of the turbulences in the volume. Since the turbulent condition is constantly changing, the path lengths and individual signal levels are also changing, resulting in a rapidly changing signal. Although the signal level is constantly changing, the average signal level is persistent, and no complete fade-out occurs.

Another characteristic of a tropospheric scatter signal is its relatively low power level. The scatter volume can be pictured as a relay station, located above the horizon, receiving the transmitted energy and reradiating it to some point beyond the line-of-sight distance. Since most of the transmitted energy is not reradiated to the receiver, the efficiency is very low, and the signal level at the final receiver point is low. To compensate for the low efficiency in the scatter volume, the incident power must be

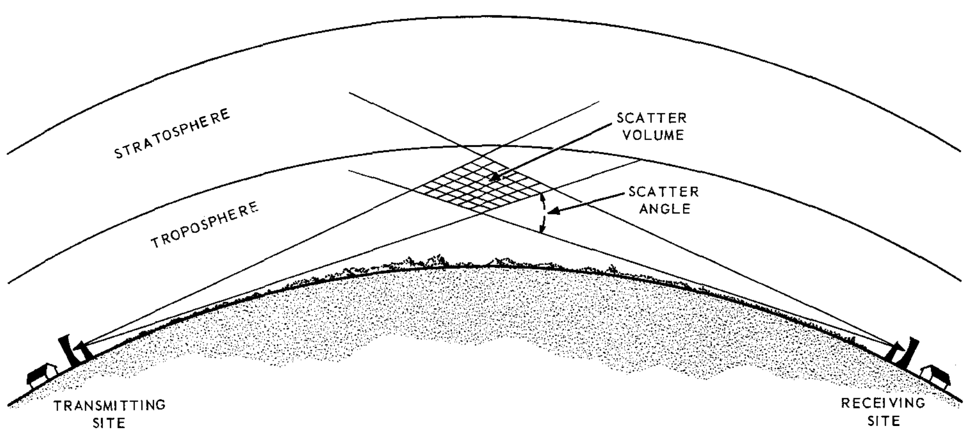

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Figure 10-13.—Scatter Propagation.

high. This is accomplished by using high-power transmitters and high-gain antennas which concentrate the transmitted power into a beam, thus increasing the intensity of energy on each turbulence in the volume. The receive must also be very sensitive to detect the low-level signals.

SATELLITE COMMUNICATIONS

Integration of reliable, flexible, and high quality communications via satellites into existing naval communications is a part of the overall system for the command and real-time control of naval forces. Not only does the Navy participate in the Phase I Defense Satellite Communications System (DSCS) and the Tactical Satellite Communications Program (TACSATCOM), but the Navy has its own synchronous communications (SYNCOM) project.

The Phase I space segment of the Satellite Communications System (summer 1969) consists of 23 operational satellites, randomly spaced in a circular, equatorial, near synchronous orbit. The satellites, equipped with earth coverage antennas, provide high quality voice, teletypewriter and high-speed graphics channels. Control over the DSCS is exercised by the DCA and through the Satellite Communication Control Facility and other elements of the Defense Operations Center complex.

The TACSATCOM Program is a cooperative research and development effort of the Department of Defense, directed by an executive committee staffed by members of the Army, Navy, Air Force and Marine Corps. Six basic terminal configurations are incorporated in the network, which range from individual manpack devices for receiving only (alert/broadcast receiver) to aircraft and shipboard terminals. The 1600 pound TACSAT I, the largest communications satellite ever built, was launched into orbit 9 February 1969, for first-phase evaluation of the system. The Navy currently has 21 TACSATCOM terminals installed in ships and at naval communications stations and units for ship-ship and ship-shore communications. The Navy Satellite Operations Center was established to perform as the Navy Satellite Communications Net Control and Scheduling Activity.

Experiments with synchronous communication (SYNCOM) satellites began in 1964, when the National Aeronautics and Space Administration launched three satellites, In 1965, the Navy installed experimental receivers in several ships to determine the feasibility of ship-ship and ship-shore communications via satellite relay. Not only were the tests successful, but they also provided valuable data for the concepts and design of the Phase I DSCS program. SYNCOM III, launched in August, 1964, continues to provide an operational capability to the Navy and serves as a tool for further fleet experiments. The SYNCOM shore terminal, originally installed on Guam by the Army, has been shipped to the CONUS for relocation in the Mediterranean area.

EFFECTS OF WEATHER ON PROPAGATION

Weather is one of the many factors affecting wave propagation. Because there are many ways in which weather may affect wave propagation, it is the purpose of this section to consider the various phenomena and to show their relationship to radio wave propagation.

Wind, air temperature, and water content of the air can combine in many ways, with different combinations causing radio signals to be heard hundreds of miles beyond their ordinary range or to be attenuated to a point where the signals may not be picked up over a normally satisfactory path. Unfortunately, no hard and fast rules may be given concerning the effects of weather on radio transmissions since the variables of weather are extremely complex and subject to frequent change. Any discussion of the effects of weather on radio must therefore be limited to general terms and will be so treated here.

PRECIPITATION ATTENUATION

Calculating the effect of weather on radio 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 in the atmosphere, even in arid regions and must be considered in all microwave calculations.

Attenuation due to raindrops is greater than attenuation due to other forms of water. Attenuation may be caused by absorption, whereby the raindrop, acting as a poor dielectric, absorbs power from the electromagnetic wave and dissipates the power by heat loss or by scattering. Raindrops will cause greater attenuation by scattering than by absorption at frequencies above 100 MHz and at frequencies above 6 GHz attenuation by raindrop scatter is quite pronounced.

Variation in raindrop size causes one of the difficulties in attempting to determine the attenuation by scattering. There is no uniformity of drop size in any rainfall; the droplets vary in diameter from less than one millimeter to five millimeters or more. As a general rule, the heaviest rate of rainfall is accompanied by the greatest drop size, and, therefore, the greatest attenuation.

Attenuation due to other forms of precipitation such as fog, snow, hail, and sleet and glaze is considerably less than from falling rain and therefore is of minor importance.

DUCTING

Unusual ranges of VHF and UHF signals are caused by abnormal atmospheric conditions a few miles above the earth. Normally, the warmest air is found near the surface of the water. The air gradually becomes cooler as altitude increases. Sometimes unusual situations develop where warm layers of air are found above cooler layers. This condition is known as TEMPERATURE INVERSION.

When a temperature inversion exists, the amount of refraction is different for the particles trapped within the boundaries from those outside them. These differences form channels or ducts that will conduct the radio waves many miles beyond the assumed normal range.

Sometimes these ducts are in contact with the water and may extend a few hundred feet into the air. At other times the duct will start at an elevation of between 500 and 1000 feet and extend an additional 500 to 1000 feet in the air.

If an antenna extends into the duct or if the wave enters a duct after leaving an antenna, the transmission may be conducted a long distance. An example of this type of transmission of radio waves in ducts formed by temperature inversions is shown in figure 10-14.

With certain exceptions, ducts are formed over water where the following conditions are observed aboard ship:

- A wind is blowing from land.
- There is a stratum of quiet air.
- There are clear skies, little wind, and high barometric conditions.
- A cool breeze is blowing over warm open ocean, especially in the tropic areas and in the trade-wind belt.
- Smoke, haze, or dust fails to rise, but spreads out horizontally.

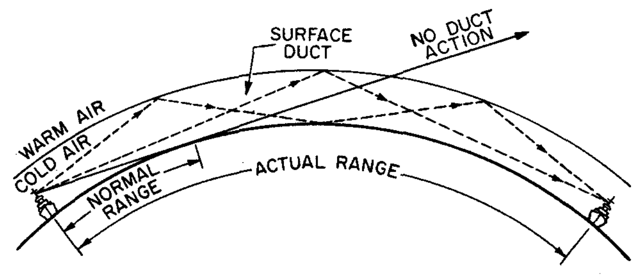

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Figure 10-14.—Duct effect in high-frequency transmissions.

ANTENNAS

Since operation of communication equipment over the entire range of the r-f spectrum requires many types of antennas, it is essential that the operator know something about the basic types, their characteristics, and uses. In many cases the operator will have a choice of antennas and therefore he must be able to select the one most suitable for the task at hand. His ability to make or change connections can mean the difference between efficient and inefficient operation.

BASIC PRINCIPLES

An antenna is a conductor or a system of conductors for radiating (transmitting) or intercepting (receiving) radio waves. In its elementary form, an antenna may be simply a length of elevated wire like the common receiving antenna for an ordinary broadcast receiver. If an antenna is fed a radiofrequency current from a transmitter, it will radiate electromagnetic waves into space. If an antenna is placed in the path of an electromagnetic wave traveling through space, a radiofrequency current will be induced in the antenna. The induced current is used as the input to a receiver. However, before discussing specific types of antennas, it will be helpful to discuss several terms which are used to describe the characteristics of antennas.

Wavelength

The physical length of an antenna is often referred to in wavelengths. Such terms as quarter-wave, half-wave, and full-wave are used extensively. Wavelength (LAMBDA) is usually expressed in meters and is defined as the velocity of a radio wave in free space divided by the frequency of the wave. The symbol for LAMBDA is λ.

Since the velocity of an electromagnetic wave in free space is considered to be 300 million meters per second, the formula for computing wavelength is expressed as:

$$\text{Wavelength in meters} = \frac{300{,}000{,}000}{\text{Frequency (in hertz)}}$$

For example, to compute the length of a full wave antenna for use on 10,000 kHz proceed as follows:

$$\frac{300{,}000{,}000}{10{,}000{,}000} = 30 \text{ meters, or, since}$$
$$1 \text{ meter} = 3.28 \text{ feet}$$
$$30 \times 3.28 = 98.4 \text{ feet}$$

If half-wave or quarter-wave antenna values are desired, simply divide the result by 2 or 4.

The strength of a radio wave radiated by an antenna depends on the length of the antenna and the amount of current flowing in it. Because the antenna is a circuit element having inductance, capacitance, and resistance, the largest current is obtained when the inductive and capacitive reactances (opposition to the flow of alternating current) are tuned out; that is, when the antenna circuit is made resonant at the frequency being transmitted.

The shortest length of wire that will be resonant at any particular frequency is one just long enough to permit and electric charge to travel from one end of the wire to the other end and back again in the time of 1 cycle. The distance traveled by the charge is 1 wavelength. Because the charge must travel the length of the wire twice, the length of wire needed to have the charge travel 1 wavelength in 1 cycle is half a wavelength. Thus, the half-wave antenna is the shortest resonant length and is used as the basis for all antenna theory.

An antenna can be made resonant by two methods: (1) by adjusting frequency to suit a given antenna length; or, as usually is more practical, (2) by adjusting the length of the antenna wire to suit a given frequency. It is, of course, impracticable to lengthen or shorten an antenna physically every time the transmitter is changed to a new frequency. The antenna length may, however, be changed electrically. This change is accomplished by a process known as tuning, or loading, the antenna.

Polarization

The polarization of a wave is determined by the direction of the electric lines of force (E field). If the E field is vertical, the polarization is vertical, etc. Since the E field is parallel to the wire or arms of a simple antenna, an antenna that is vertical with respect to the earth radiates a vertically polarized wave, while a horizontal antenna radiates a horizontally polarized wave. The sine wave in figure 10-15A represents the vertical electric field component of a vertical antenna. Figure 10-15B shows the horizontal electric field component of a vertical antenna. Figure 10-15B shows the horizontal electric field component of a horizontal antenna as a sine wave lying in a horizontal plane. When high-frequency transmission is used, the polarization usually varies, sometimes quite rapidly due to changes in polarization when refracted from the ionosphere.

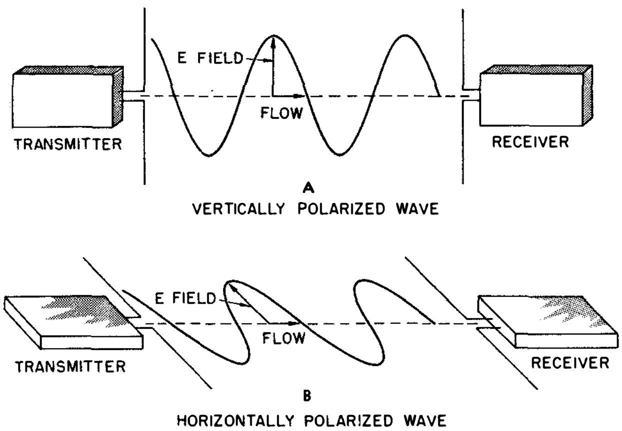

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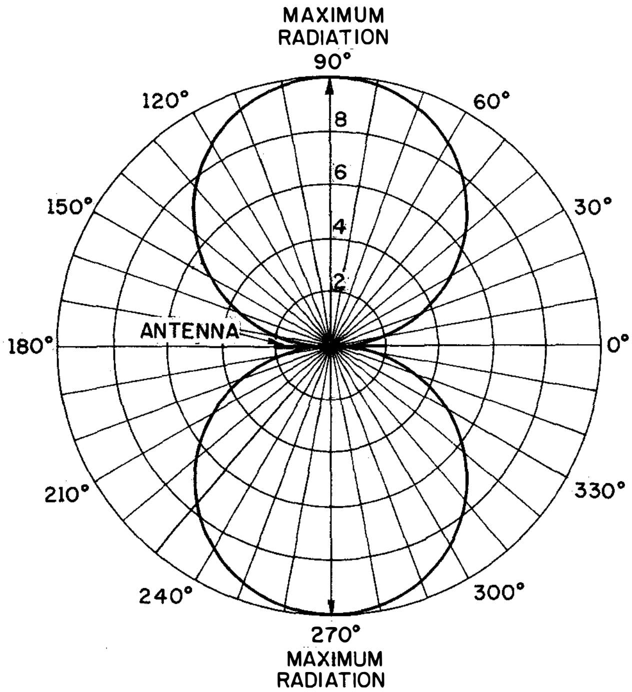
Figure 10-15.—Vertical and Horizontal polarization.

Field Strength

The field strength of an electromagnetic wave radiated from an antenna is the magnitude of its electric field (measured in volts per meter) at a given point. Since it is a vector field, it has a direction as well as a magnitude. The variation of signal strength around an antenna can be shown graphically by polar diagrams as in figure 10-16. Zero distance is assumed to be at the center of the chart (indicating the center of the



20.248

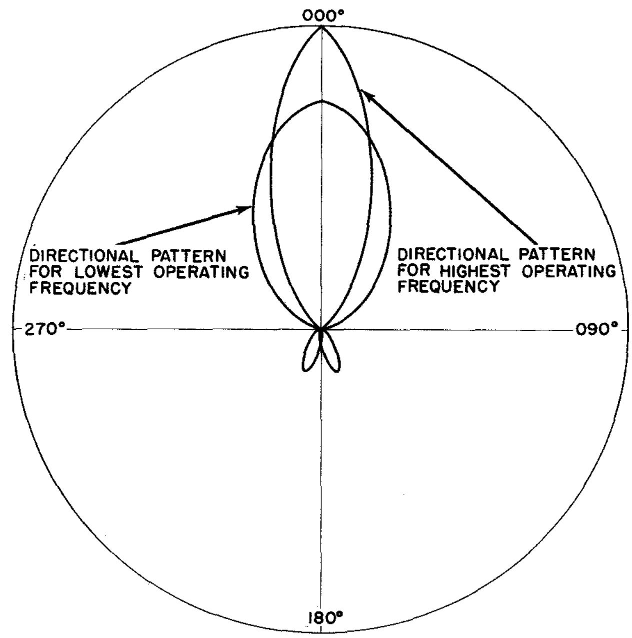
Figure 10-16.—Polar diagram of an antenna showing relative field strength.

antenna) and the circumference of the tangent circles is laid off in angular degrees. Computed or measured values of field strength then may be plotted radially in a manner that shows both magnitude and direction for a given distance from the antenna. Field strengths in the vertical plane are plotted on a semicircular polar chart (not shown in figure) and are referred to as vertical polar diagrams.

Directivity

When considering the energy radiated from an antenna, an important concept is the directivity of the antenna. The directivity of an antenna is a measure of its ability to radiate energy in the desired direction (or directions) and to suppress the radiation in other directions. The same is true of a receiving antenna, only in this case, signals from the favored direction (or directions) are received more effectively than those from other directions.

The directional characteristics of an antenna are determined to a great extent by its design and the position in which it is installed. Thus certain directional qualities are associated with each type of antenna. The radiation pattern, which is a good indication of the directivity of an antenna or antenna array, is commonly plotted on a polar graph paper but may also be plotted on rectangular graph paper. (See figure 10-17.) The rounded projections of the polar pattern are called LOBES and the indented portions, representing no (or minimum) energy pickup in the test antenna, are called NULLS. The information shown on the chart can be used to determine the best operational use for an antenna. An operator should be able to interpret and use these charts if they are available.



13.33

Figure 10-17.—Plot of directional characteristics of an antenna.

The directivity of an antenna is often referred to in terms of "beamwidth" which refers to the width of the directive lobes expressed in degrees of azimuth.

The following three terms are used to describe general directional qualities of an antenna:

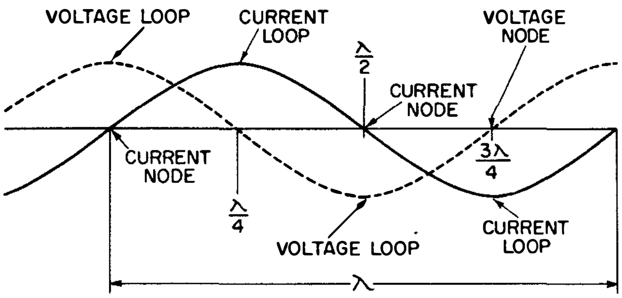
OMNIDIRECTIONAL. Receives or radiates equally well in all directions except off the ends.

BIDIRECTIONAL. Receives or radiates efficiently in two directions; for example, North and South or East and West.

UNIDIRECTIONAL. Receives or radiates efficiently in only one direction.

Standing Waves

If an antenna is energized by an alternating current of a frequency equal to the antenna's resonant frequency, current and voltage values vary along the length of the wire, and always are 90° out of phase. Figure 10-18 shows the relationship of current and voltage in a fullwave antenna. Points where voltages or current are maximum are called voltage or current loops. Points of minimum voltage or current are known as voltage or current nodes. Current and voltage nodes appear every half wavelength, but are separated from each other by one-fourth wavelength.



76.14

Figure 10-18.—Standing waves along full-wave antenna.

The wave of energy sent out by the transmitter travels to the ends of the antennas, and from there it is reflected back along the length of the wire. The wave moving from the transmitter toward the end of the antenna is called the incident wave; its reflection is called the reflected wave. The time required for this process depends on antenna length and hence on frequency. If the antenna is resonant to the frequency generated by the transmitter, the returning wave arrives at the driving point exactly in phase with the outgoing wave, and the two waves tend to reinforce each other. This condition continues as long as the antenna is energized. The effect is the same as though there were standing waves along the length of the wire instead of two sets of moving waves, as really happens. Only in the presence of standing waves does the antenna radiate at maximum.

BASIC TYPES

An invention often borrows the name of its inventor. This is true about two basic antennas, the Hertz and Marconi.

Half-Wave

A basic form of antenna with a length of one-half wavelength or a multiple thereof is known as a dipole or Hertz antenna. (See figure 10-19.) This type of antenna will not function efficiently unless its length is one-half wavelength (or a multiple thereof) of the frequency to be radiated or received. Therefore, this antenna is not suitable when a wide range of frequencies is to be used. A distinguishing feature of a dipole antenna is that it need not be connected to the ground as are other antennas which will be described later. At low frequencies, half-wave antennas are rather long; therefore they are used primarily at shore installations where there is sufficient room. At very high and ultrahigh frequencies, the shorter wavelength permits construction using metal rods or tubing. Depending upon the wave polarization desired, the dipole may be mounted either horizontally or vertically. Transmission lines may be connected in the center or at the ends of the dipole. Because the dipole is an ungrounded antenna, it may be installed far above the ground or other absorbing structures. The half-wave antenna is sometimes referred to by other terms which indicate its shape or electrical characteristics, such as doublet, end-fed, center-fed, etc.

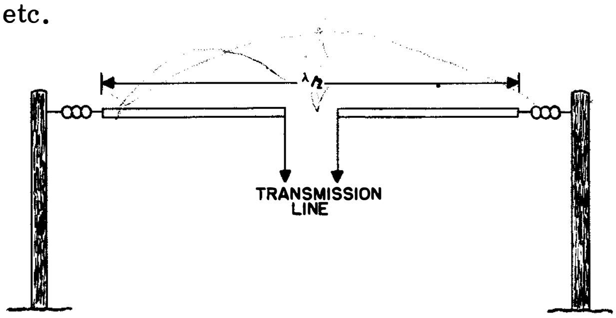


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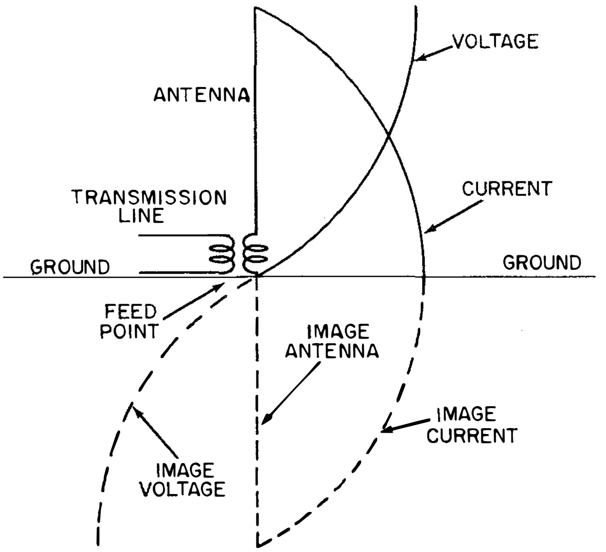
Figure 10-19.—Half-wave (Hertz) antenna.

Quarter-Wave

A grounded antenna which is one-fourth wavelength, or any odd multiple thereof, of the frequency to be radiated or received is known as a Marconi antenna. (See figure 10-20.) Notice that the transmission lines are connected between the bottom of the antenna and the ground. Although the antenna itself is only a quarter wavelength, the earth acts as another quarter-wave antenna—the image antenna shown in figure 10-20. Half-wave operation is obtained by



13.35

Figure 10-20.—Marconi antenna and waveforms of current and voltage.

aid of this image. This type of antenna can be used on planes and ships where the plane's fuselage or the ship's hull provides the image antenna. It is often practical to use a quarter-wave antenna where space is a problem.

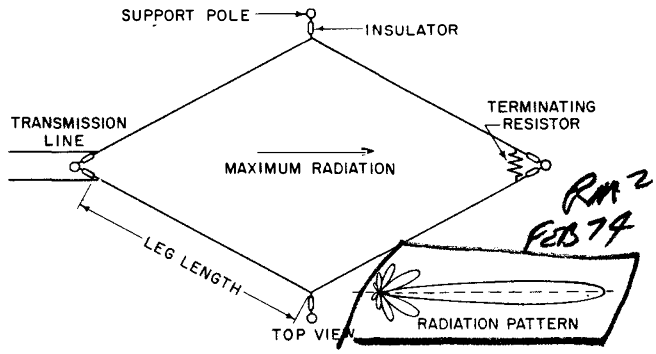
There are many variations of the quarter- and the half-wave antenna as well as many different types designed for special use throughout the range of the radio frequency spectrum. They are often used as components of more complex antennas. Combinations of elements, electrically connected and physically spaced in the proper manner, can be used to obtain many desirable features. Such combinations of elements are called ARRAYS.

COMMON CONFIGURATIONS

It is difficult to classify a particular type of antenna as strictly a shore station type or a shipboard type unless, of course, its physical dimensions are the fundamental consideration. For this reason, several antennas described in the remainder of this chapter are used both ashore and afloat, even though they may be indicated as either typical shore station or typical shipboard types. The types described are merely a sampling of the many and varied antennas which will be encountered.

Rhombic

The rhombic, an antenna frequently used at receiver sites, consists essentially of four long wires, positioned in a diamond shape so that the major lobes are aligned in a common direction. The rhombics used at receiver sites are generally the terminated, unidirectional type. See figure 10-21. Because of its directive radiation pattern (fig. 10-21) the terminated rhombic is very useful for point-to-point communications.



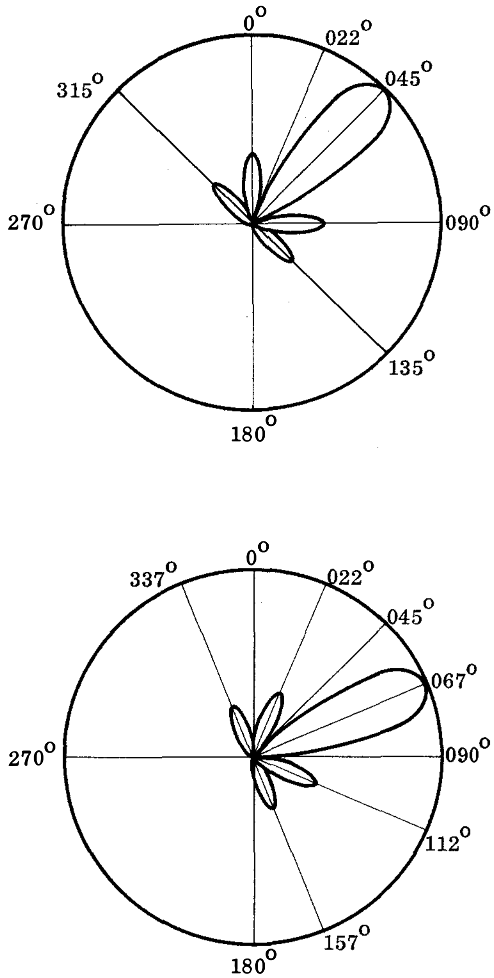
13.37

Figure 10-21.—Typical rhombic antenna.

The length of the rhombic legs determines its lowest efficient operating frequency. A rhombic may be used with good results over a frequency range ratio of 3 to 1. For best results, each leg should be at least two wavelengths at the lowest operating frequency. If, for example, the lowest desired operating frequency is 3000 kHz, each of the four legs should be at least 656 feet long. If an antenna is two wavelengths at 3000 kHz, it will be a greater number of wavelengths at a higher frequency; and the lobe position with relation to the leg axis will change. The change in lobe position with change in frequency means that the alignment of the lobes in a common direction will be more effective at some frequencies than at others.

The azimuth directivity patterns in figures 10-22 and 10-23 show the major lobe and the minor lobes for a typical frequency of a rhombic. Note that the antenna receives signals with fair ability in the directions favored by the minor lobes. Note also that there are spots between lobes where the sensitivity of the antenna falls to almost zero.

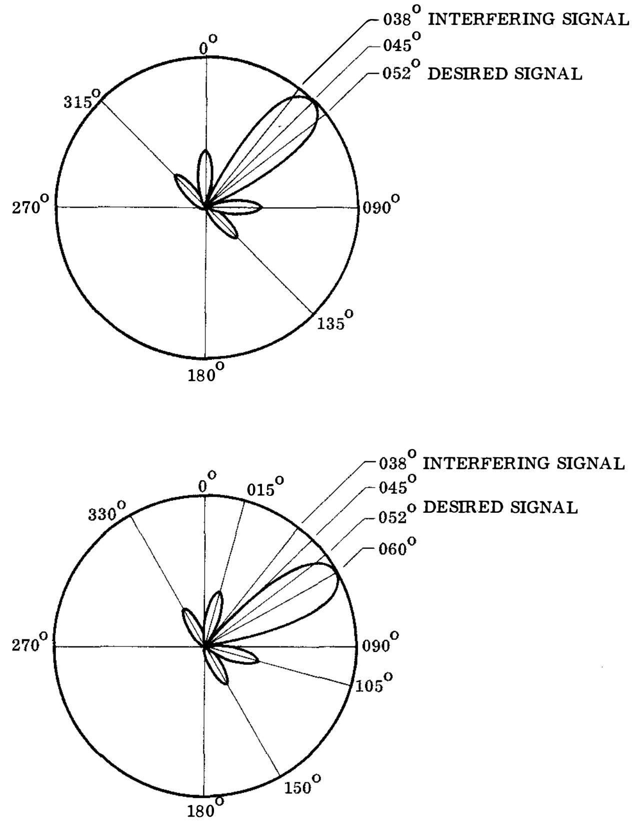
If an antenna patchboard bears a label that an antenna is a 000-degree rhombic, it means that the rhombic connected to that patch socket



34.4
Figure 10-22.—Directivity patterns of two rhombic antennas.

has the center of its major lobe oriented at 000 degrees. There is no indication of the width of that major lobe, and no bearings of the minor lobes and nulls are given.

An operator must keep directivity patterns in mind when selecting a rhombic antenna. For example, imagine that figure 10-22 is the directivity pattern for two rhombic antennas which are available to an operator in copying a transmitting station bearing 022 degrees from the receiver site. The operator has available for use one rhombic at 045 degrees and one rhombic at 067 degrees. It would be incorrect for the operator to assume that the 045-degree antenna, the antenna with its major lobe closes to the desired direction, would be the better of the two

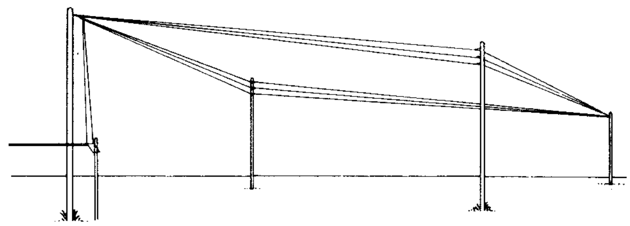


34.5
Figure 10-23.—Using nulls to attenuate interfering signals.

antennas for reception of the transmitted signal. Note from the two polar diagrams that the 045 antenna has a sharp and definite null at 022 degrees, whereas the 067 antenna has a minor lobe that peaks at 022 degrees. The ability of the 067-degree antenna to receive the 022-degree signal will be much greater than the 045-degree antenna because of the positioning of the minor lobe of the former and the null of the latter.

The null points of an antenna can be used by an alert operator to attenuate unwanted interfering signals. Referring to figure 10-23, assume that an operator is copying a signal on 052 degrees using a directional antenna oriented at 045 degrees. The operator is encountering severe interference from a signal that is bearing 038 degrees from the receiver site. Note that both these signals are within the major lobe receiving plot of the 045 antenna. If the operator shifts to a 060 antenna, the desired signal will still be within the major lobe are of the antenna, but the interfering signal will be greatly reduced in strength because it is positioned in the null point in the directivity pattern of the 060-degree antenna. Proper selection of receiving antennas can often reduce the level of an interfering signal to the point where copy of an otherwise uncopiable signal is possible.

The relative position of the minor lobes of an antenna is related to the wavelength of the antenna. Therefore, with an antenna of fixed dimensions, changing frequency will shift the relative positions of the minor lobes and the nulls. The major lobe, although it may narrow or broaden with change in frequency, will remain at the same bearing throughout the operating frequency range of the antenna. An operator in selecting an antenna for the strongest signal of the transmitting station, or the best antenna to attenuate an interfering signal, must experiment with several antennas oriented in the general desired direction. One method of choosing the proper antenna is to listen to the transmitting station while changing antennas. However, monitoring the "S" meter readings on a receiver is a more accurate method.



13.37

Figure 10-24.—Three-wire rhombic antenna.

Multi-Wire Rhombic

A rhombic antenna will improve in performance if more than a single wire is used to form each leg. By using three wires (see figure 10-24) to form each leg and connecting all of them at both ends to a common point, but spacing them vertically 5 to 7 feet apart of the side poles, an improved antenna known as a "curtain rhombic" is formed. Advantages of the multi-wire or curtain rhombic over the single-wire rhombic are: (1) the impedance of the antenna is held at a more constant value over a given range of frequencies, (2) the value of impedance is reduced somewhat so that a better impedance match to an ordinary two-wire line is possible.

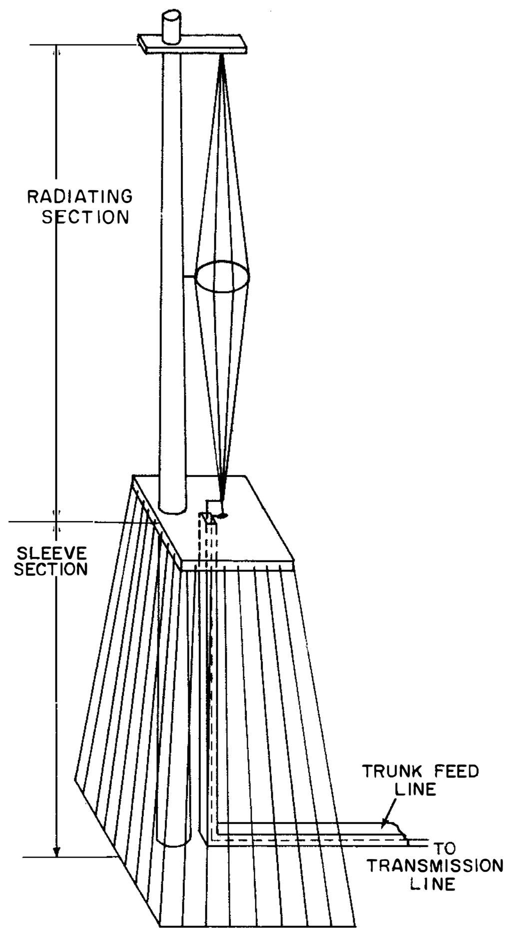


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Figure 10-25.—Sleeve antenna (shore station).

Sleeve Antenna

The sleeve antenna, a high-frequency antenna, is capable of operating over a wide range of frequencies as a broad-band antenna. Originally it was developed to fill the need for a versatile antenna at shore stations, but it has been modified for shipboard use also. Figure 10-25 is a shore station version of a sleeve antenna. The shipboard sleeve antenna is shown in figure 10-26.

Sleeve antennas are especially helpful in reducing the total number of conventional narrow-band antennas that otherwise would be required to meet the requirements of shore stations. By using multicouplers one sleeve antenna can serve several receivers operating over a wide

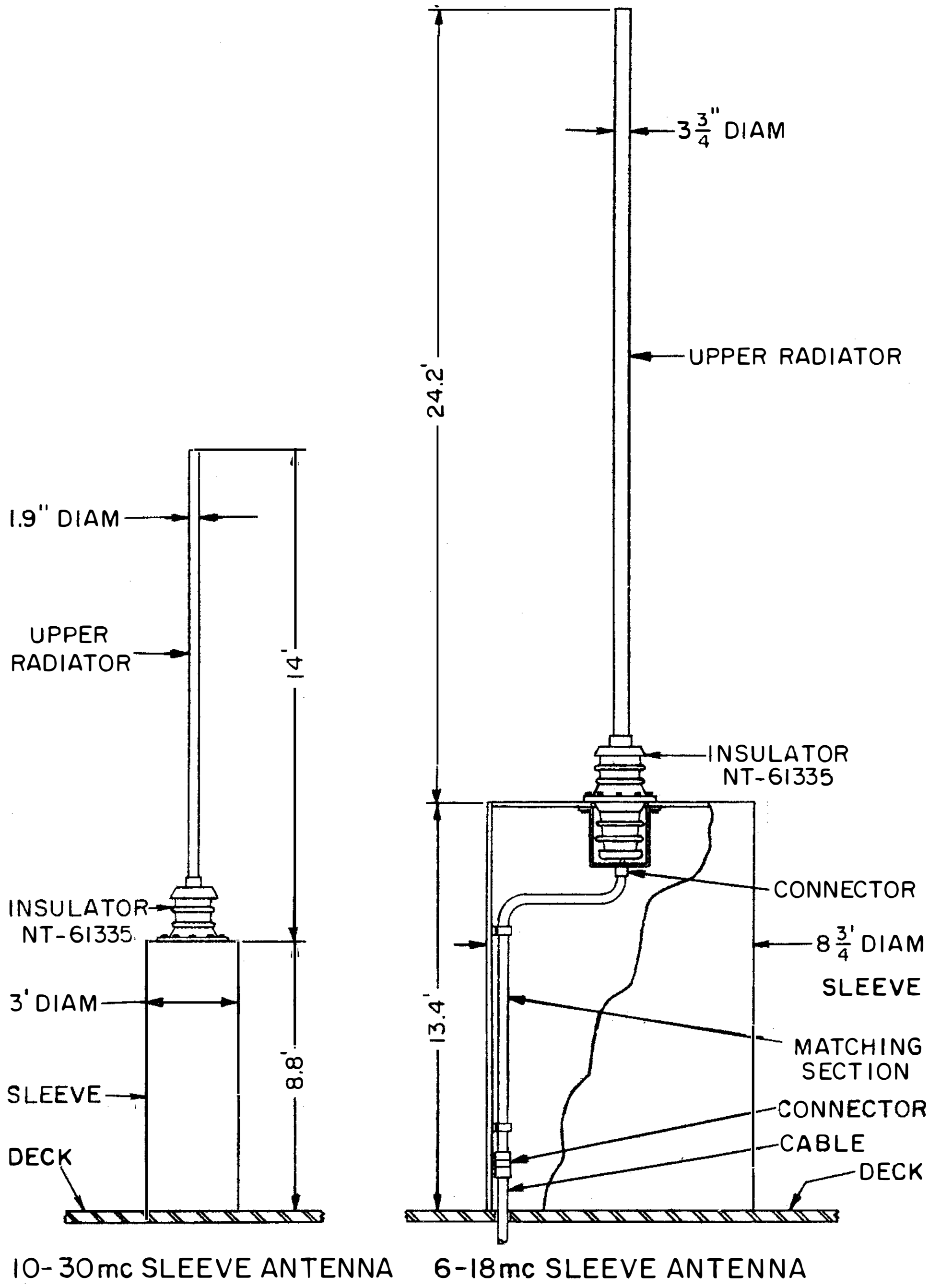

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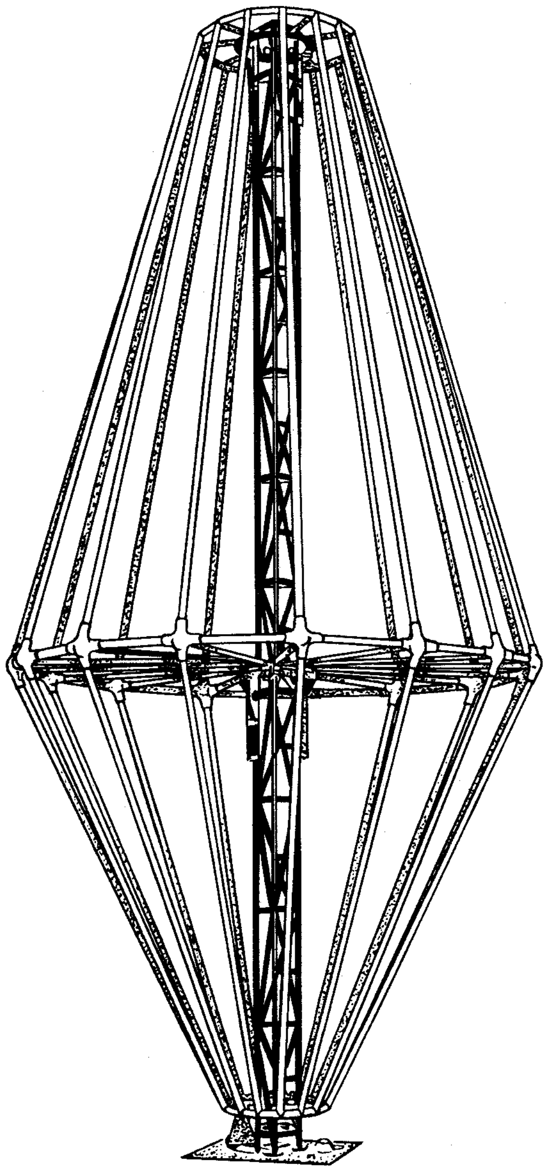
Figure 10-26.—Sleeve antennas for shipboard use.



25.214
Figure 10-27.—Conical monopole antenna.

range of frequencies. This feature also makes the sleeve antenna ideal for small antenna sites.

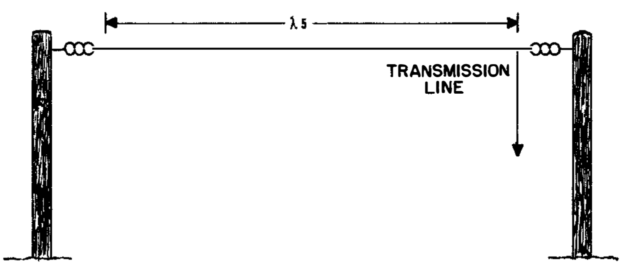
Conical Monopole Antenna

Another broad-band antenna that is used extensively is the conical monopole shown in figure 10-27. Like the sleeve antenna, it is used both ashore and aboard ship.

When operating at frequencies near the lower limit of the high-frequency band, the conical radiates in much the same manner as a regular vertical antenna. At the higher frequencies the lower cone section radiates, and the effect of the top section is to push the signal out at a low angle. The low angle of radiation causes the skywave to return to the earth at great distances from the antenna. Hence, the conical monopole antenna is well suited for long-distance communication in the high-frequency range.

Wire Antennas

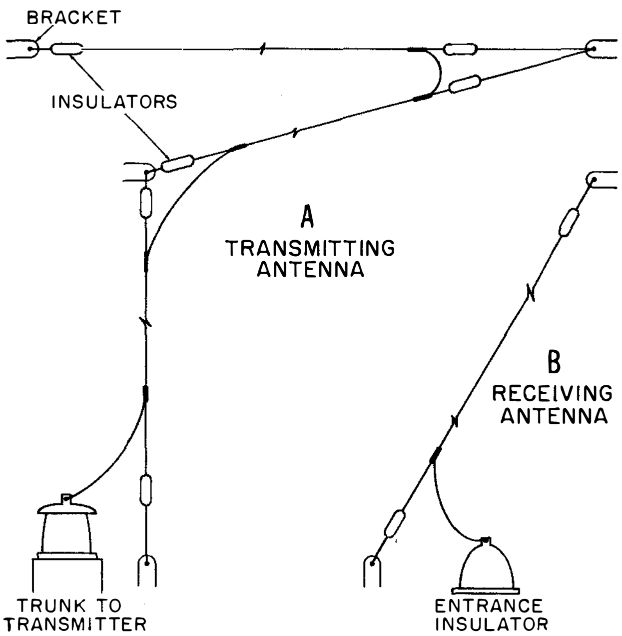
For some applications ashore, especially in VLF and LF transmissions, it is practical to use an antenna that is simply a long wire with one end connected to the equipment. A long-wire antenna will usually be stretched between poles in such a manner that the wire is essentially parallel to the surface of the earth. (See figure 10-28.) Long single-wire antennas are constructed several wavelengths long; in some cases in the VLF band, the antenna may extend several miles. If a long-wire antenna is five or more wavelengths, the antenna will be quite directional along its axis. The longer the antenna in wavelengths, the more directional it will be along its axis.



13.36
Figure 10-28.—Long-wire antenna.

Wire antennas (fig. 10-29) are installed aboard ship for medium- and high-frequency coverage. Normally, they are not cut for a given frequency. Instead, a wire rope is strung either vertically or horizontally from a yardarm (or the mast itself) to outriggers, another mast, or to the superstructure. If used for transmitting, the wire antenna is tuned electrically to the desired frequency.

Much larger wire is used for shipboard antennas than for land installations. The larger wire is less likely to break under the strain of shipboard vibrations. Additionally, it can be



1.46
Figure 10-29.—Shipboard wire antennas.

stretched tighter to avoid sagging in hot weather. The wire is twisted and stranded for additional strength. Usually it is made of phosphor-bronze, a material that is nonmagnetic and resists corrosion. Wire of receiving antennas ordinarily is covered with a plastic insulation, but wire of transmitting antennas is uninsulated.

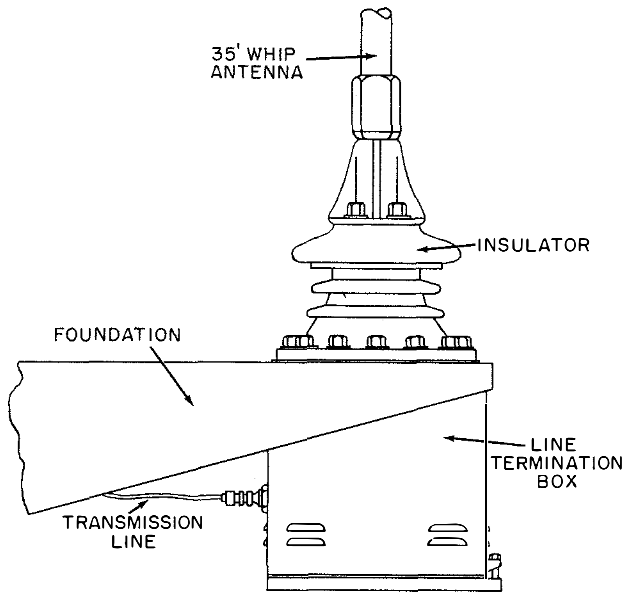
Receiving wire antennas normally are installed forward on the ship, rising nearly vertically from the pilothouse top to brackets on the mast or yardarm. They are located as far as possible from transmitting antennas so that a minimum of energy is picked up from local transmitters. The transmission line (lead-in) for each receiving antenna terminates in antenna transfer panels in radio spaces.

Transmission lines of the transmitting antenna may be of coaxial cable or copper tubing. They are supported on standoff insulators and are enclosed in rectangular metal ducts called antenna trunks. Each transmission line connects with an individual transmitter or with an antenna multicoupler.

The metal rings, antenna knife switches, antenna hardwire, and accessories associated with transmitting antennas are painted red. Hardware and accessories used with receiving antennas are painted blue. This color scheme is a safety precaution in that it shows at a glance, whether an antenna is used for radiating or receiving.

Whip Antennas

Whip-type antennas have replaced many wire antennas aboard ship because they are essentially self supporting, may be deck-mounted, or mounted on brackets on the stacks or superstructure (fig. 10-30). The physical characteristics of tiltable whips for use along the edges of aircraft carrier flight decks and retractable whips for use aboard submarines are two more advantages of the whip antenna for shipboard use. Whip antennas commonly used aboard ship are 25, 28, or 35 feet in length and are made up of several sections.



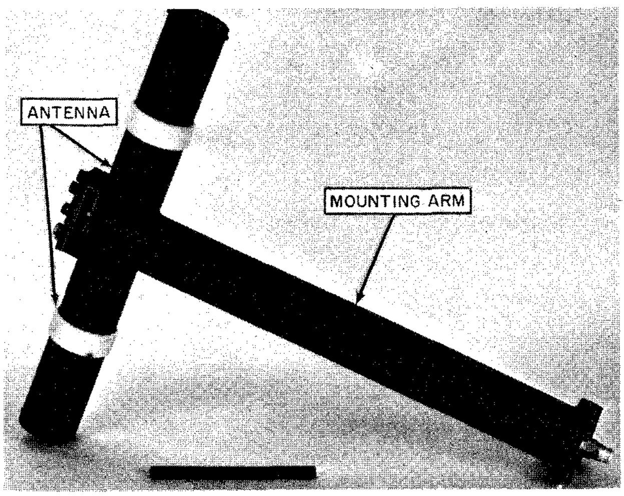
1.47
Figure 10-30.—Whip antenna.

VHF-UHF Antennas

At VHF and UHF frequencies, the shorter wavelength makes the physical size of the antenna relatively small. Aboard ship these antennas are installed as high and as much in the clear as possible. The reason for the high installation is that vertical conductors, such as masts, rigging, and cables in the vicinity, cause unwanted directivity in the radiation pattern.

For best results in the VHF and UHF ranges, both transmitting and receiving antennas must have the same polarization. Vertically polarized antennas are used for all ship-to-ship, ship-to-shore, and air-ground VHF-UHF communications. Usually, either a vertical half-wave dipole or a vertical quarter-wave antenna with ground plane is used.

An ultrahigh frequency antenna of the half-wave (dipole) type is the AT-150/SRC (fig. 10-31). The horizontal (longer) portion of the antenna does not radiate, but acts as a mounting arm for the antenna and as an enclosure for the antenna feed line. This type of antenna is normally mounted horizontally.

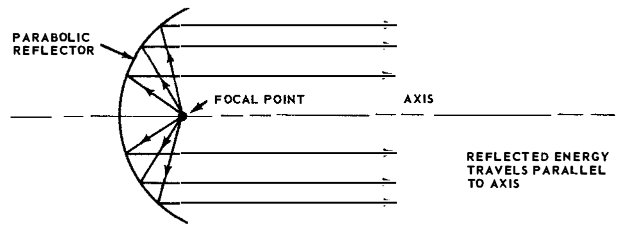


1.48
Figure 10-31.—UHF antenna At-150/SRC.

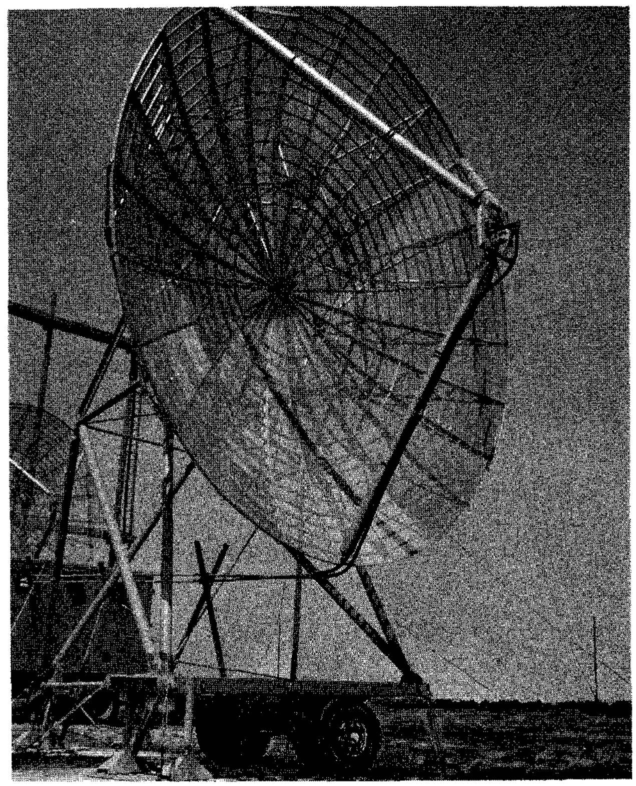
PARABOLIC ANTENNA.—Communication systems such as microwave line-of-sight radio and tropospheric scatter use parabolic antennas. These systems operate at frequencies that have radiation properties approaching those of light waves and therefore can be reflected in much the same manner that a searchlight reflector controls a light beam.

Parabolic reflectors are designed to fit the needs of the particular system with which they will be used, but they all work on the same basic theories. Figure 10-32 illustrates that energy from a radiating element placed at the focal point of a parabolic reflecting surface will be reflected into a narrow beam. Antennas or radiating elements used with parabolic reflectors are either dipole or horn type.

Figures 10-33 and 10-34 show two types of tropospheric scatter antennas. Because of the

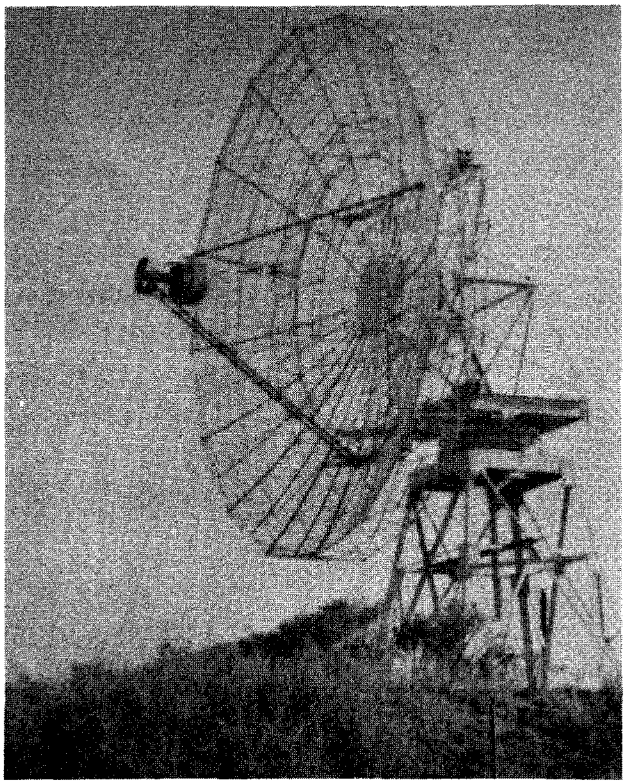


1.49
Figure 10-32.—Principle of parabolic reflection.

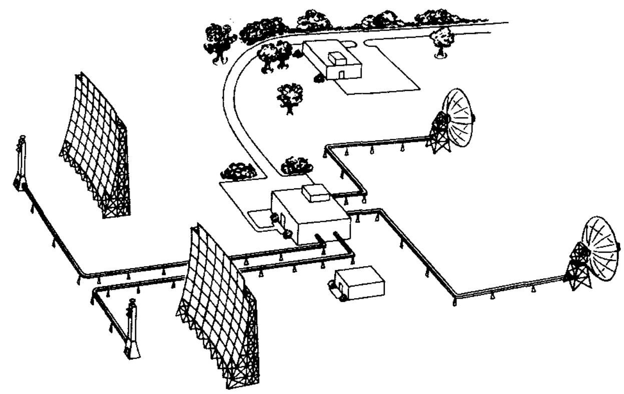


76.58
Figure 10-33.—Mobile tropospheric 30-foot scatter antenna.

wave propagation in the troposphere, the signal strength fluctuates considerably, consequently much of the signal is lost. A steady signal can be maintained by using diversity reception. Energy from each of a number of fluctuating signals may be combined. All tropo scatter systems use diversity reception. To obtain signals over different paths that fade and vary independently, some or all of the following methods may be used. Signals obtained over two or more independent paths by the methods are combined



76.59
Figure 10-34.—Tropospheric scatter antenna.



76.60
Figure 10-35.—Possible arrangement of a tropospheric scatter communication site.

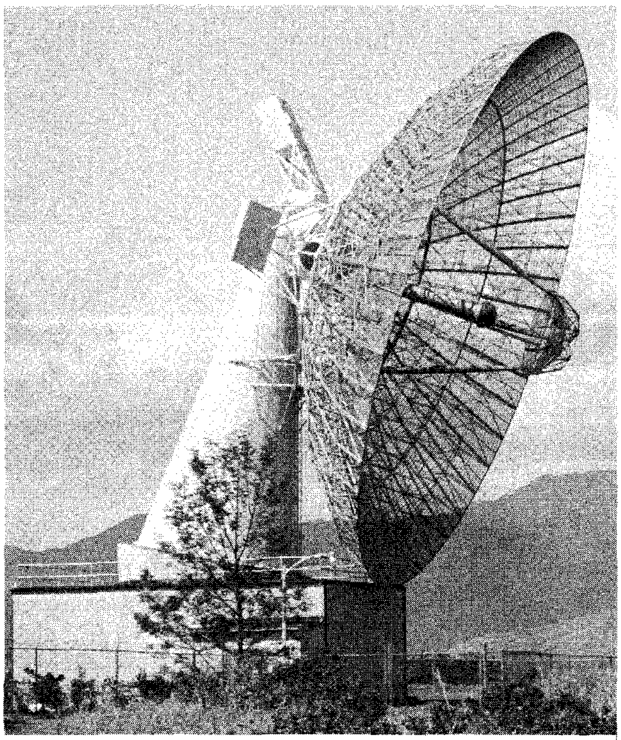
in the receiver in such a way as to utilize the best signal at all times.

- Space diversity: Receiving antennas separated by 50 wavelengths or more at the signal frequency (usually 10 to 200 feet is sufficient).
- Frequency diversity: Transmission on different frequencies fades independently, even when transmitted and received through the same antenna.
- Angle diversity: Two feedhorns produce two beams from the same reflector at slightly different angles. This method results in two paths based on illuminating different scatter volumes in the troposphere.

Figure 10-35 shows a possible arrangement of a tropospheric scatter site. Antennas on the left are called billboard antennas; those on the right are dish antennas. Antennas vary in size from 60 feet in diameter to 120 feet in diameter or more. In addition to tropospheric scatter sites, dish-antennas of the type shown in figure 10-36 are installed at several sites for communications by moon relay.

LOG-PERIODIC ANTENNA.—A requirement has existed in the HF and VHF bands, as well as other frequency bands, for an antenna which will operate over an extremely wide frequency range. Recently, types of LOGARITHMICALLY PERIODIC ANTENNAS (LPA) have been developed. These antennas are of a general class whose structure (figure 10-37) is such that the directivity pattern will vary periodically with the logarithm of the frequency. If the variations over one period are small, and continue to be small for all periods, the result will be an extremely broad-band antenna.

Figure 10-37 shows a typical LPA designed for extremely broad-band, VHF communications. The radiation patterns and impedance characteristics are essentially independent of frequency. An LPA is unidirectional and will provide an average gain of 8 db over a frequency range in a ratio of approximately 10 to 1. A typical frequency range would be from 30-300 MHz, where the low frequency limit of the antenna occurs when the longest transverse element is approximately one-half wavelength.



31.61
Figure 10-36.—84-foot parabolic Dish Antenna.

The high frequency limit is obtained when the shortest transverse element is approximately one-quarter wavelength. The LPA can be mounted on steel towers or utility poles that incorporate rotating mechanisms and is particularly useful where antenna area is limited. A rotating LPA is known as an RLPA.

Circularly Disposed Antenna Array System

The circularly disposed antenna array (CDAA) system is a more recent development than any of the antenna systems previously discussed. It has been used primarily in the VHF and UHF bands, and is now being adapted for use in the HF band. The CDAA system (also known as the Wullenweber system) has some gain characteristics which make it much more desirable than any other systems used for direction finding. These gain characteristics are particularly greater than those of previously designed systems for use in the HF band. The reason for the advantage in gain will be pointed out shortly.

The CDAA consists of a group of omnidirectional antennas (monopoles) symmetrically spaced about the periphery of a circular reflector screen. The location of each antenna with respect to the screen and to the adjacent antennas is so designed that, by the use of a suitable antenna output scanning system, the antenna array provides high, unidirectional gain in all directions of azimuth. Figure 10-38 shows two concentric CDAAs—the outer one a high band array and inner one a low band array. The desired signal is obtained by scanning the outputs of the antennas, around the circle. The output of the scanning system is greatest when it sweeps through the sector having high forward gain in the direction of a target transmitter. The scanning procedure results in sweeping the horizon with a direction finding beam, analogous to sweeping the horizon with a spotlight through a continuous arc of 360°.

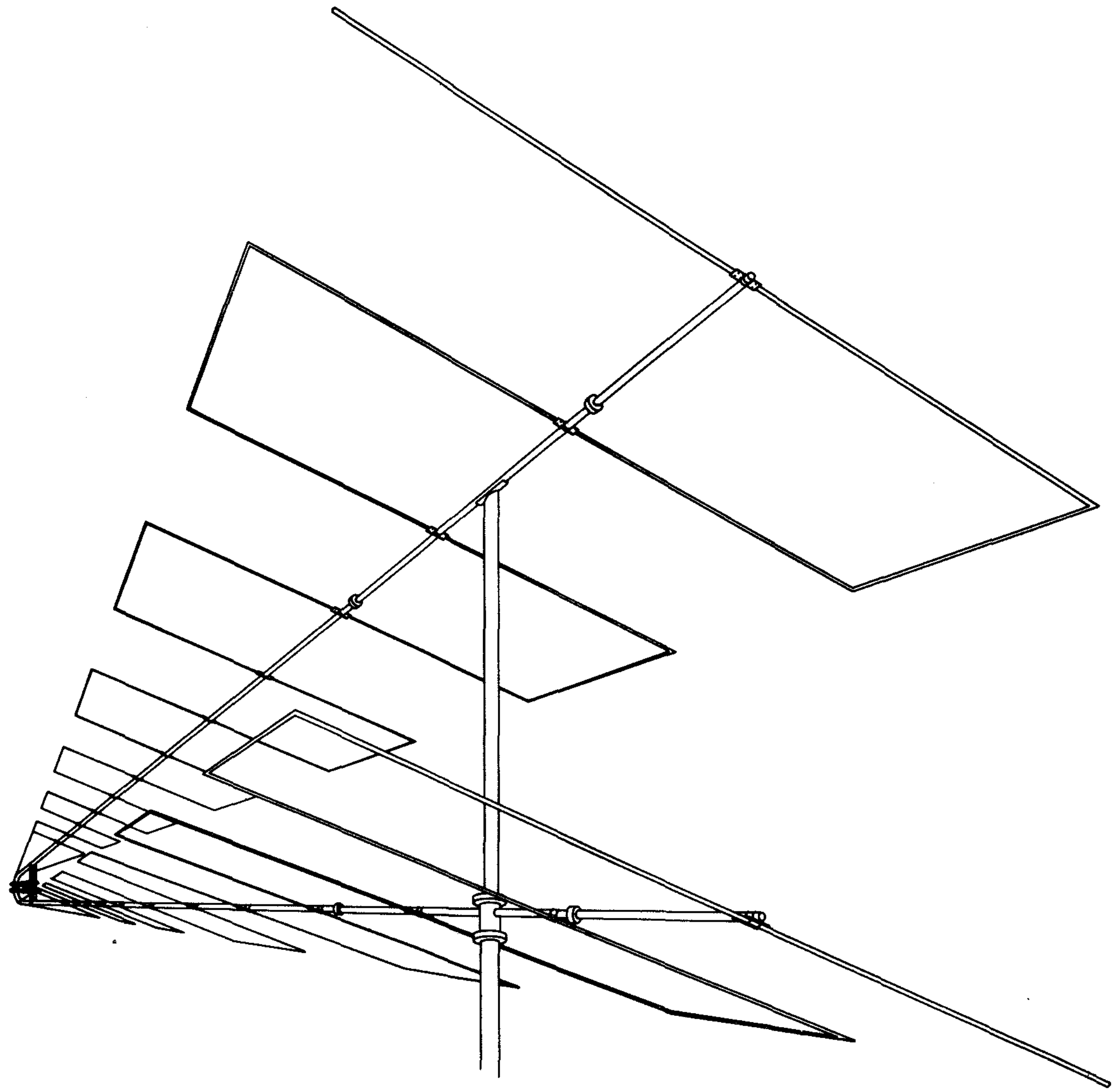
Also, it is possible to utilize any one of the monopoles for fixed point-to-point communications (receive only). By selecting the monopole located in the CDAA which is most nearly oriented towards the desired transmitting station, a signal directional receiving antenna capability can be simulated.

Another advantage inherent with the CDAA is the relative small amount of real estate required for 360° of coverage. In comparison, rhombic antennas, discussed earlier, require considerable acreage for construction and are limited to a few degrees in directivity.

EMERGENCY ANTENNAS

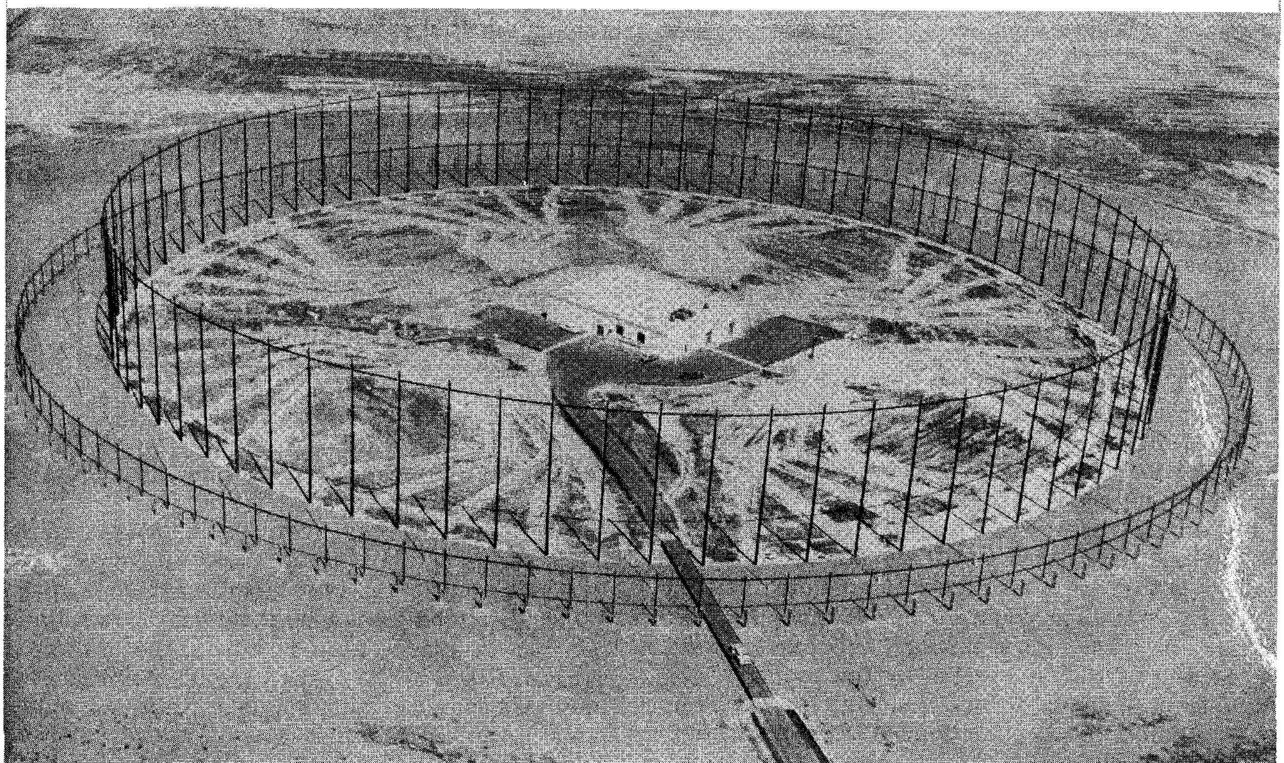
Loss of damage to an antenna from heavy seas, violent winds, or enemy action may cause serious disruption of communications. Sections of a whip antenna may be carried away, insulators may be damaged, or a wire antenna may snap loose from its moorings, or break. If loss or damage should happen when all available equipment is needed, you may have to rig an emergency antenna (or at least assist) to restore communications on a temporary basis until the regular antenna can be repaired.

The simplest emergency antenna consists of a length of wire rope to which a high-voltage insulator is attached to one end and a heavy alligator clip or lug is soldered to the other. The end with the insulator is hoisted to the nearest structure and secured. The end with the alligator clip (or lug) is attached to the equipment transmission line. To radiate effectively, the antenna must be sufficiently clear of all grounded objects.



93.26

Figure 10-37.—Log-periodic antenna.



25.117

Figure 10-38.—Circularly disposed antenna array (CDAA).

CHAPTER 11
TELETYPEWRITER EQUIPMENT

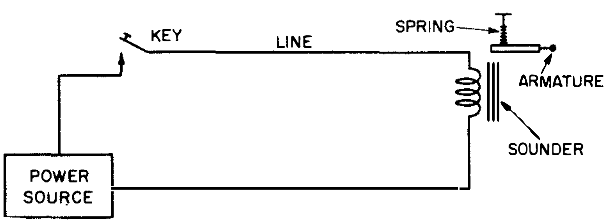
In this chapter we cover two topics: teletypewriter equipment and AUTODIN terminal equipment.

INTRODUCTION TO TELETYPE

The teletypewriter is little more than an electrically operated typewriter. The prefix "tele" means "at a distance." By the operating of a keyboard similar to that of a typewriter, signals are produced that cause the teletypewriter to print the selected characters (letters, figures, and symbols). The characters appear at both sending and receiving teletypewriters, and one teletypewriter actuates as many machines as may be connected together.

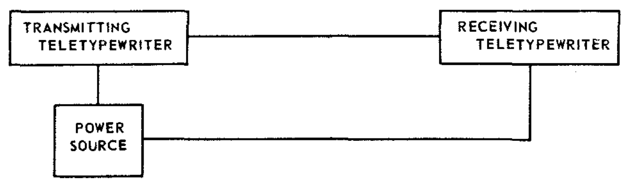
To see how intelligence is sent by teletypewriter, let us consider one of the simpler devices for electrical communication: the manual telegraph circuit. In this series or loop-connected circuit, shown in figure 11-1, we have a telegraph key, a source of power (called battery), a telegraphic sounder, 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. This action causes a clicking sound. When the key is opened, current stops flowing and the armature returns to its original position. With these two electrical conditions of the circuit—closed and open—it is possible, by means of a code, to transmit intelligence.

The telegraph circuit in figure 11-1 can be converted to a simple teletypewriter circuit by



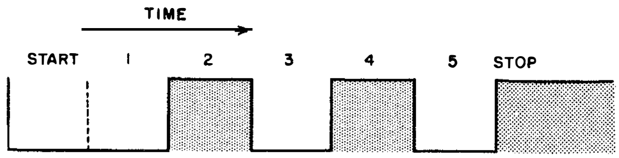
1.196
Figure 11-1.—Manual telegraph circuit.

substituting a transmitting teletypewriter for the key at station A, and a receiving teletypewriter for the sounder at station B. This arrangement for a given word-per-minute system is shown in figure 11-2. In the teletypewriter circuit each current and no-current interval consumes a set period of time, whereas in the telegraph circuit these time intervals vary with the code being transmitted by the operator.



1.200
Figure 11-2.—Simple teletypewriter circuit.

A teletype signal can be represented as mark and space pulses as shown in figure 11-3. In the common teletype configuration a mark pulse is a condition where current flows in the circuit. A space pulse is a condition where no current flows in the circuit. Shaded areas show intervals during which the circuit is closed (mark), and the blank areas show intervals during which the circuit is open (space). Each character of the teletype code consists of a combination of five mark or space pulses. To transmit each character it takes a total of seven pulses. The first pulse is always a space and is called the start pulse. The next five pulses are those of the teletype code and their arrangement is dependent upon which character



1.197
Figure 11-3.—Mark and space signals in the teletypewriter character R.

is being transmitted. These five pulses are called the intelligence pulses. The seventh pulse is always a mark and is called the stop pulse. Although a teletype machine may be operating at its maximum speed there are always seven pulses generated for each character transmitted. The first and last (start/stop) pulses are there to maintain synchronization between sending and receiving units. The time duration of each pulse is determined by the speed of operation of the teletype machine.

When the sending and receiving teletypewriters are wire-connected, as in a landline system, the exchange of intelligence between them is direct. But when the teletypewriters are not joined by wire, the operation becomes more complex; direct current mark and space intervals cannot be sent through the air. The gap between the teletype machines must be bridged by radio.

RADIOTELETYPE (RATT) SYSTEMS

The Navy uses two basic teletype systems aboard ship. One is the audio frequency tone-shift radioteletype (AFTSRATT) system, used for short-range operation and similar to the common AM radio method of broadcasting. The other is the radiofrequency carrier-shift radioteletype (RFCSRATT) used for long-range operation and similar to the familiar FM radio communications.

TONE-SHIFT MODULATION SYSTEM

A teletypewriter, a tone converter, and a transmitter are used to transmit messages by the tone-shift modulation method. The teletypewriter sends out a d.c. signal. The signal is changed to audio tones in the tone-shift converter. The transmitter impresses the audio tones on the carrier to carry the mark and space intelligence and sends out a tone-shift modulated carrier wave (fig. 11-4A).

To receive messages with the tone-modulated system, a radio receiver, a tone-shift converter, and a teletypewriter are required. The tone-shift modulated carrier wave enters the receiver, which extracts the mark and space intelligence from the carrier wave, and sends the audio tones to the tone-shift converter. The converter changes the audio tones into d.c. mark and space pulses for the teletypewriter (fig. 11-4B).

In practice, the same frequency tone shift converter (tone terminal) is used for the receiving and the sending circuits.

FREQUENCY CARRIER-SHIFT SYSTEM

At the transmitting end of the long-range frequency carrier-shift system (fig. 11-4C) are a teletypewriter, and a transmitter with frequency shift capability. The keyer unit is built into the transmitter. When the teletypewriter is operated, the d.c. mark and space signals are changed by the keyer unit into radiofrequency carrier-shift output signals (RFCSRATT) which carry the mark and space intelligence. This RFCSRATT is transmitted by conventional Navy transmitters.

On the receiving side of the long-range system (fig. 11-4D) are a receiver, a frequency carrier-shift converter, and a teletypewriter. When the frequency carrier-shift signal enters the receiver, it is detected and changed into corresponding frequency carrier-shift audio signals. The audio output of the receiver is fed to the converter, which changes the frequency carrier-shift audio signals into d.c. mark and space signals.

In both the tone-shift system and the frequency carrier-shift system, all teletypewriter signals pass through the teletypewriter panel. As illustrated in figure 11-5, the teletypewriter (RATT) panel permits every possible RATT interconnection available aboard ship. This operational flexibility gives maximum efficiency with the fewest circuits and the least equipment in the Navy's compact RATT systems afloat.

TELETYPE EQUIPMENT

Because of the increasing variety of teletype equipment installed afloat and ashore it is impractical to describe every piece of equipment you are likely to encounter. The equipment discussed in the ensuing paragraphs, however, is representative of the types commonly employed in shipboard installations.

TELETYPEWRITER SETS

Most of the teletypewriter sets used by the Navy belong to the model 28 family of teletypewriter equipments. The model 28 equipments feature light weight, small size, quietness, and

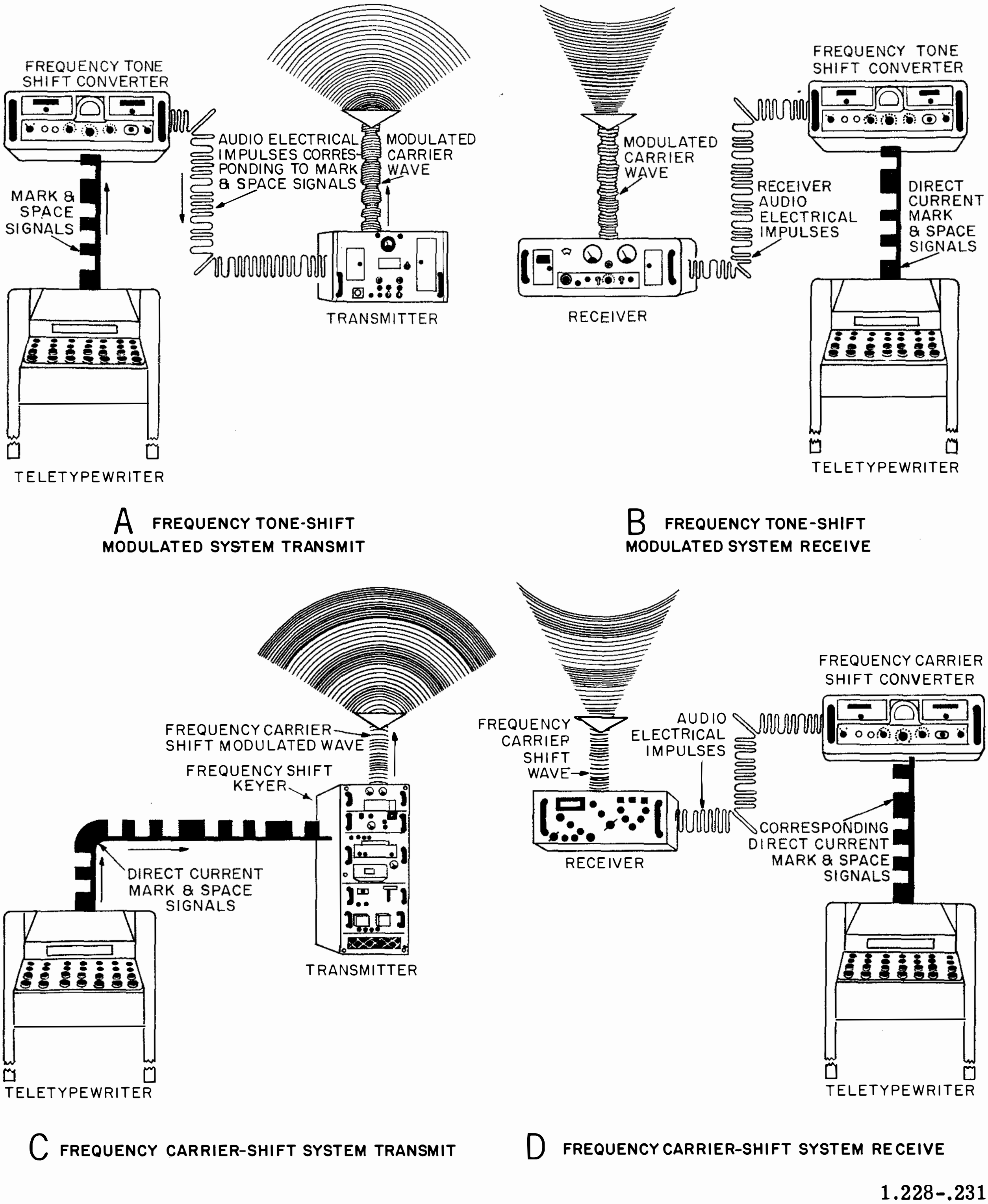
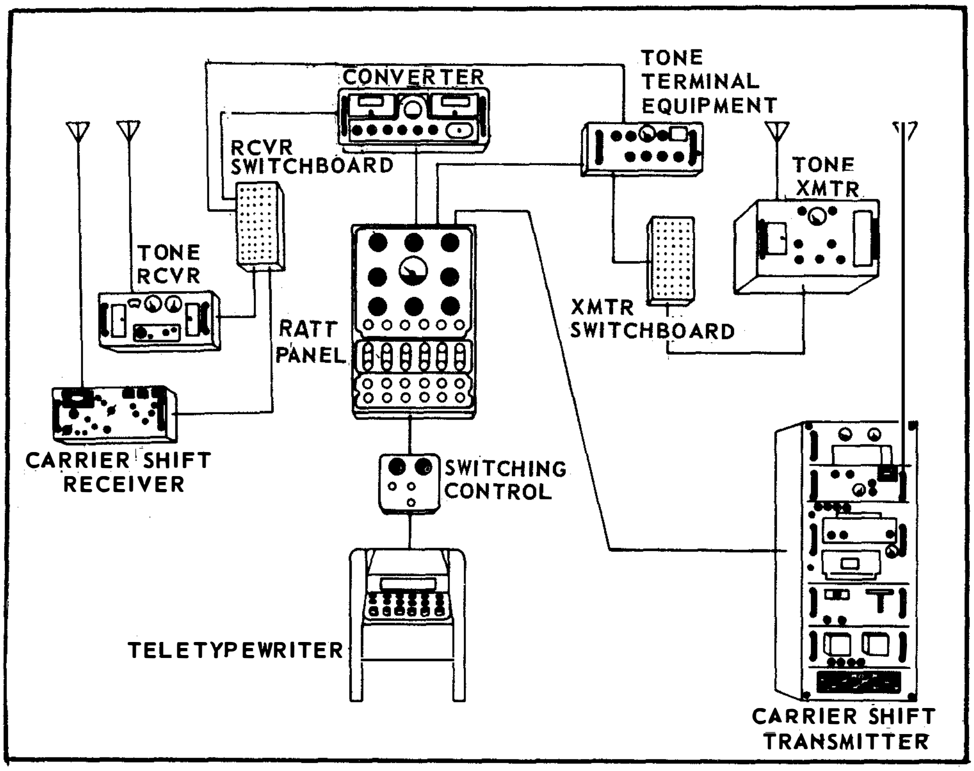


Figure 11-4.—Tone and frequency shift modulation.



1.225

Figure 11-5.—Integrated RATT system.

high-speed operation. They present relatively few maintenance problems, and are suited particularly for shipboard use under severe conditions of roll, vibration, and shock.

Another feature of the model 28 teletypewriters is their ability to operate at speeds of 60, 75, and 100 words per minute. Conversion from one speed to another is accomplished by changing the driving gears that are located within the equipment. Most of the Navy's teletypewriters are presently operated at 100 words per minute.

Teletypewriters may be send-receive units or receive units only. They may be designed as floor model, table model, rack mounted, or wall mounted sets.

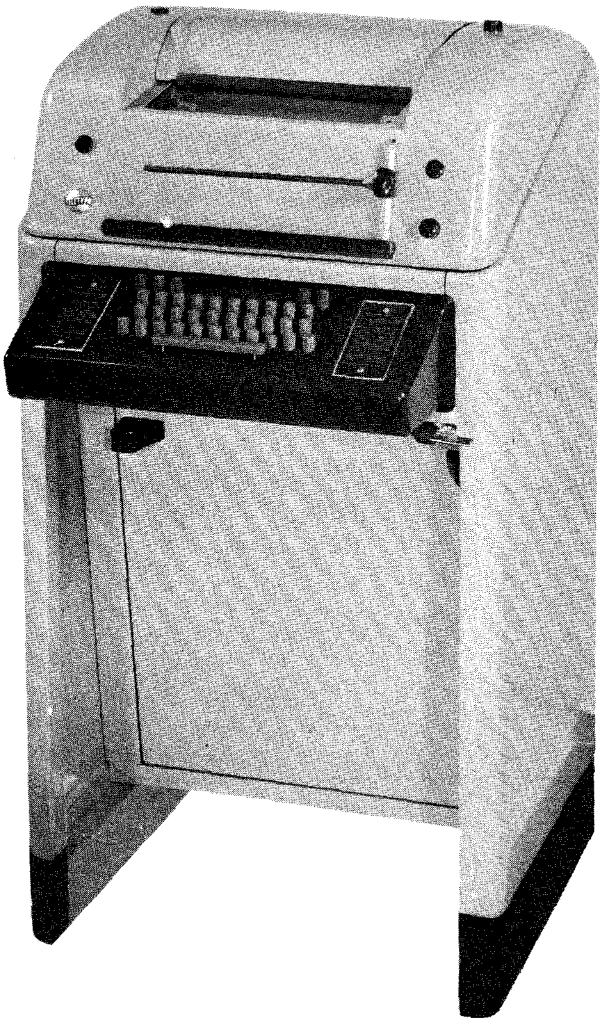
Model 28 Send-Receive and Receive Sets

The model 28 send-receive teletypewriter page printers are basically the same. The TT-48( )/UG is a floor model keyboard-sending and page-receiving teletypewriter (fig. 11-6). The TT-48( )/UG provides means for exchanging typewritten page messages between two or more ships or stations that are similarly equipped and connected by a radio (or wire) circuit. While transmitting from the keyboard, monitor copy is presented by the typing unit. Hence, messages cannot be transmitted and received simultaneously.

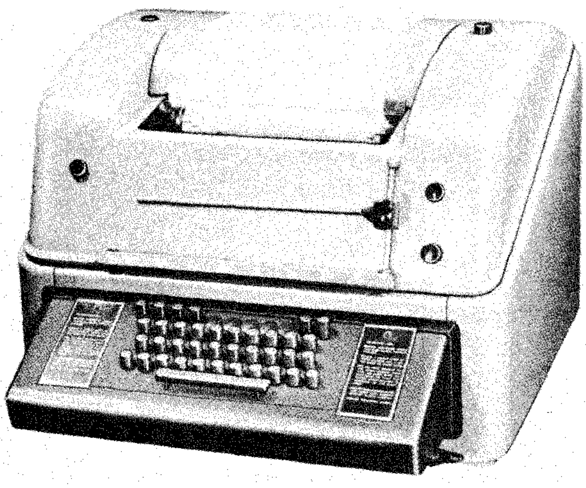
The TT-47( )/UG is an older floor model still in use, and differs from the TT-48( )/UG by the type of motor used. The TT-47( )/UG has a 60 hertz synchronous motor, and the TT-48( )/UG uses a series governed motor.

Another example of modification is the TT-69( )/UG (fig. 11-7). Except for being installed in a cut-down cabinet, the TT-69( )/UG is like the TT-48( )/UG. It serves the same purpose, and it functions in the same manner. Usually, the TT-69( )/UG is installed on small ships where space is of prime consideration.

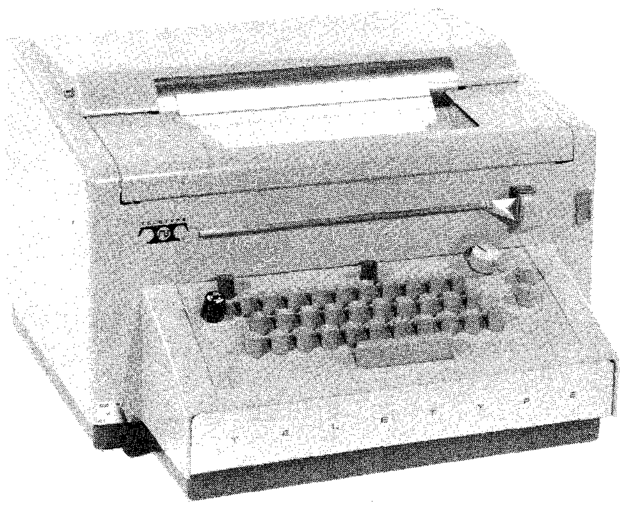
The TT-176A/UG (not illustrated) is a rack-mounted send-receive teletypewriter. Rack-mounted units such as teletypewriter, radio, and other equipments are designed narrower in



1.217-28
Figure 11-6.—Model 28 Teletypewriter TT-48( )/UG.



1.217(-69-70)
Figure 11-7.—Teletypewriter TT-69( )/UG.



1.361(120C)
Figure 11-8.—Compact Keyboard Send-Receive Teletypewriter AN/UGC-20.

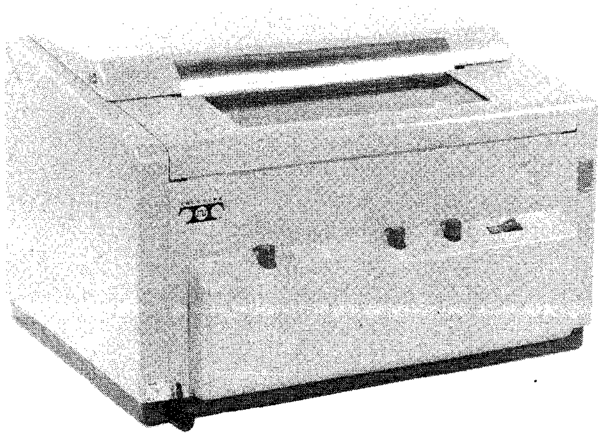
width. They are mounted aboard ships where space is a premium and stand-up operation is necessary.

The AN/UGC-20 (fig. 11-8) send-receive teletypewriter reduces the transmitter keyboard from 32 to 28 typing units. All mechanisms have been mounted to require minimum space. This compact teletypewriter is designed for use where space is of importance.

The model 28 receive-only sets are similar to the send-receive sets but have no keyboard sending capabilities. The AN/UGC-25 page printer (fig. 11-9) is a receive-only, compact, table model teletype set presently being supplied to the fleet for use copying the fleet broadcasts. It has no keyboard and therefore no transmit capability.

Teletypewriter Perforator-Reperforator TT-253/UG

An extremely useful teletypewriter equipment is the TT-253/UG (fig. 11-10). Its chief use is for preparing messages in tape form for transmission by automatic means. When connected to an external circuit, however, the



1.362(120C)
Figure 11-9.—Compact receive-only Teletypewriter AN/UGC-25.

machine also can be utilized to transmit and receive messages.

When a character is typed on the keyboard, its corresponding teletype code is perforated in the paper tape. Simultaneous with this action, the character is printed on the tape. In addition, the mark and space combinations for that character are sent from the keyboard directly to the external circuit (if connected).

Signals from the external circuit cause the machine to perform as just described. Thus, the TT-253/UG can be employed for communicating directly with distant stations or for the off-circuit preparation of message tapes. If both tape and printed page copy of a message are desired, the perforator-reperforator is used in conjunction with a page-printing teletypewriter.

Teletypewriter Reperforator TT-192( )/UG

The TT-192( )/UG (not illustrated) is basically the same as the TT-253/UG except for not having a keyboard.

Normally, the reperforator's wiring is terminated in a patch panel (described later in this chapter) so that it can be patched or

50.116(120C)
Figure 11-10.—Send-Receive Typing Perforator-Reperforator TT-253/UG.

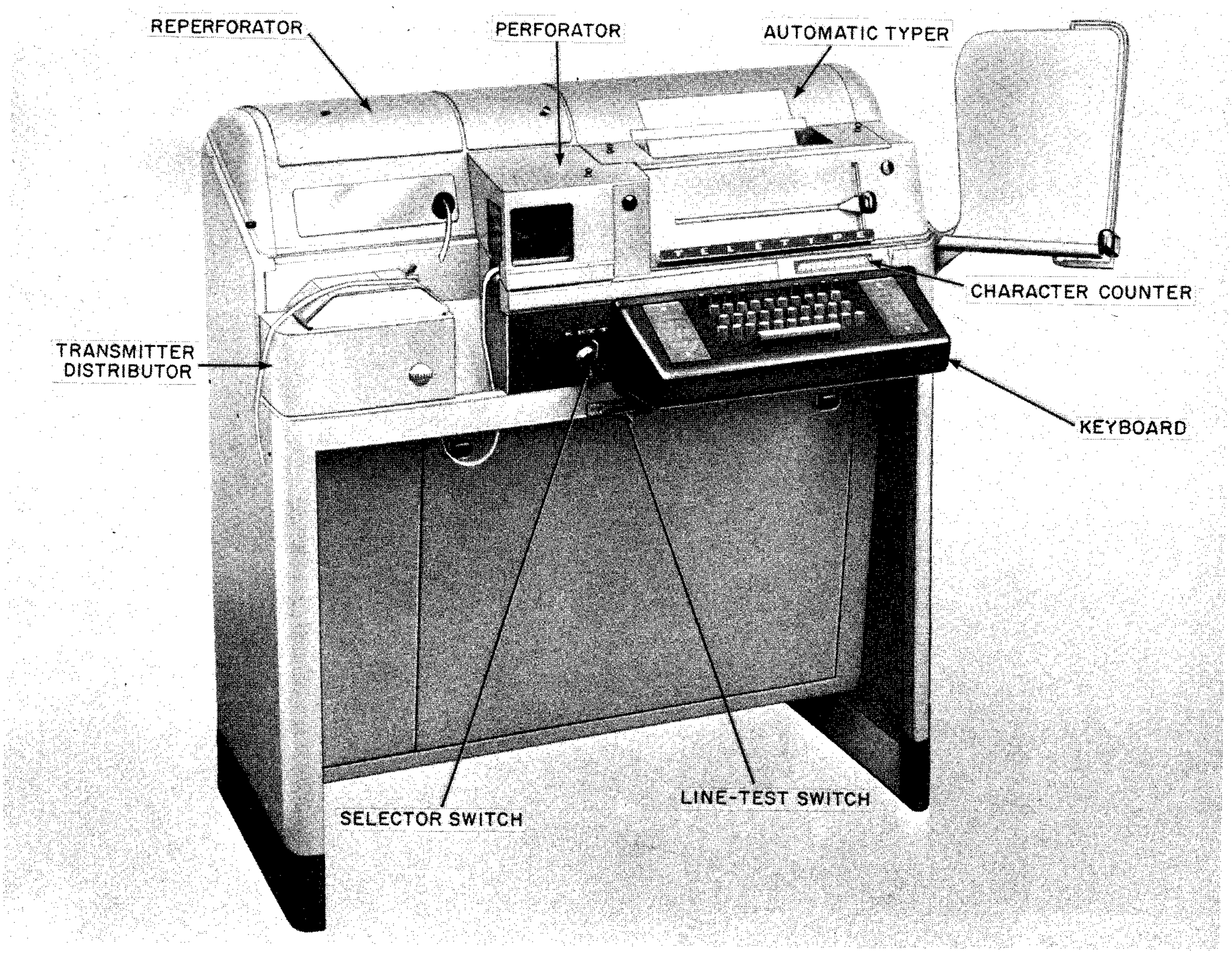
connected into any teletype circuit wired through the panel. By patching the reperforator into a circuit, a tape copy of each message is obtained, and messages requiring further processing in tape form need not be retyped by the operator.

Teletypewriter
Set AN/UGC-6

The AN/UGC-6 teletypewriter (fig. 11-11) is a versatile communication equipment. It receives messages from the signal line and prints them on page size copy paper. In addition, it can receive messages and record them on tape and in printed form. With page-printed monitoring, the teletypewriter transmits messages that are originated either by perforated tape or by keyboard operation. It mechanically prepares perforated and printed tape for separate transmission with or without simultaneous transmission and page-printed monitoring.

The teletypewriter set is composed of the following components: a cabinet, a keyboard, an automatic typer, a typing perforator, a transmitter distributor, a typing reperforator, and power distribution panels.

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



1.217(-6)

Figure 11-11.—Teletypewriter AN/UGC-6.

distributor. Signals are received, and local transmission can be monitored, on the automatic typer. 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.

The keyboard, typing perforator, automatic typer, and transmitter distributor (TD) are operated by the motor mounted on the keyboard. Selection of these components for either individual or simultaneous operation is by the selector switch located at the front of the cabinet, to the left of the keyboard. All these components are connected in series in the signal line, but the selector switch has provisions for excluding various components from the line. The external signal line is connected to the equipment through a line-test switch located below the selector switch on the front of the cabinet. This arrangement provides a means of disconnecting the equipment from the line for local testing of the components. The typing reperforator is operated by a separate motor and power distribution system. It also is connected to a separate external signal line.

Teletypewriter AN/UGC-13

To become a part of the Naval Tactical Data System (NTDS), the AN/UGC-6, when modified with an adapter to provide input/output communications with a selected data processing computer, becomes AN/UGC-13.

The adapter (contained in the teletypewriter cabinet, fig. 11-12) modifies data to provide compatibility between a computer and the teletypewriter unit. With the addition of the adapter, not only can the teletypewriter set communicate with other stations, but also can exchange information with the digital-data processing computer.

The teletypewriter keyboard consists of a set of manually operated keys which generate teletypewriter codes. The printing unit may accept teletypewriter codes from the keyboard, transmitter-distributor, or the computer. The transmitter-distributor (fig. 11-12) reads perforated paper tape and converts it into teletypewriter codes which can be transmitted to the printing unit, the typing reperforator, the auxiliary typing reperforator, and the computer. The maintenance and control section produces the control signals and the interrupt codes which are sent to the computer indicating the condition which exists in the adapter. By use of the maintenance controls, the teletypewriter set can be disconnected from the computer and adapter so teletypewriter operation can be tested.

An auxiliary line relay circuit (fig. 11-13) permits the adapter to perform multiplex operation with equipment other than this teletypewriter machine. An auxiliary line relay, built into the teletypewriter cabinet, is connected in the teletypewriter adapter loop. This line relay permits radio link equipment and/or other teletypewriter equipment to be connected into the teletypewriter adapter data loop. Compared to computer operation, the teletypewriter set is a slow-speed device. This permits the computer to perform other functions during the time between teletypewriter codes.

KEYERS AND CONVERTERS

Keyers and converters are an integral part of every radioteletype system. In some instances, the keyer is built into the radio transmitter, but the converter is a separate piece of equipment.

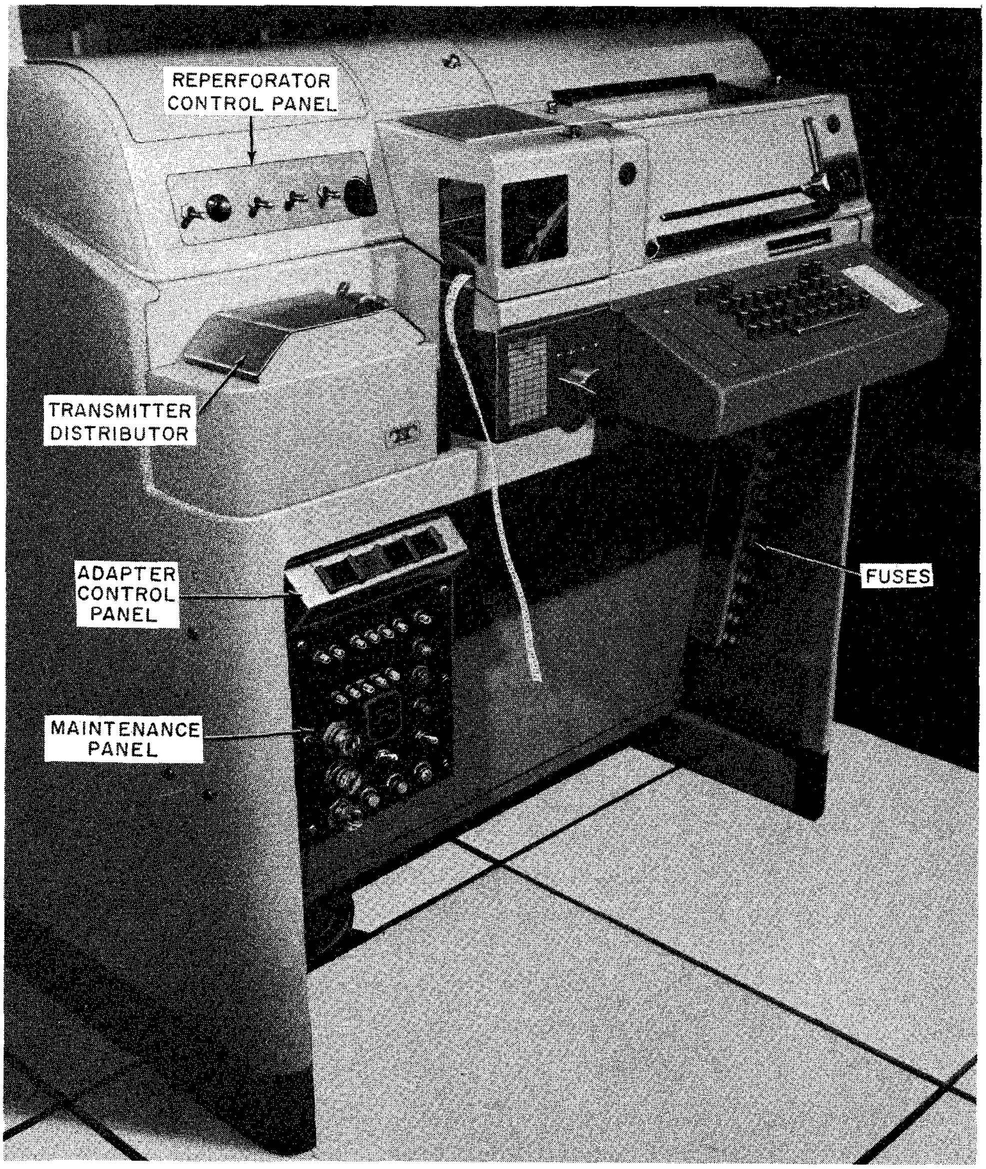
Tone-Shift Keyer/Converter AN/SGC-1( )

OPERATION & SETTINGS KM2 FEB74

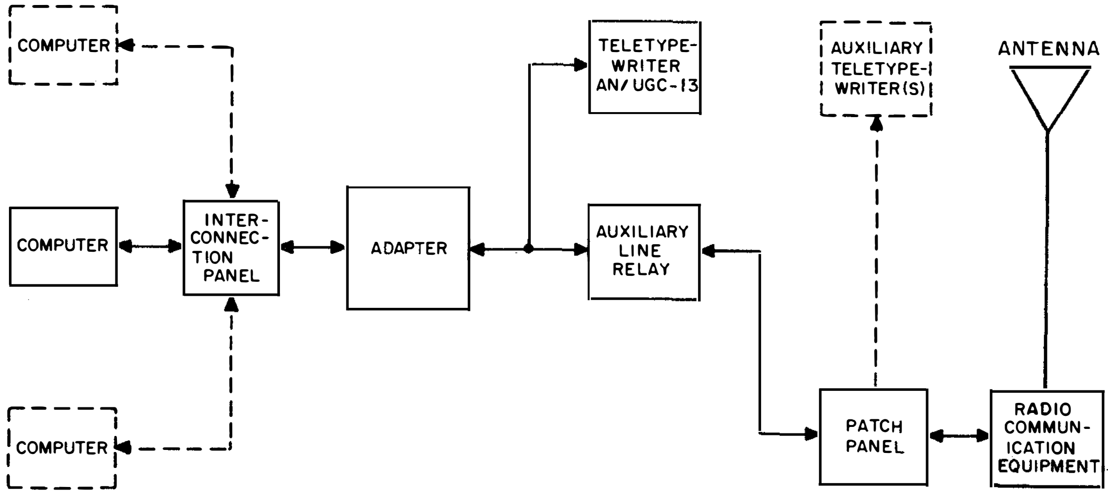
Tone-shift keyer-converter model AN/SGC-1( ) is used for short-range RATT operation. Normally it is used for communication on UHF and VHF bands, but it can be used with any transmitter designed for voice modulation. The AN/SGC-1( ) is shown in figure 11-14, with blocks indicating other equipment necessary for a complete tone-shift system.

In tone modulation transmission, the teletypewriter pulses are converted into corresponding audio tones, which amplitude modulate the carrier frequency of the transmitter. Conversion to the audio tones is accomplished by an audio oscillator in the tone converter, which operates at 700 hertz when the teletype loop is in a closed-circuit (mark) condition and at 500 hertz when the loop is in an open-circuit (space) condition.

An internal relay in the tone converter closes a control line to the radio transmitter, which places the transmitter on the air when the operator begins typing a message. The control line remains closed until after the message is transmitted.



1.217-13
Figure 11-12.—Teletypewriter AN/UGC-13 with adapter.



31.29(124)

Figure 11-13.—Teletypewriter system for NTDS.

When receiving messages, the tone converter accepts the mark and space tones coming in from an associated radio receiver and converts the intelligence of the tones into signals that close and open the contacts of a relay connected in the local teletypewriter d.c. loop circuit. This action causes the local teletypewriter to print in unison with the mark and space signals from the distant teletypewriter.

Converter-Comparator Groups AN/URA-8( ) and AN/URA-17( )

The AN/URA-8( ) and AN/URA-17( ) frequency carrier shift converter-comparator groups (fig. 11-15 and 11-16) are used for diversity reception of Frequency Shifted Radio Teletype signals. Their most common usage are on ship to shore or ship to ship circuits.

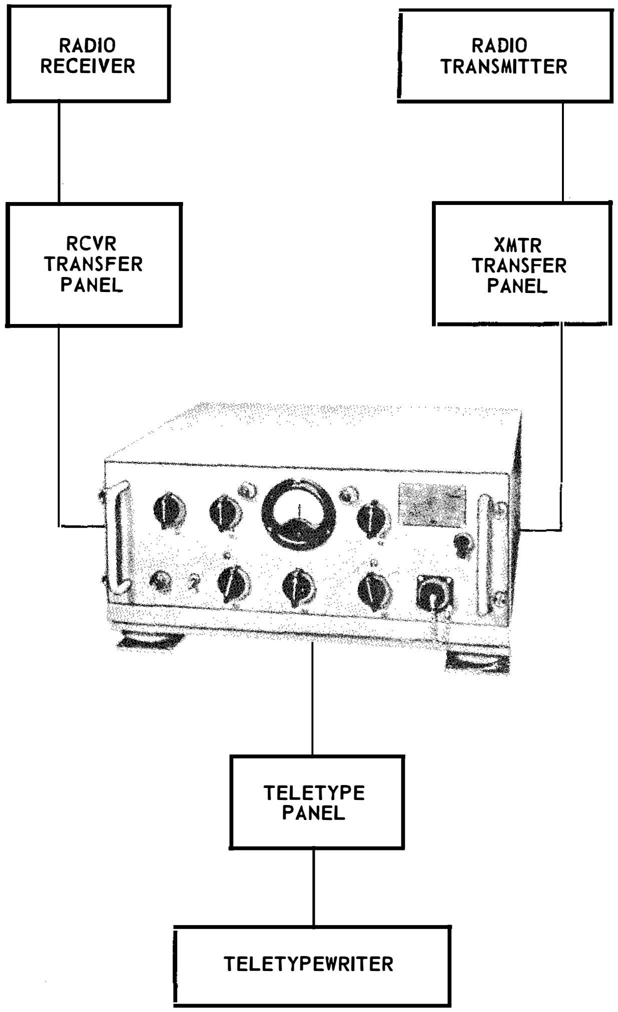
For either space diversity or frequency diversity reception, two standard Navy receivers are employed in conjunction with the converter-comparator group. In space diversity operation, the two receivers are tuned to the same carrier frequency, but their receiving antennas are spaced some distance apart. Because of the required spacing between antennas, space diversity usually is limited to shore station use. In frequency diversity operation, the two receivers are tuned to different carrier frequencies that are carrying identical intelligence. Frequency diversity reception commonly is used aboard ship for copying fleet broadcasts, which are keyed simultaneously on several frequencies.

In diversity reception, the audio output of each receiver is connected to its associated frequency shift converter, which converts the frequency shift characters into d.c. pulses. The d.c. (or mark-space) pulses from each converter are fed to the comparator. In the comparator, an automatic circuit compares the pulses and selects the stronger mark and the stronger space pulse for each character. The output of the comparator is patched to the teletypewriter. The converter units also can be used individually with separate teletypewriters to copy two different FSK signals.

The newest converter-comparator group, the AN/URA-17( ) (fig. 11-16) is a completely transistorized equipment designed to perform the same functions as the AN/URA-8( ). Since present procurement of frequency shift converters is confined to the AN/URA-17( ), there are relatively few installations having AN/URA-8( ) converters.

The AN/URA-17( ) consists of two identical converter units. Each converter has its own comparator circuitry. Hence, a separate comparator unit is not required. The physical size of the AN/URA-17( ) is further reduced by

LOCKED IN MARK POSITION ON TTY. WHAT'S WRONG? RM2 FEB74



1.240

Figure 11-14.—Tone Shift Keyer/ Converter AN/SGC-1( ).

using transistors and printed circuit boards. The complete equipment is less than half the size of the older AN/URA-8( ).

Proper tuning of the receivers feeding these converters is important. Good communications are often the result of a properly tuned receiver. Each converter has a small oscilloscope mounted in the front which supplies the operator with a visual presentation of the input signal into the converter. The operating instructions for the converters have examples of what the correct presentation should be when the receiver has been properly tuned.

TELETYPE PATCH PANELS

To provide flexibility in teletype systems, the wiring of all teletypewriters and associated equipments is terminated on jacks in teletype patch panels. The equipment then is connected electrically in any desired combination by means of patching cords (lengths of wire with plugs on each end). 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 in such a manner, however, that the individual pieces of equipment can be "lifted" from the combination, and then used alone or in other combinations.

In addition to providing flexibility, teletype patch panels also furnish a central point for connecting the d.c. 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

Teletype panels SB-1203/UG and SB-1210/UGQ (fig. 11-17) are used for interconnection of teletypewriter equipment aboard ship with various radio adapters, such as converters. 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 cryptographic equipments. A patch panel used cryptographically is commonly painted red and has red bands installed or painted on its cables. Black is used to identify a nonsecurity patch panel.

Each of the panels contains six channels, with each channel comprising a looping series circuit of looping jacks, set jacks, and a rheostat for adjusting line current. The number of looping and set jacks in each channel varies according to the panel model. Each panel includes a meter and rotary selector switch for measuring the line current in any channel. There are six miscellaneous jacks to which may be connected any teletypewriter equipment not regularly assigned to a channel.

If the desired teletype equipment is wired in the same looping channel as the radio adapter (keyer or converter) to be used (normal through

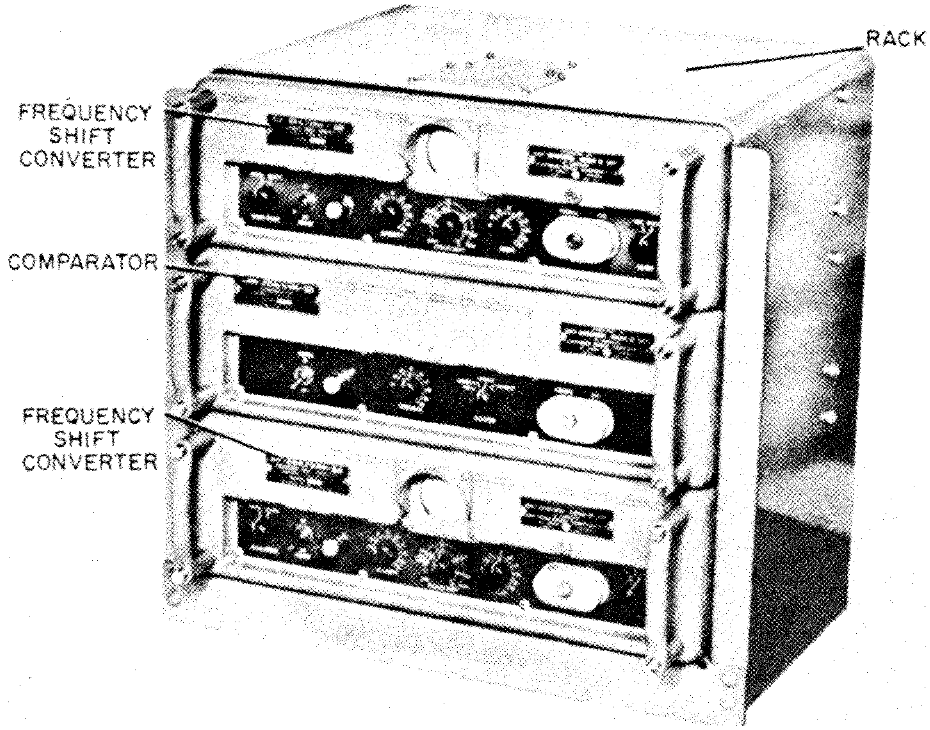


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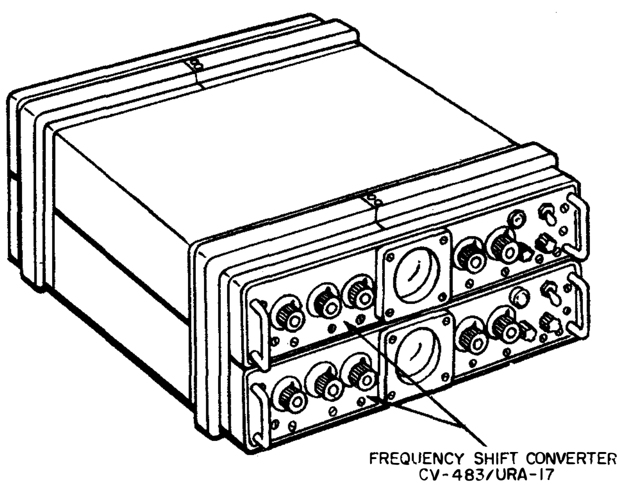
Figure 11-15.—Converter-Comparator Group AN/URA-8( ).



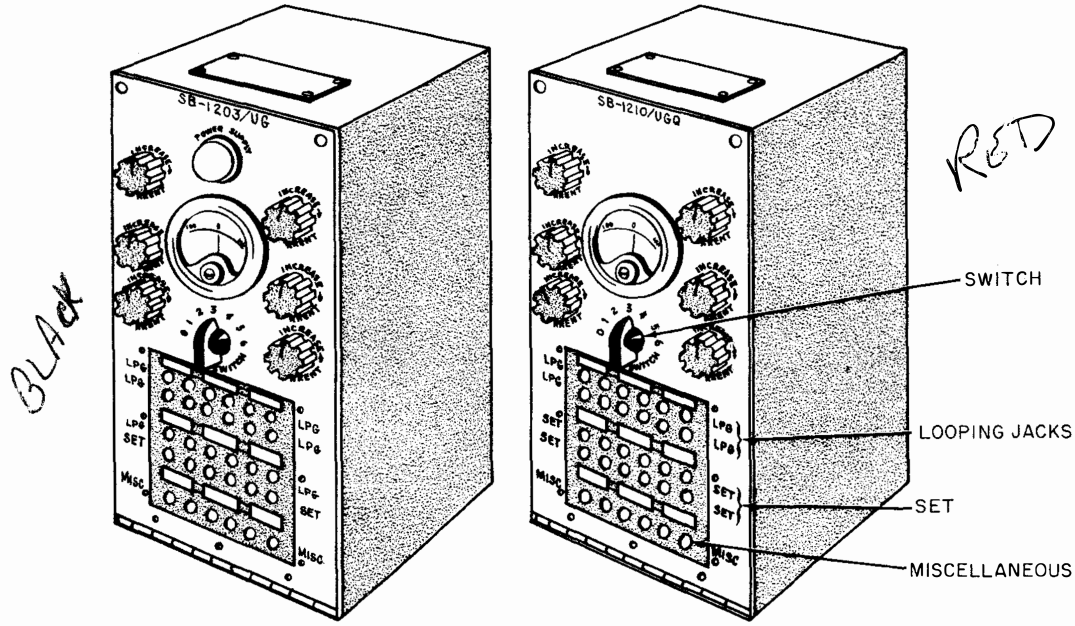
50.76
Figure 11-16.—Converter-Comparator Group AN/URA-17( )

connection), no patch cords are required. But, if the desired teletypewriter (for example, in channel 1) is not wired in the same looping channel as the keyer or converter to be used (for example, channel 3), one end of the patch cord must be inserted in the set jack in channel 1, and the other end in either one of the two looping jacks in channel 3.

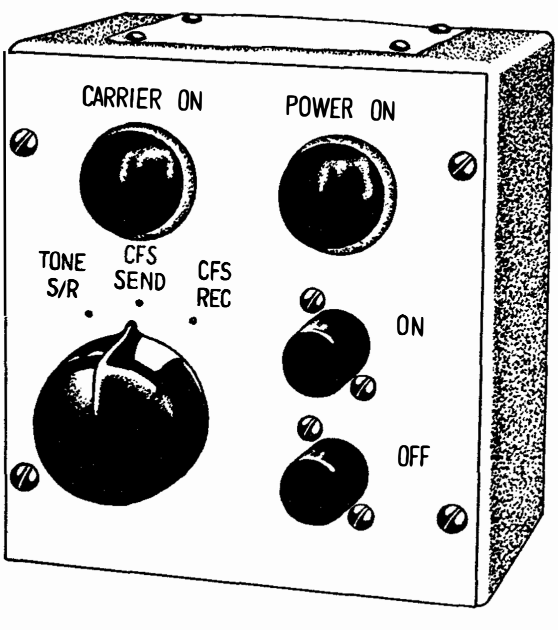
In any switching operation between the various plugs and jacks of a teletype patch panel, the cord plug must be pulled from the looping jack before removing the other plug from the set (machine) jack. Pulling the plug from the set jack first open-circuits the channel, causing all teletype messages in the channel to be interrupted. It may also produce a dangerous voltage on the exposed plug.

REMOTE TRANSMITTER CONTROL UNIT C-1004( )/SG

Another piece of equipment used with teletypewriter installations aboard ship is the C-1004( )/SG control unit shown in figure 11-18. This unit is mounted close to the teletypewriter keyboard and permits remote control of the radio transmitter. It has a transmitter power on-off switch, a power-on indicator



70.76
Figure 11-17.—Teletype patch panels SB-1203/UG and SB-1210/UGQ.



1.244.1
Figure 11-18.—Remote Control Unit C-1004( )/SG.

lamp, a carrier-on indicator lamp, and a three-position rotary selector switch.

The TONE S/R switch position is used for both sending and receiving when using a tone-shift keyer converter. When using frequency carrier-shift mode of operation, the operator must switch to SEND position for transmitting and to REC position for receiving.

MULTIPLEXING

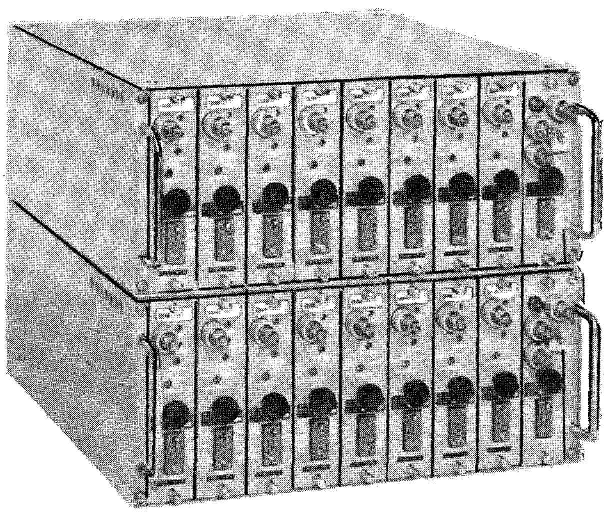
The number of communication networks in operation per unit of time throughout any given area is increasing constantly. In the not too distant past, each network was required to operate on a different frequency. As a result, all areas of the radio-frequency spectrum had become highly congested.

The maximum permissible number of intelligible transmissions taking place in the radio spectrum per unit of time can be increased through the use of multiplexing. The main purpose of a multiplex system is to increase the message-handling capacity of radio communication, or teletypewriter channels and the transmitters and receivers associated with them. This increase in capacity is accomplished by the simultaneous transmission of several messages over a common channel. The frequency division multiplexing telegraph terminal employs a number of tone channels slightly displaced in frequency. Each tone channel carries the signals from a separate teletypewriter circuit and modulates a common carrier frequency. Receiving equipment at a distant station accepts the multiplex signals, converts them to mark-space signals, and distributes them in the proper order to a corresponding number of circuits.

Most of the active fleet is equipped with multiplex equipment.

TELEGRAPH TERMINAL SET AN/UCC-1(V)

The AN/UCC-1(V) (fig. 11-19) consists of frequency division multiplex terminal equipment for use with radio (or wire) circuits. The equipment is completely transistorized.



120.26(120C)
Figure 11-19.—Telegraph Multiplex Terminal AN/UCC-1(V).

Each of the two electrical cabinets houses one control-attenuator (right-side) for switch control. The module has 8 keyers for transmission, or 8 frequency-shift converters for receiving.

In multi-channel communications utilizing the AN/UCC-1(V) the common configuration uses two receive converters for each transmit keyer. As you will learn later when chapter thirteen discusses communications systems that the AN/UCC-1(V) can be employed for exchanging information on as many as eight different channels.

Because of its light weight, small size, and high message-handling capacity, the AN/UCC-1(V) is suitable for installation on most types of ships.

A block diagram of a basic 4-channel multiplex installation is shown in figures 11-20 and 11-21. The normal shipboard or shore installation would have associated on-line cryptographic equipments in the systems to provide the necessary degrees of security for transmission and reception of classified traffic. On-line configurations are covered in detail in chapter thirteen of this manual.

On the send side of a 4-channel multiplex system the AN/FGC-60 (shore equivalent of the AN/UCC-1(V)) is fed intelligence in the form of teletype signals from one or more (maximum of four) separate teletype circuits. The AN/FGC-60 will convert these teletype signals to a composite package of audio tones which are fed to a SSB transmitter through the audio patch panel. This frequency multiplexed package is then transmitted through space (or selected medium) at the operating frequency of the transmitter.

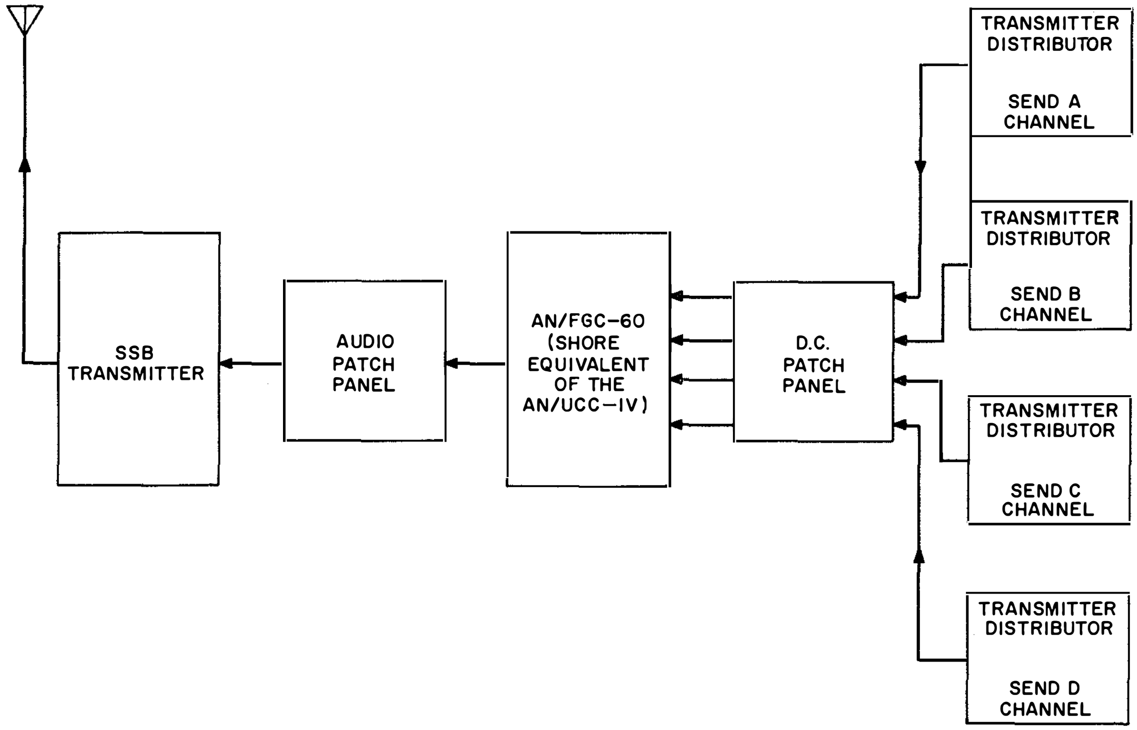
On the receiving side of the 4-channel multiplex system a SSB receiver is tuned to the operating frequency of the transmitter and feeds the composite package of tones to the AN/UCC-1(V) through an audio patch panel. The AN/UCC-1(V) then separates these tones and feeds them to appropriate drawers within the AN/UCC-1(V). The individual drawer (converter) then converts the audio input to teletype signal and feeds the appropriate teletype machine through the d-c teletype patch panel.

AUTODIN EQUIPMENT

As a Radioman you stand a good chance of being assigned to a large ship or a communications station ashore. With the advent of the AUTODIN (Automatic Digital Network) system, more and more communications stations are being equipped with multi-purpose equipment, one type of which is the Digital Subscriber Terminal Equipment (DSTE); therefore, a major portion of this chapter will be devoted to that system.

HOW AUTODIN WORKS

First of all just what is AUTODIN? The Automatic Digital Network is a Defense



50.83(120C)A

Figure 11-20.—Send Side Multiplex installation employing 4-channel terminal equipment.

communications worldwide, high-speed, common-user communications system operated for and managed by the Defense Communications Agency to provide both direct user-to-user and store-and-forward message switching service for the Department of Defense and other government agencies.

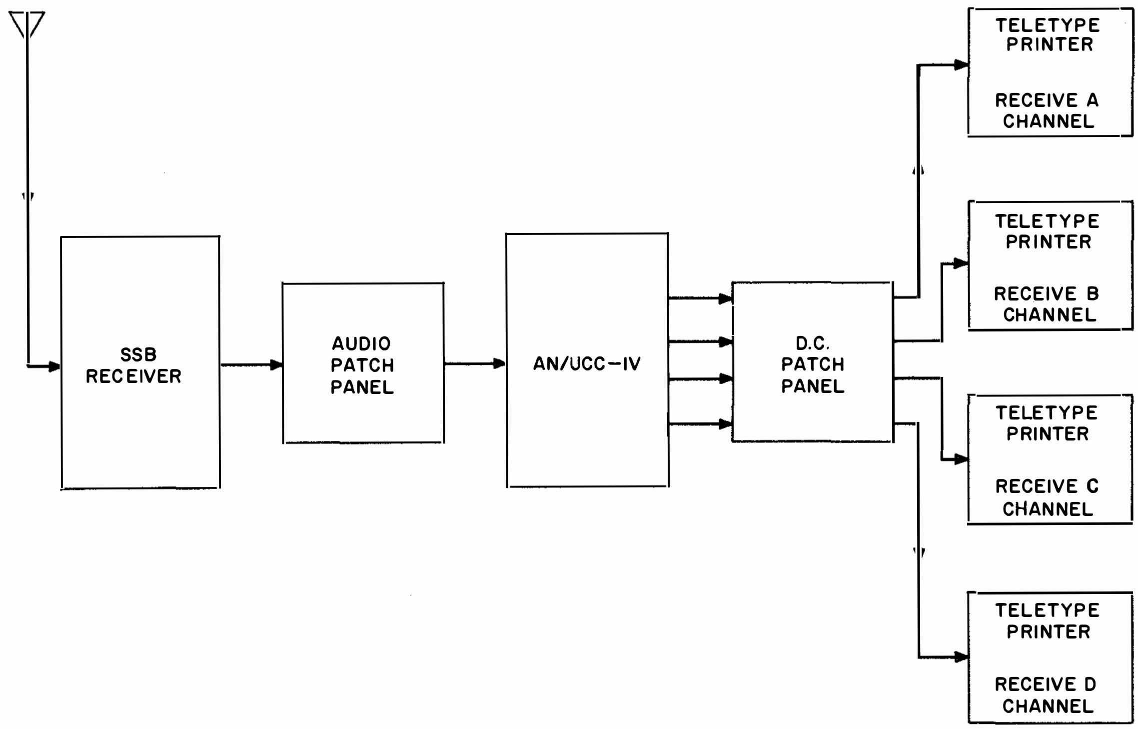
As a digital communications telegraphic store-and-forward network, AUTODIN consists essentially of switching centers interconnected by trunk lines with local lines radiating from each center to subscriber terminals in the area served by each center. Messages originating at any of the subscriber terminals are forwarded through one or more switching centers to their addressed subscriber destination. The message switching center's function is to accept messages from any of the subscribers, determine their classification and precedence, and relay the messages to the addressed subscribers. Figure 11-22 shows the switching center and its related terminals.

Communications system planners have found that to attempt to link by direct lines all terminals that may have an occasion to communicate with one another would require a preposterously large number of circuits. Accordingly, AUTODIN links only a score of switching centers with trunk circuits for long-haul and overseas connections while terminals connected to a particular switching center communicate with one another through electronic switching and programming at their center.

Mechanization by Programming

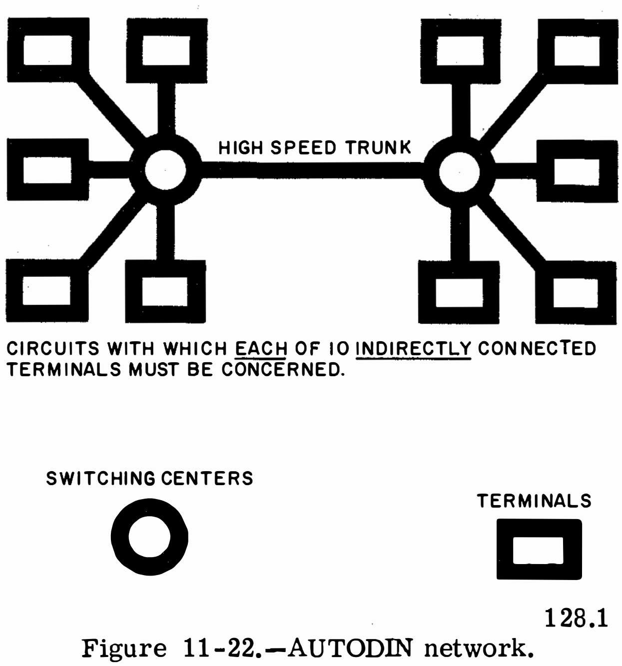
At the start of each message is a header containing pertinent information relating to the destination of the message. Messages can be sent to a single addressee or, if directed by the header information, copies can be sent to many addressees. This system affords a great saving in time and communications facilities, since only one message is prepared by the originator and sent to the switching center.

The AUTODIN timing system briefly connects a switching center to each terminal in turn. Computer memories act as reservoirs for the incoming messages of each subscriber



50.83(120C)B

Figure 11-21.—Receive Side Multiplex installation employing 4-channel terminal equipment.



128.1

Figure 11-22.—AUTODIN network.

terminal. The computer is programmed to connect each terminal in turn during a cycle. The computer services low and higher speed terminals as well as the trunks linking it to the other switching center. Messages which have been completely received are scheduled for output to the addressee's channel when its turn arrives in the cycle. This action is possible since the electronic speed of the computer is so much faster than the mechanical tape and card handling apparatus at the terminals. Due to the cycling scheme, a terminal desiring to send a message into the system is normally never presented with an extended busy condition.

Error Detection

All communications facilities are subject to natural disturbances and terminal hardware failure. AUTODIN has built-in safeguards which detect almost any type of hardware or format error.

Message Tracing

Verifying words or tracing messages represents no problem to AUTODIN. A complete (reference) copy of all messages relayed remains on AUTODIN computer tape. A separate (journal) copy is made of only the address. Using the journal copy as an index permits AUTODIN to locate any message's reference copy.

Message Precedence

All AUTODIN messages are assigned one of four precedences.

• High precedence messages automatically move first. In fact, if a flash message is received, it will interrupt the text of a more routine message.

System Compatibility

AUTODIN is exceptionally flexible. Appropriate interface equipment translates all inputs into a common machine language. AUTODIN is compatible with many different computer codes, speeds, and media (card, tape, etc.). Thus, communications equipment at all government and key industrial sites can be integrated into the enormous AUTODIN system.

DIGITAL SUBSCRIBER TERMINAL EQUIPMENT

Input and output devices provide the AUTODIN computer with the facilities necessary for communicating with the users. Input devices such as card readers and teletypewriters supply the computer with data and instructions, while output devices provide the means for changing the data processed by the computer into a form specified by or intelligible to the users. The selection of input/output devices depend on the specific use for which a computer is intended. In the following discussions, the applications, types and characteristics of input/output devices are presented.

Generally, input/output devices must meet two basic requirements. First, the devices must be able to modify all data so that it is acceptable to the computer during the input phase of the operation and must be able to present data in usable form during the output phase. Second, the devices must operate quickly and efficiently in conjunction with the computer.

Conventional input devices read coded data into computers or other devices from punched cards or punched paper tape. In the communications application, the input devices will be included in the Digital Subscriber Terminal Equipment (DSTE).

In the presentation of these devices it is necessary to use code language which may not be familiar to you; therefore, the following codes are defined so that you will fully understand the functions of the devices.

Hollerith code: Standard punch card language.
Punch card: Standard 3 1/4" x 7 3/8" card. These cards are both punched and interpreted and serve a dual purpose: one as an index file and the other as a storage medium.
ASC II code: American standard code information interchange, eight-level paper tape.
ITA #2 code: American version of international TTY alphabet, five-level paper tape.

The DSTE system will be used in communications terminals around the world. They will be linked together by automatic digital message switching centers (ADMS). In this chapter we will cover only the equipments comprising the terminals.

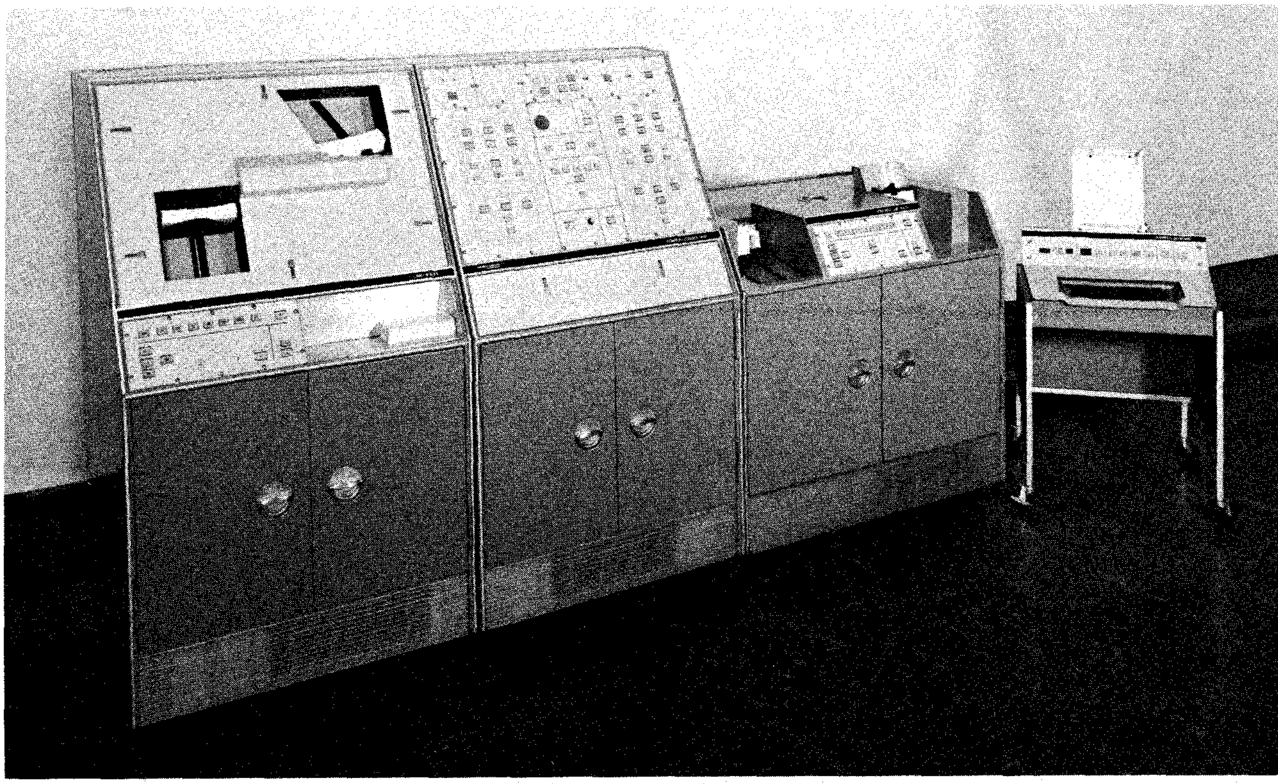
The DSTE may be configured in various forms—(see figs. 11-23, 11-24, and 11-25) as a card only terminal, as a tape only terminal, or as a combined card and tape terminal.

The largest configuration, using all of the equipment furnished, is a combined card and paper tape terminal which operates at speeds up to 1500 words per minute. The DSTE includes all of the following equipments.

The Common Control Unit
Card Reader
Paper Tape Reader
Low-Speed Card Punch
High-Speed Card Punch
Universal Keyboard
Page Printer
High-Speed and Low-Speed Paper Tape Punches

Common Control Unit (CCU)

The common control unit is the prime control device in each digital terminal. This unit



128.2

Figure 11-23.—Low-Speed card configuration.

(fig. 11-26) automatically coordinates and interconnects full-duplex message traffic. The sending operation consists of: (1) accepting data characters from tape or card readers; (2) accumulating the input characters into data blocks in the CCU memory; and (3) transmitting the completed framed blocks and waiting for acknowledgement code.

The receiving operation consists of: (1) accepting data blocks from the line; checking for errors and sending proper response code; (2) accumulating message blocks in memory; and (3) distributing data blocks to an output tape or card device on a character basis.

Card Reader

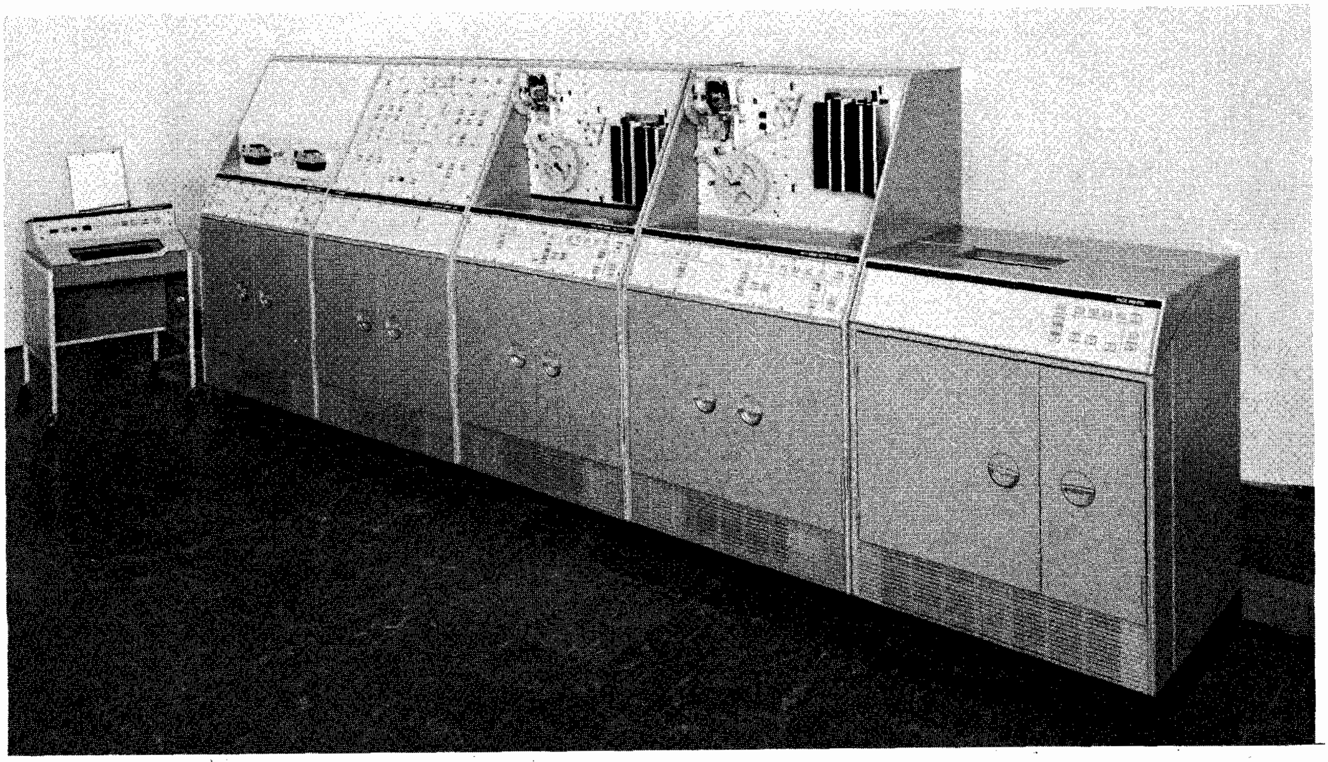
The card reader (fig. 11-27), is a message-input device for the transmit operation of the DSTE. The flow of intelligence is as follows:

1. Messages punched in cards in Hollerith code are read by the card reader.
2. The Hollerith characters are electronically converted to ASC II characters.
3. The ASC II characters are transferred to the common control unit.
4. The common control unit accumulates the characters into blocks and sends them to the line.

The card reader can read cards and transfer data to the common control unit at a rate up to 1500 words per minute.

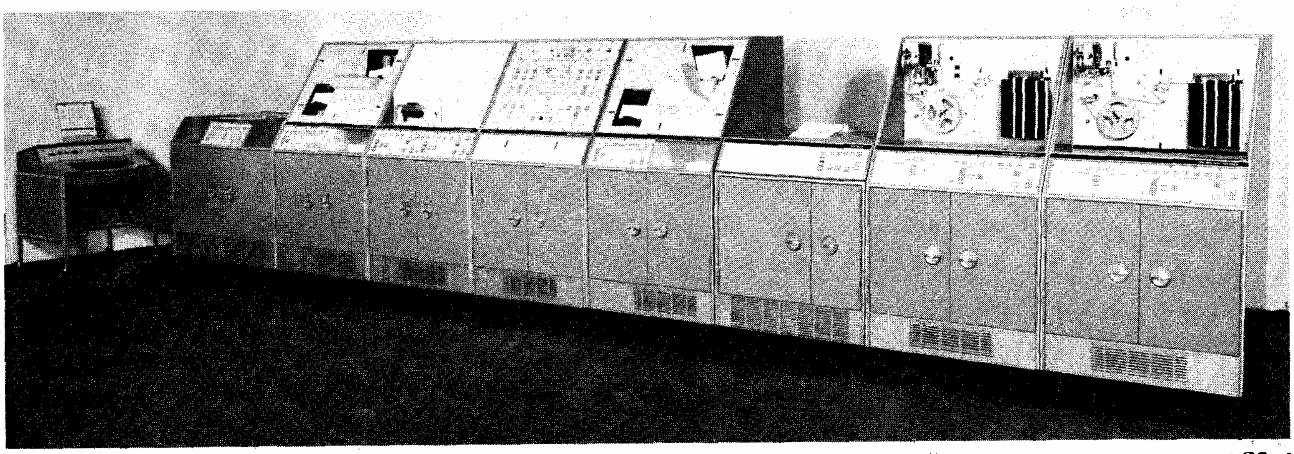
Paper-Tape Reader

The paper-tape reader (fig. 11-28), converts the perforations in punched paper tape to electrical data in the form of ASC II-coded characters and transfers this data to the common control unit. A switch provides the option of reading data punched in either ASC II or ITA #2 code form. The data on ITA #2 coded tape is converted to the ASC II code form required as an input to the common control unit. The punched paper tape is stepped through the



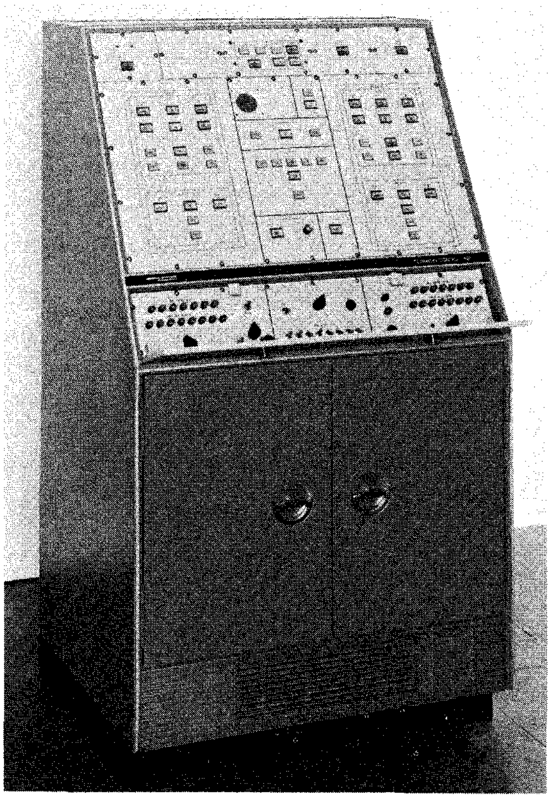
128.3

Figure 11-24.—High-Speed Paper Tape Terminal Configuration.

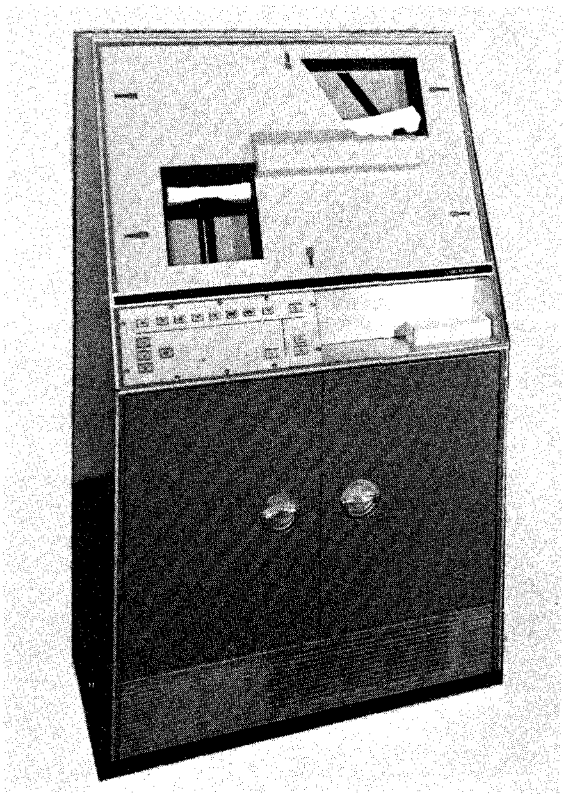


128.4

Figure 11-25.—High-Speed Card and Tape Configuration.



128.5
Figure 11-26.—Common control net.



128.6
Figure 11-27.—Card Reader.

reader mechanism one character at a time in response to control signals received from the common control unit. The paper tape reader is capable of reading fully perforated paper tape and transferring the data at a rate of 1500 words per minute. A speed-limiting switch permits reading chadless paper tape and transferring the data for any rate up to 187.5 words per minute.

Low-Speed Card Punch

The low-speed card punch (fig. 11-29), can be used at a DSTE either as an on-line output device or off-line in conjunction with the Universal Keyboard.

The low-speed card punch accepts data from the common control unit or keyboard in ASC II code. This data is converted to Hollerith code and punched in cards. The punch logic substitutes an asterisk for any character received in ASC II which does not have an assignment in Hollerith.

The low-speed card punch can punch and print cards at any rate compatible with a common control unit rate up to 375 WPM (28 cards a minute).

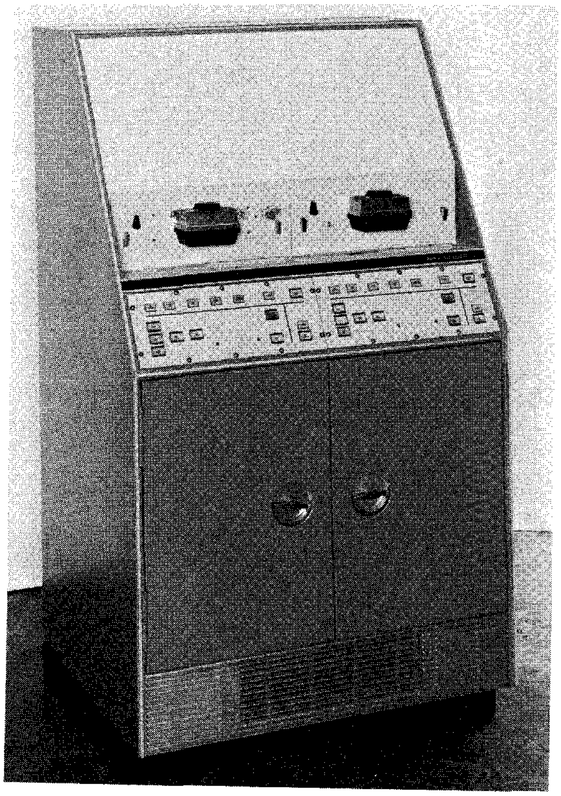
High-Speed Card Punch

The high-speed card punch (fig. 11-30), accepts data from the common control unit in eight-level ASC II code. At the card punch, this data is then converted to Hollerith and punched in cards. The punch logic substitutes an asterisk for any character received in ASC II which does not have an assignment in Hollerith.

The high-speed card punch supports speeds up to 1500 WPM or an equivalent of 150 characters per second (112 cards a minute).

Universal Keyboard

The Universal Keyboard (fig. 11-31), is used in conjunction with a paper-tape punch or a card punch (see fig. 11-29). An off-line device,



128.7
Figure 11-28.—Paper-Tape Reader.

it affords the means to prepare messages for subsequent transmittal via the appropriate DSTE reader unit.

The input of the Universal Keyboard is in ASC II code. Depending on the type of punch employed, the following data media can be prepared:

1. Paper tape in ASC II characters.
2. Paper tape in ITA #2 code.
3. Punched cards in Hollerith code.

Page Printer

The page printer (fig. 11-32) can be used in a digital terminal as an output monitor, or as an input monitor.

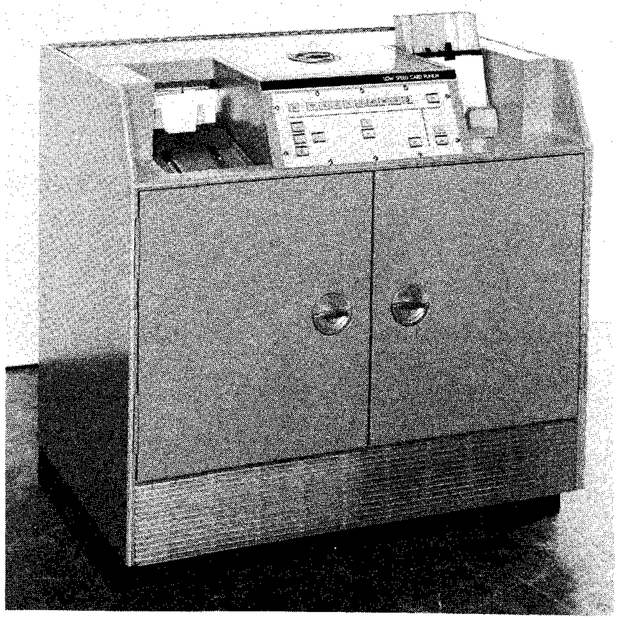
As an output monitor the page printer provides a printout of the data received at the terminal. As an input monitor, the page printer provides hard copy of data transferred to the common control unit by the various DSTE readers. The assignment of a page printer to the input or output monitor is controlled at the common control unit. (See fig. 11-26.)

The page printer operates at speeds up to 3000 WPM. Data is printed ten characters per inch, one to eighty characters per line, with six lines per inch. The printer accommodates standard sprocket hole single ply paper, multilith masters, ditto masters, and 2, 3, 4, and 5 multi-ply paper with carbons.

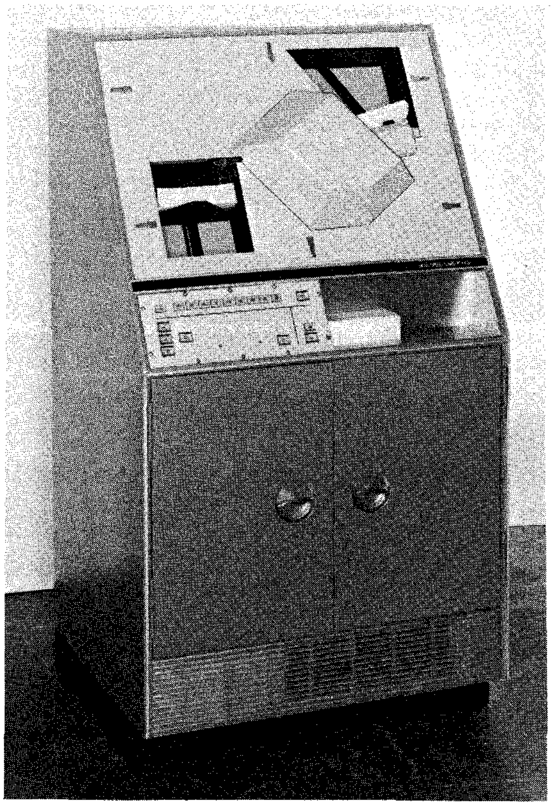
High-Speed and Low-Speed Paper-Tape Punches

The high-speed and low-speed paper-tape punches (fig. 11-33), function as on-line output devices. Both paper-tape punches can also be used for off-line keypunch operation in conjunction with the Universal Keyboard.

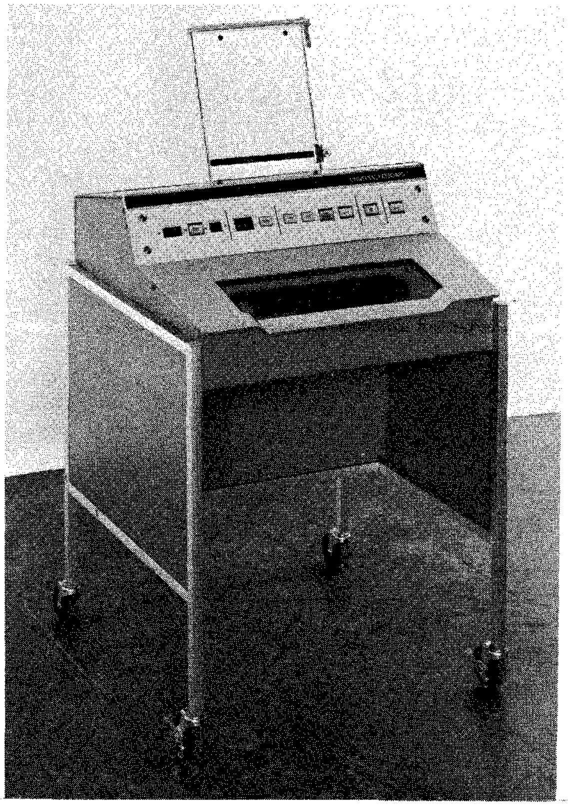
As output devices, the paper-tape punches accept ASC II coded data from the common control unit and enter this data onto punched paper tape in the form of either ASC II or ITA #2-coded characters. In addition a printer-interpreter prints characters between the sprocket holes on the paper tape corresponding to the punched characters. The high-speed paper-tape punch, punches paper tape at speeds up to 1400 words per minute. The low-speed paper-tape punch punches and prints paper tape



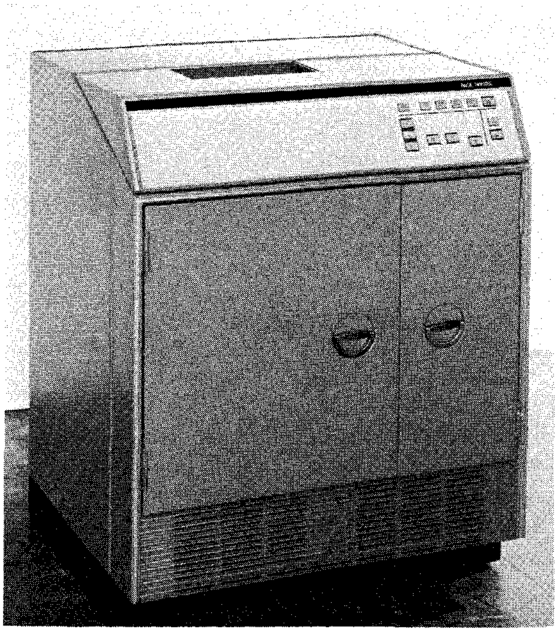
128.8
Figure 11-29.—Low-Speed Card Punch.



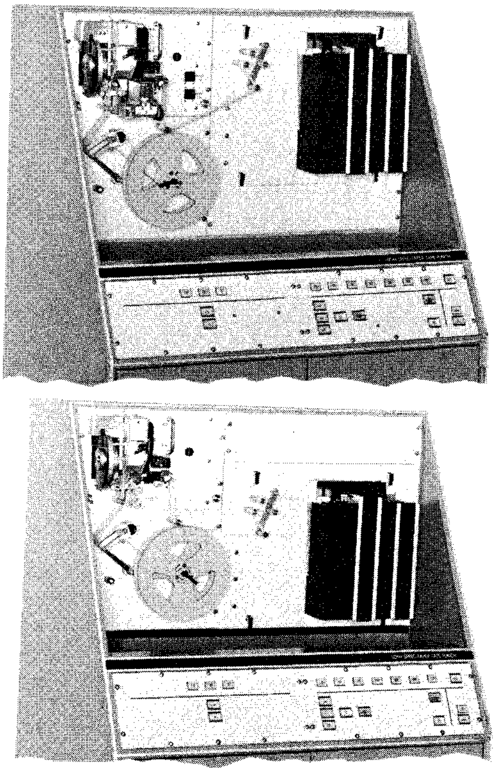
128.9
Figure 11-30.—High-Speed Punch.



128.10
Figure 11-31.—Control Keyboard.



128.12
Figure 11-32.—Page Printer.



128.13
Figure 11-33.—High-Speed and Low-Speed Paper-Tape punches.

at speeds up to 18.75 characters per second and will punch, without printing, up to 75 characters per second.

A unique feature of the paper-tape punches is the ability to operate the tape-punch and printer-interpreter independently. This permits off-line printing of previously prepared paper tape while the punch mechanism remains on-line.

At this point you may be thinking that all our work-load problems are solved now that data communications are a reality. This is just not true, and well-trained sailors will still have to man this equipment. Some disadvantages of the data processing communications systems are as follows:

1. Limited decision-making ability of each piece of equipment.

2. Complex problems require the utilization of many separate pieces of equipment with the necessity of transmitting large volumes of cards and tapes from machine to machine.

3. Erroneous information is processed as rapidly as correct information, and errors are sometimes not as easily detected as with manual systems.

4. Exceptions cannot be handled by machines and normally must be processed manually.

TELETYPEWRITER SUPPORT

Support of the teletypewriter includes changing paper, ribbon, and tape as the need arises.

CHANGING PAPER

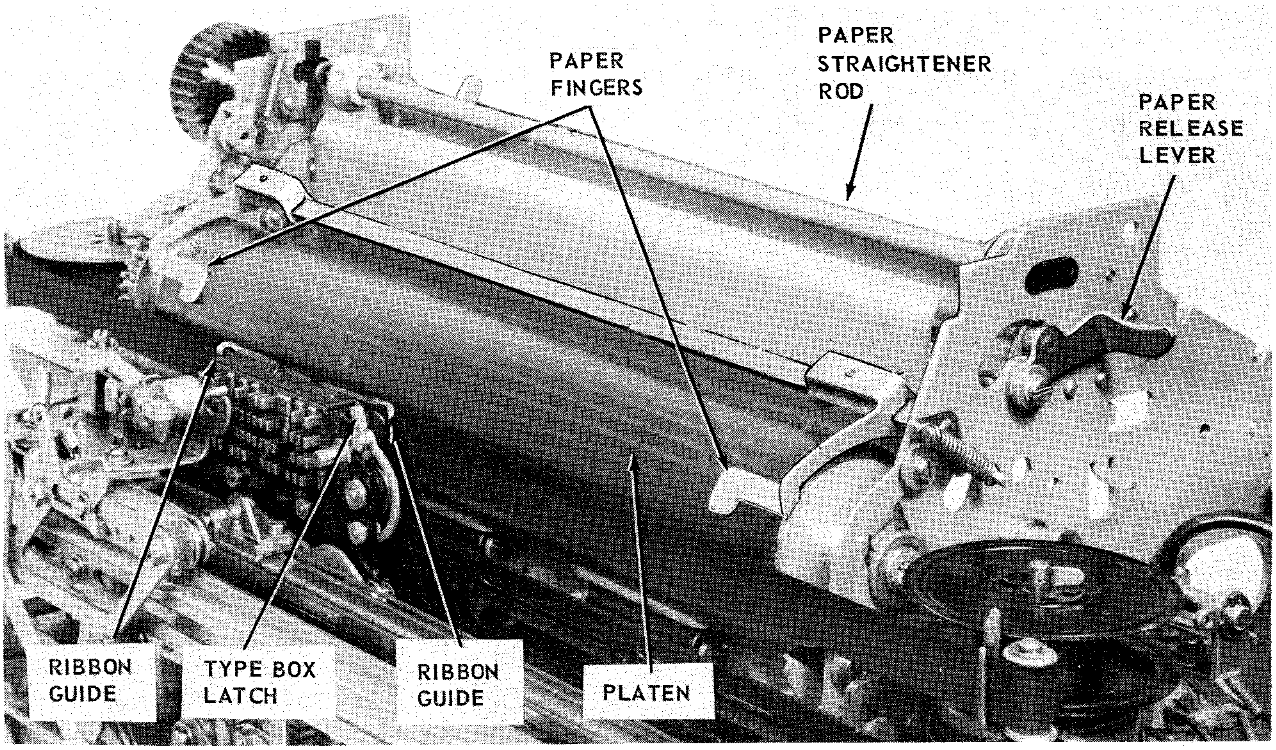
To insert a new roll of paper in the machine, first shut off the power. Press cover release pushbutton and lift cover. (Refer as necessary to figs. 11-34 and 11-35.) Push back paper release lever, lift paper fingers, and pull paper from platen.

Lift the used roll from machine and remove spindle from core of used roll. Insert spindle in new roll. Replace spindle in spindle grooves with paper feeding from underneath roll toward operator. Feed paper over paper-straightener rod, down under platen, and up between platen and paper fingers. Pull paper up a few inches beyond top of platen, and straighten it as though straightening paper in a typewriter. Then lower paper fingers onto paper and pull paper release lever forward.

While inserting paper, avoid disturbing the ribbon or the type box latch. After paper is in place, check to see that ribbon still is properly threaded through ribbon guides. Also check to make certain that type box latch has not been disengaged. It should be in a position holding the type box firmly in place. Close cover. Open lid by pressing lid release pushbutton, bring up the end of the paper, and close lid with paper feeding out the top of it.

CHANGING RIBBONS

To replace a worn ribbon on the typing unit, press cover release pushbutton and lift cover. (Refer as necessary to figs. 11-36 and 11-37.) Lift ribbon spool locks to a vertical position, and remove both spools from ribbon spool shafts. Remove ribbon from ribbon rollers, ribbon reverse levers, and ribbon guides. Unwind and remove old ribbon from one of the spools. Hook end of new ribbon to hub of empty



1.219

Figure 11-34.—Paper roll removed.

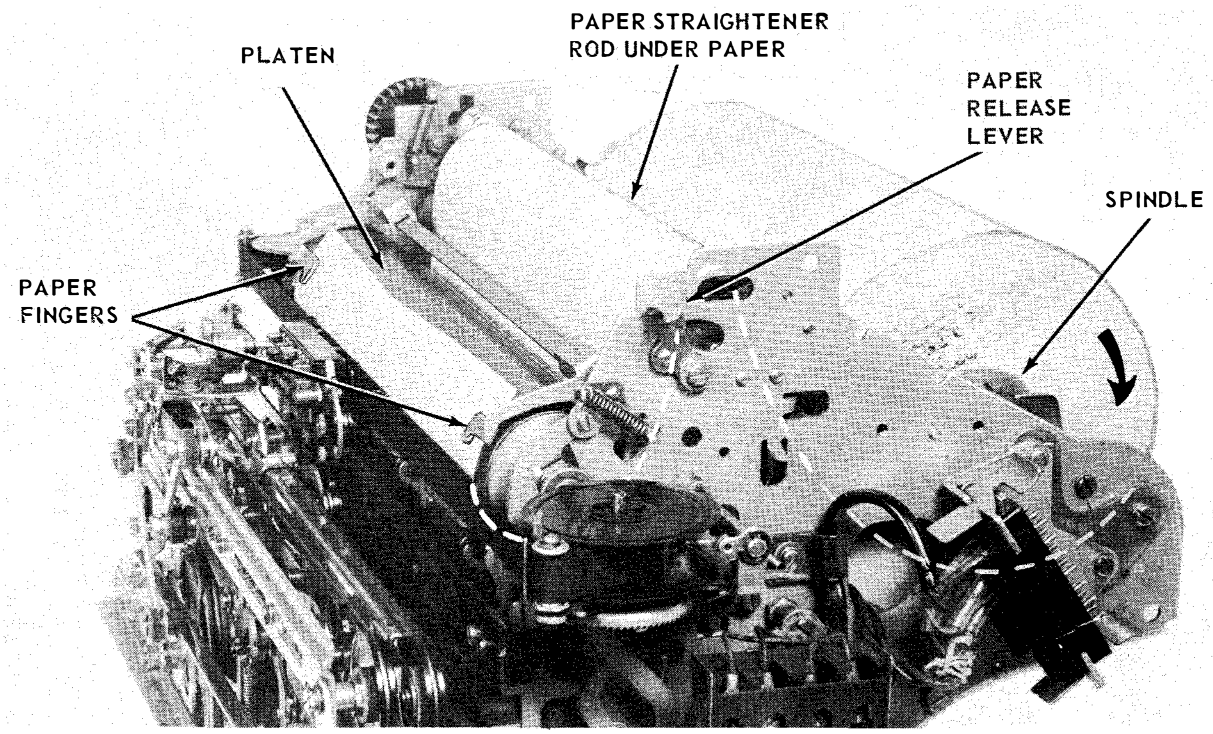


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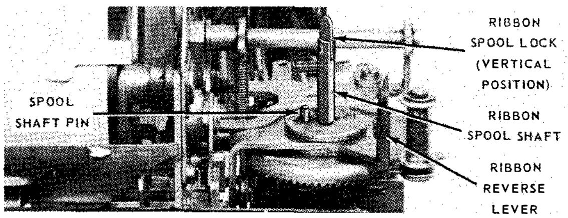
Figure 11-35.—Paper roll inserted.



1.221

Figure 11-36.—Ribbon spool mechanism.

spool, and wind until reversing eyelet is on the spool. If the ribbon has no hook at the end, the spool will have a barb that should be used to pierce the ribbon near its end.

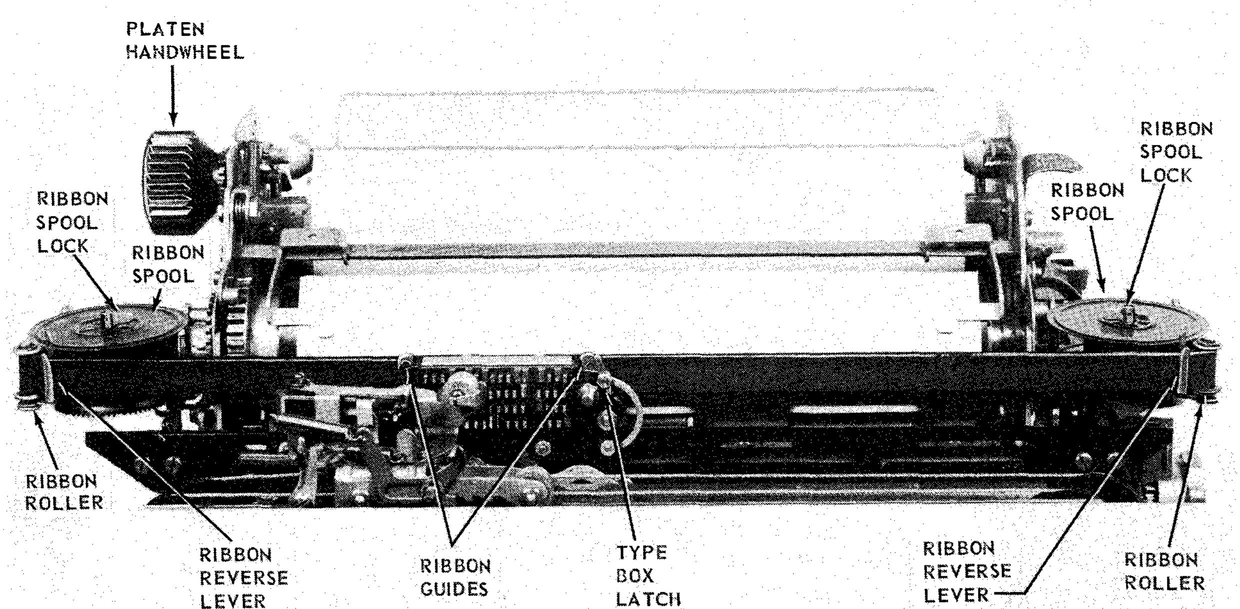
Replace spools on ribbon spool shafts, making sure they settle on spool shaft pins, and that the ribbon feeds from the front of the spools. Turn down ribbon spool locks to a horizontal position, locking spools in place. Thread ribbon forward around both ribbon rollers, through the slots in the ribbon levers and ribbon guides. Take up slack by turning free spool. After slack has been taken up, check to make certain that ribbon still is properly threaded through ribbon guides, and that the reversing eyelet is between spool and the reverse lever. Also see that the type box latch has not been disengaged. It should be in position, holding the type box firmly in place.

Turn the paper up a few inches by pressing down and turning platen handwheel. Close cover. Open lid, bring up the end of the paper, and close lid, with paper feeding out on top of it.

CHANGING TAPE

A visual indication of low tape supply is incorporated into each roll of tape. When the color of the tape changes from pale yellow to red, it is a warning that the roll is nearly exhausted and requires replacement. Additionally, the warning device in the reperforator's tape container is activated when the tape supply for that unit is low. Heed these warnings! Don't miss a message by trying to use up the last bit of tape on a roll.

To change tape in the perforator, set the keyboard selector switch to the T mode of operation. Raise the perforator cover, and open the lid in the center of the cabinet dome. Tear the old tape at the point where it enters the tape chute (fig. 11-38). With power applied to the equipment, depress the REPT key and any character on the keyboard until the old tape is



1.222

Figure 11-37.—Ribbon inserted.

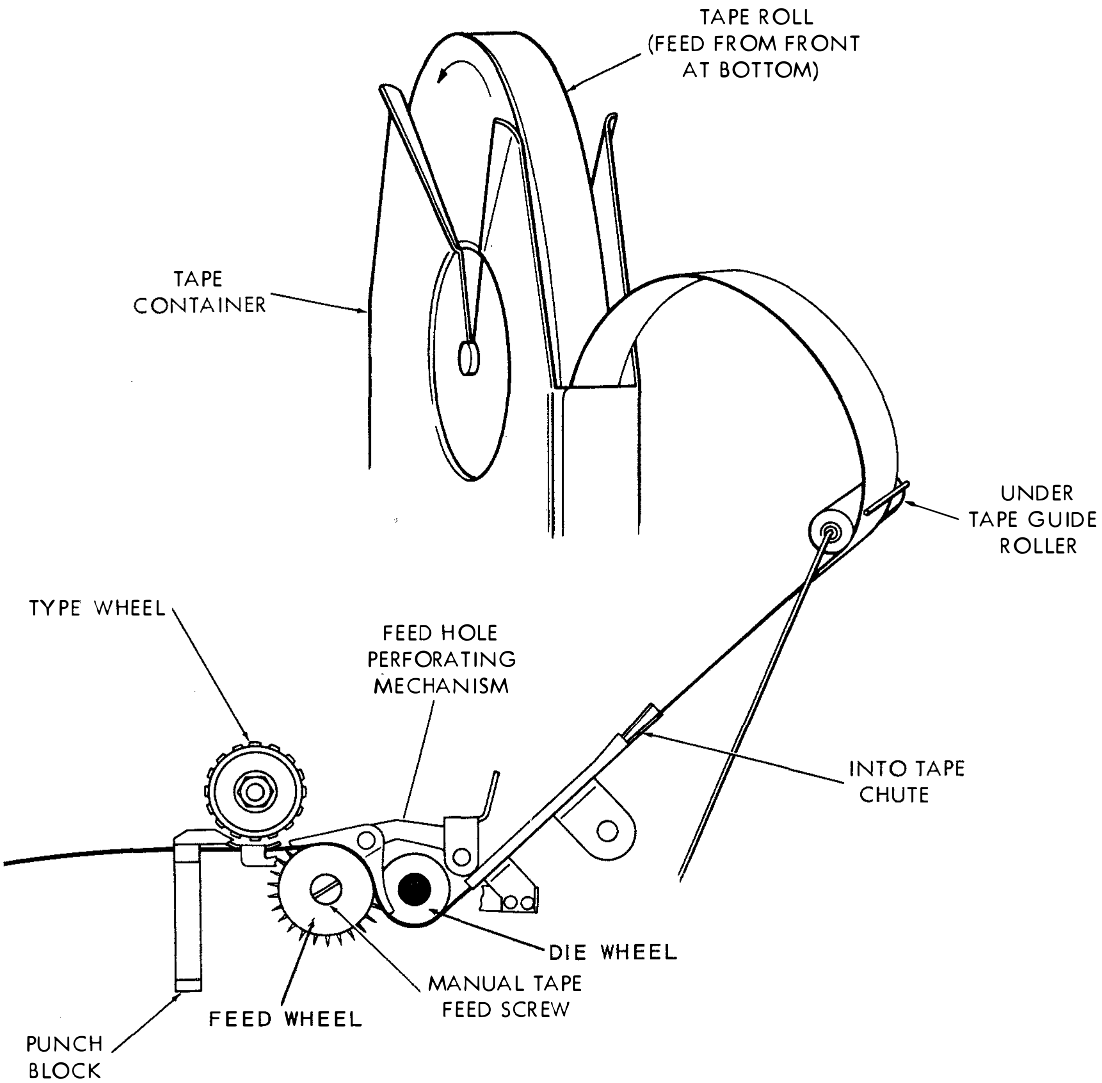


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Figure 11-38.—Path of tape in typing perforator.

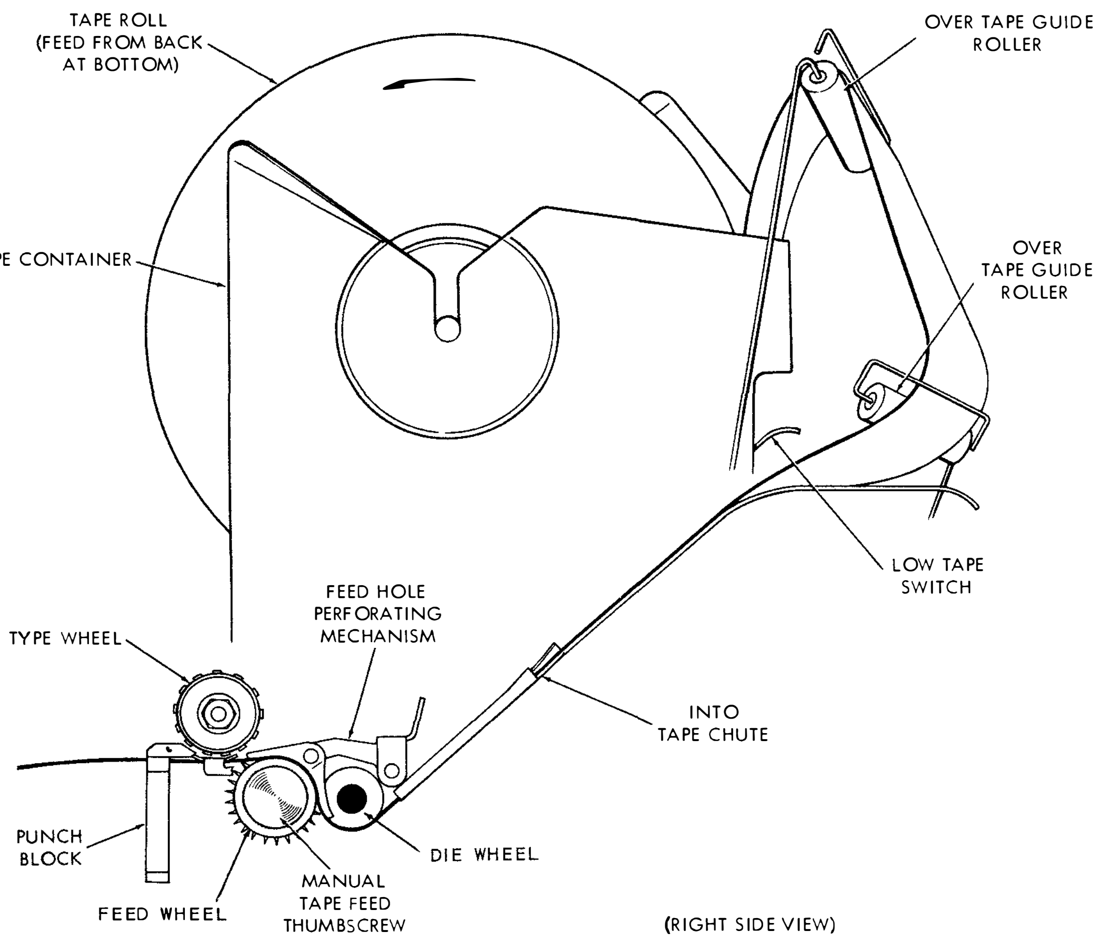


Figure 11-39.—Path of tape in typing reperforator.

fed out of the punch block. Then, lift the tape reel from its container and remove the remainder of the old tape from the reel. Insert a fresh roll of tape on the reel. Place the reel back into its container so that the tape feeds from the front of the container and off the bottom of the reel. Thread the tape over the tape guide roller and into the chute of the punch mechanism. Depress the REPT key and any character on the keyboard for automatic feeding. Simultaneously, push the tape downward until it is engaged by the feed and die wheels. Continue feeding tape until the tape appears at the left side of the punch block. Close the lid in the cabinet and lower the cover over the perforator.

The procedure for changing tape in the reperforator is almost identical to that for changing tape in the perforator. The path of the tape through the two units is identical. (Refer to fig. 11-39 as necessary.)

For access to the reperforator and its tape supply, open the left rear lid in the cabinet. Tear the tape at the tape chute and clear it out of the punch block by manually rotating the feed wheel or, if the reperforator is so equipped, by pressing the automatic tape feed button. Lift the tape reel from its container, remove the old tape, and insert a fresh roll of tape on the reel. Position the reel in its container in such a manner that tape feeds from the rear of the container and off the bottom of the reel. Make certain that the lever on the tape out switch assembly is toward the rear of the cabinet and under the roll of tape. Lead the tape over the tape roller at the rear of the tape container, to the right and over the roller mounted on the typing reperforator, and to the tape chute. Slide the tape into the chute, and rotate the tape feed wheel until the tape emerges from the punch chute at the left of the reperforator. Close the lid, making sure that the tape feeds through the hole in the front of the lid.

CHAPTER 12

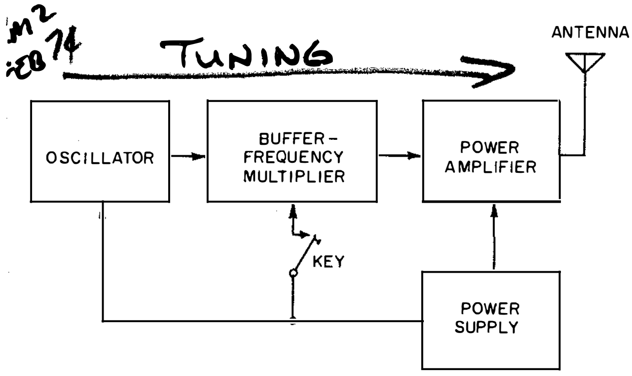
COMMUNICATIONS TRANSMITTERS AND RECEIVERS

A well-rounded knowledge of present-day communication equipments is essential to the Radioman, if he is to be efficient in performing all duties to which he is assigned. Communication equipment today is becoming increasingly more complex and although the Radioman is not required to qualify as a specialist in electronics, he must be familiar with the designating systems, principles of operation, and capabilities of the equipment he operates.

In descriptions of representative communication equipment, only fundamental features are given. Circuits are represented largely by block diagram. Emphasis is on the types and purposes of the stages on which performance capabilities and limitations of equipment are based.

TRANSMITTERS

The purpose of a radio transmitter is to produce radiofrequency energy, and, with its amplifiers, coupler, and antenna to radiate a useful signal. The general plan for all transmitters is seen in figure 12-1.



20.201

Figure 12-1.—Stages of a typical transmitter.

Every transmitter has an oscillator that generates a steady flow of radiofrequency energy. An oscillator may be the self-excited type, which originates a signal in electron tubes or transistors and associated circuits. Or it may be of the crystal type, which uses, in conjunction with an electron tube or transistor, a quartz crystal cut to vibrate at a certain frequency when electrically energized. In either type, voltage and current delivered by the oscillator are weak. Thus, the outputs of both types of oscillators must be amplified many times to be radiated any distance.

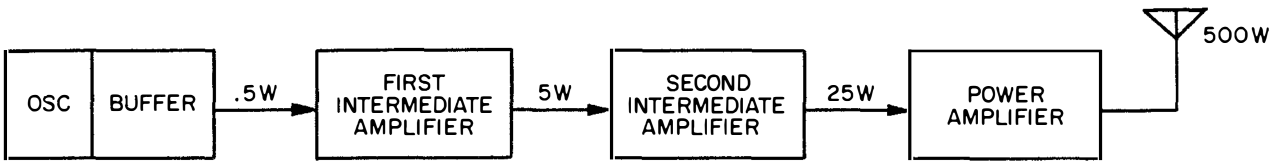
The buffer stage or first intermediate power amplifier stage is a voltage amplifier that increases the amplitude of the oscillator signal to a level that will drive the power amplifier. Power delivered by the buffer varies with the type of transmitter, but it may be hundreds or thousands of volts.

The buffer serves two other purposes, one of which is to isolate the oscillator from the amplifier stages. Without the buffer, changes in the amplifier due to keying or variations in source voltage would vary the load on the oscillator and cause it to change frequency. It may also be a frequency multiplier, as we will see later.

The final stage of a transmitter is the power amplifier. Power is the product of current times voltage, and in the power amplifier a large amount of r-f current is made available for radiation by the antenna.

The power amplifier of a high-power transmitter may require far more driving power than can be supplied by an oscillator and its buffer stage. One or more low-power intermediate amplifiers may be required between the buffer and the final amplifier that feeds the antenna. The main difference between many low- and high-power transmitters is in the number of intermediate power-amplifying stages that are used.

In the block diagram of figure 12-2, the input and output powers are given for each stage of a typical medium-frequency transmitter. It is shown that the power output of a transmitter can be increased by adding amplifier stages capable of delivering the power required.



76.15

Figure 12-2.—Intermediate amplifiers increase transmitter power.

HARMONICS AND FREQUENCY MULTIPLICATION

The term harmonics sometimes is loosely used to designate unwanted radiations caused by imperfections in the transmitting equipment, but this interpretation is not entirely accurate. True harmonics are always exact multiples of the basic or fundamental frequency generated by an oscillator, and are created in vacuum tubes and their associated circuits. Even harmonics are 2, 4, 6, 8 (and so on) times the fundamental; odd harmonics are 3, 5, 7, 9 (etc.) times the fundamental. If an oscillator has a fundamental frequency of 2500 kHz, harmonically related frequencies are—

5000	2d harmonic
7500	3d harmonic
10,000	4th harmonic
12,500	5th harmonic

The series ascends indefinitely until the intensity is too weak to be detected. In general, the energy in frequencies above the third harmonic is too weak to be significant.

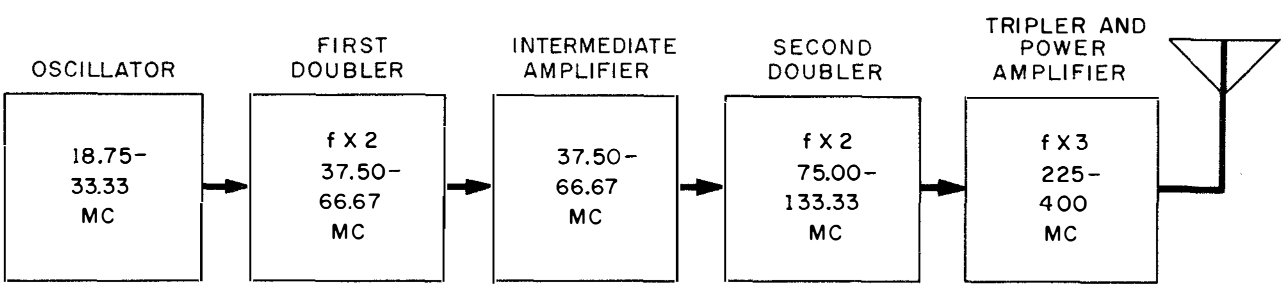
It is difficult to design and build a stable oscillator, since the crystal must be ground so thin that it might crack while vibrating. These transmitters therefore have oscillators operating at comparatively low frequencies, sometimes as low as one-hundredth of the output frequency. Oscillator frequency is raised to the required output frequency by passing it through one or more frequency multipliers. Frequency multipliers are special power amplifiers that multiply the input frequency. Stages that multiply the frequency by 2 are called doublers; those that multiply by 3 are triplers; and those multiplying by 4 are quadruplers.

The main difference between many low-frequency and high-frequency transmitters is in the number of frequency-multiplying stages used. Figure 12-3 shows the block diagram of a typical Navy VHF/UHF transmitter. The oscillator in this transmitter is tunable from 18.75 MHz to 33.33 MHz. The multiple stages increase the frequency by a factor of 12 by multiplying successively by 2, 2, and 3.

In high-power, high-frequency transmitters, one or more intermediate amplifiers may be used between the last frequency multiplier and the final power amplifier.

TRANSMISSION OF INFORMATION BY RADIO

Because the high-frequency output from the radiofrequency (r-f) section of a transmitter is



76.16

Figure 12-3.—Frequency-multiplying stages of typical VHF/UHF transmitter.

constant in frequency and amplitude, it does not convey any intelligence by itself. This output is called the CARRIER WAVE, or simply the CARRIER, and information to be transmitted is added to it. The process of adding or superimposing information on the carrier is called MODULATION.

Modulation is accomplished by combining another (modulating) signal with the carrier. This is done in such a manner as to cause the output to vary in frequency or in amplitude according to the current or voltage variations of the modulating signal. The modulating signal usually is of a much lower frequency than the carrier.

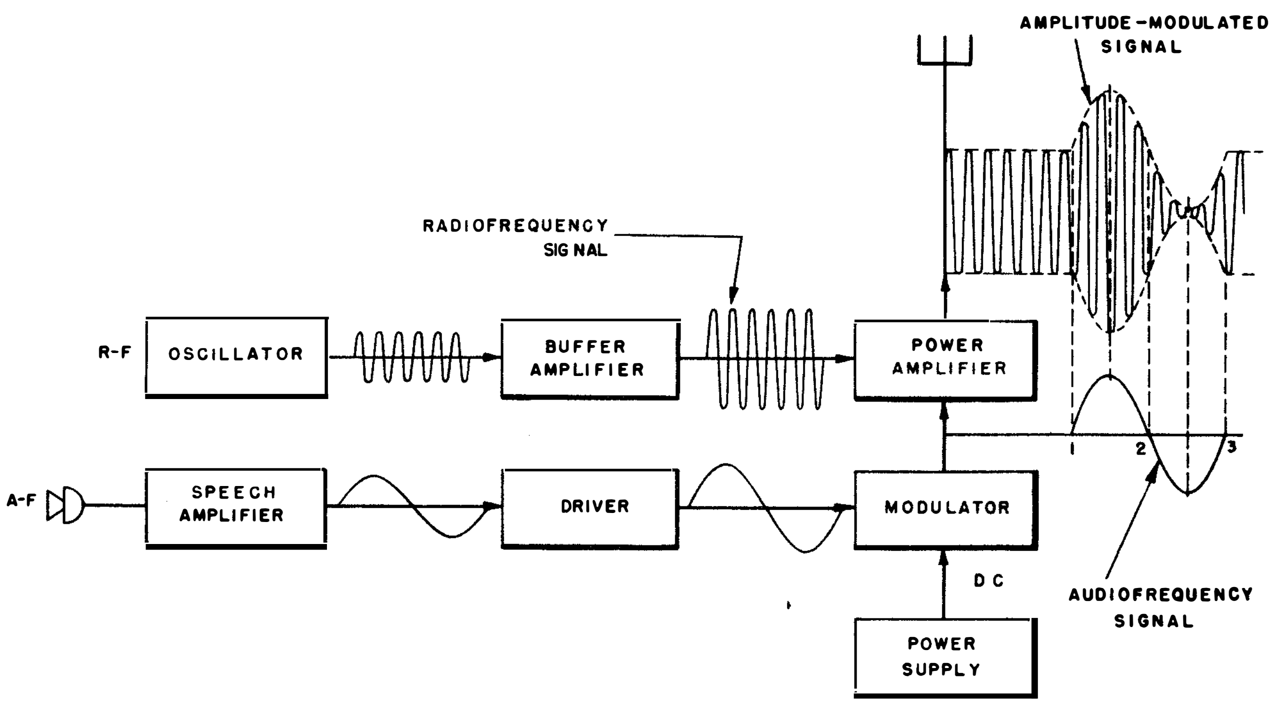
Amplitude Modulation

If the modulating frequency is impressed on the r-f output to vary its amplitude, it is called amplitude modulation (abbreviated a-m).

Figure 12-4 is a block diagram of an a-m radiotelephone transmitter, showing the waveforms for the various stages. The top row of blocks indicates the r-f section. The next row of blocks shows the a-f section; and the lower block points out the power supply, which provides all d.c. voltages to the transmitter.

The r-f section (explained previously) generates the high-frequency carrier radiated by the antenna. The audiofrequency (a-f) section includes a speech amplifier that receives considerably less than 1 volt of a-f signal from the microphone and builds it up to several volts at the input to the driver stage. The driver stage is made up of power amplifiers that convert the signal into a relatively large voltage. The modulator section is capable of handling considerable audio power. Its output is fed to the final r-f power amplifier in such a way as to alternately add to and subtract from the plate voltage of the power amplifier.

The result of modulation is that amplitude of the r-f field at the antenna is increased gradually during the time the a-f output is increasing the r-f power. Amplitude is decreased gradually during the time the a-f output is decreasing the r-f power. In other words, during the positive alternation of the audio signal (between point 1 and point 2 in figure 12-4), amplitude of the r-f output wave is increased. During the negative alternation (between point



13.53

Figure 12-4.—An a-m radiotelephone transmitter.

2 and point 3), amplitude is decreased. Amplitude modulation consists of varying amplitude of the r-f antenna current (and r-f output wave) gradually over the relatively long a-f cycle. Thus, the r-f field strength is alternately increased and decreased in accordance with the a-f signal and at the a-f rate.

Frequency Modulation and Phase Modulation

Besides its amplitude, the carrier wave has two other characteristics that can be varied to produce an intelligence-carrying signal. These qualities are its frequency and its phase. The process of varying the frequency of the carrier in accordance with the audiofrequencies of voice or music is called frequency modulation (f-m). A basic type of f-m is frequency shift. In frequency shift transmission, the intelligence pulses shift the carrier frequency back and forth between two fixed values. The term frequency shift keying is the common expression used to describe this type of modulation. Phase modulation (p-m) is the process of varying the phase. These two types of modulation are closely related. When f-m is used, the phase of the carrier wave is indirectly affected. Similarly, when p-m is used, the carrier frequency is affected.

The primary advantages of f-m are improved fidelity and increased freedom from static. Because of these qualities, frequency modulation is of considerable use in commercial broadcasting, but its shortcomings—frequency extravagance, short range on available frequencies, among others—have severely limited its naval communication applications. The Navy has, however, found f-m satisfactory for other purposes, among them altimeters and some radars.

Sidebands

When an r-f carrier is modulated by a single audio note, two additional frequencies are produced. One is the upper frequency, which equals the sum of the frequency both of the carrier and of the audio note. The other frequency is the lower one, which equals the difference between the frequencies of the carrier and the audio note. The one higher than the carrier frequency is the upper side frequency; the one lower than the carrier frequency is the lower side frequency. When the modulating signal is made up of complex tones, as in speech or music, each individual frequency component of the modulating signal produces its own upper and lower side frequencies. These side frequencies occupy a band of frequencies lying between the carrier frequency, plus and minus the lowest modulating frequency, and the carrier frequency plus and minus the highest modulating frequency.

Bands of frequencies containing the side frequencies are called sidebands. The sideband that includes the sum of the carrier and the modulating frequencies is known as the upper sideband (USB). The band containing the difference of the carrier and the modulating frequencies is known as the lower sideband (LSB). Space occupied by a carrier and its associated sidebands in a frequency spectrum is called a channel. The width of the channel (called bandwidth) is equal to twice the highest modulating frequency.

SINGLE SIDEBAND.—A mode of radio emission that has become increasingly important to the communicator is single sideband (SSB). Single sideband is not a new term in the history of communications. It has been used extensively by the shore communications system for many years. A new impetus to the advantages of using SSB in fleet communications has resulted from the congestion in medium- and high-frequency bands and recent developments that have reduced the physical sizes of equipments.

In studying sidebands, it was learned that modulation of the carrier produces a complex signal consisting of three individual waves: the original carrier, plus two identical sidebands, each carrying the same intelligence. However, the same intelligence can be transmitted in a single sideband by eliminating the carrier and one of the sidebands at the transmitter, resulting in a savings of power and frequency bandwidth.

SUPPRESSED CARRIER.—In SSB, the carrier itself is suppressed (or eliminated) at the transmitter, so that sideband frequencies are produced but the carrier is reduced to a minimum. This reduction or elimination usually is the most difficult or troublesome aspect in understanding SSB suppressed carrier. In single sideband suppressed carrier, there is no carrier present in the transmitted signal. It is eliminated after modulation is accomplished, and reinserted at the receiver for the demodulation process. All radiofrequency energy appearing at the transmitter output is concentrated in the sideband energy of "talk power."

After eliminating the carrier, 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, however, 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 in conventional a-m. This provision amounts to an increase in power for the wanted sideband. Equally important, the bandwidth required for SSB voice circuits is approximately half that needed for conventional a-m. (See fig. 12-5.)

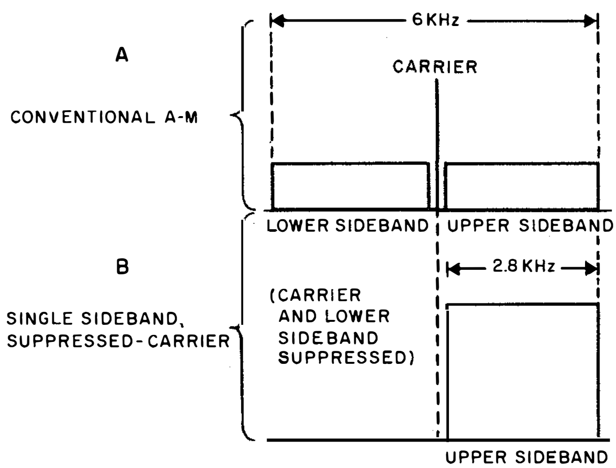


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Figure 12-5.—Comparison of bandwidths of conventional a-m and SSB voice channels.

SSB ADVANTAGES.—Advantages of single sideband over conventional amplitude modulation are numerous, but only a few of the main ones are presented in the following paragraphs.

- Minimization of distortion: In conventional a-m, the two sidebands and the carrier must arrive at the receiver with the same phase relationship as they had when transmitted. If they are not received in phase (usually because of multipath skywave propagation conditions), the signal heard is fuzzy, distorted, and possibly quite loud. (You may have heard the report expressed "Loud but distorted.") This condition may occur if one sideband experiences a slight phase shift and cancels a portion of the other sideband, resulting in distortion and loss of intelligibility. Fading or slight phase shift of the carrier can produce similar results. With the suppressed-carrier type of SSB, however, these problems are minimized because only one sideband (and no carrier) is transmitted.

- Increased effective power: In a conventional a-m system, approximately one-half of the transmitter's power goes into the carrier, and the remaining half is divided equally between the two sidebands. With the suppressed-carrier SSB system, virtually all of the transmitter's power goes into the single sideband that carries the useful intelligence. This more efficient utilization of power gives the SSB voice circuit a much greater distance range than that of a normal a-m voice circuit.

- Provision for double number of channels: In the system of SSB suppressed carrier, the number of voice channels utilizing the same frequency in the radio spectrum is doubled. These two channels are referred to as upper and lower sidebands. With the scarcity of frequencies available for new assignments in the spectrum, particularly in the 2- to 30-MHz range, this advantage in fleet communications is important.

- Reduction of interference: In voice systems employing conventional amplitude modulation, the carrier of the transmitting station remains on the air as long as the microphone button is depressed. If an additional station transmits while the carrier of the other station is on, squeals and howls result. They are caused by the heterodyning of two or more signals transmitting simultaneously. In SSB, as soon as an individual stops speaking into the microphone, talk power in the remaining (or single) sideband leaves the air. Even though two stations may transmit at the same time, it may be possible for a receiving station to read through the interfering station the same way it is possible to listen to more than one conversation coincidentally.

INDEPENDENT SIDEBAND.—In independent sideband (ISB) systems, the carrier is suppressed or reduced, and each sideband is modulated independently by separate information. In effect, ISB can be referred to as consisting

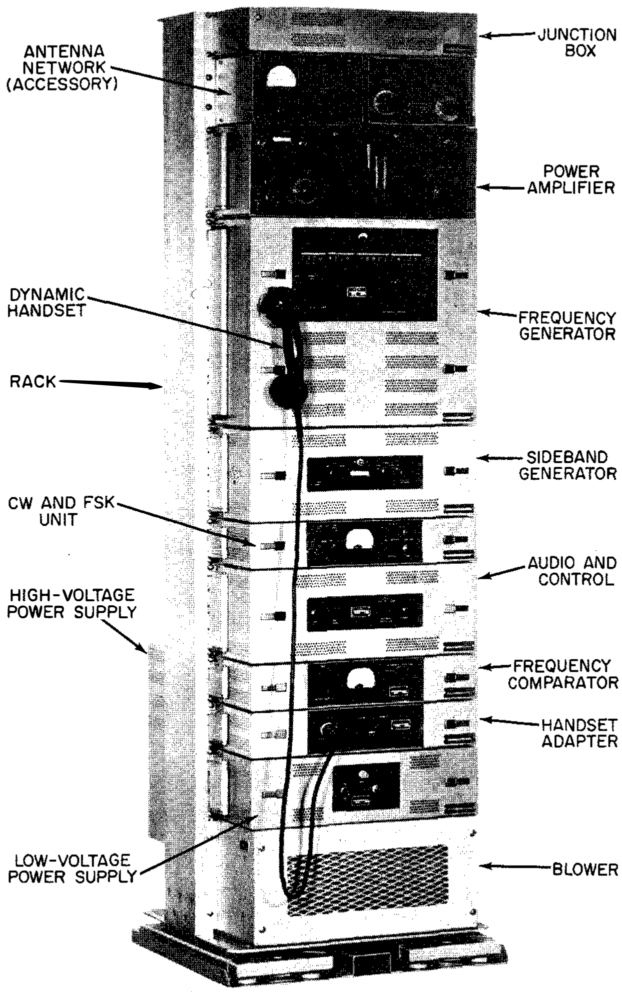

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Figure 12-6.—Radio Transceiver AN/URC-32B.

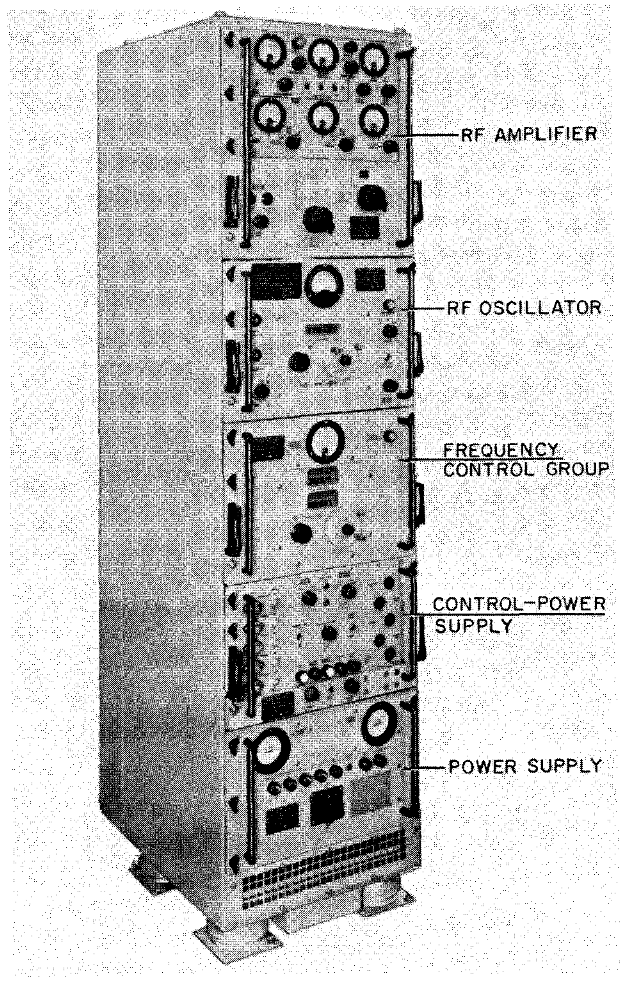

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Figure 12-7.—Radio Transmitter AN/WRT-1A.

of two single sidebands and having the same suppressed or reduced carrier. The ISB systems can accommodate either one or two 3-kHz channels on the upper sideband and the same number on the lower sideband. The number of channels depends on whether these sidebands are 3 or 6 kHz wide.

REPRESENTATIVE TRANSMITTERS

Modern medium-frequency and high-frequency shipboard transmitters must be capable of transmitting over a wide range of frequencies. In addition to CW and radiotelephone modes of operation, they must be capable of handling RATT and FAX transmissions. They must be of rugged construction for long service life. Transmitters that meet these requirements, therefore, are quite complex and because of the limited space available for their installation in naval vessels, they are of compact construction.

One method of obtaining equipment compactness is to combine a transmitter and a receiver into a single unit called transceiver. A transceiver uses part of the same electronic circuitry for both transmitting and receiving, hence cannot transmit and receive simultaneously. A transmitter-receiver, however, is a separate transmitter and receiver mounted in

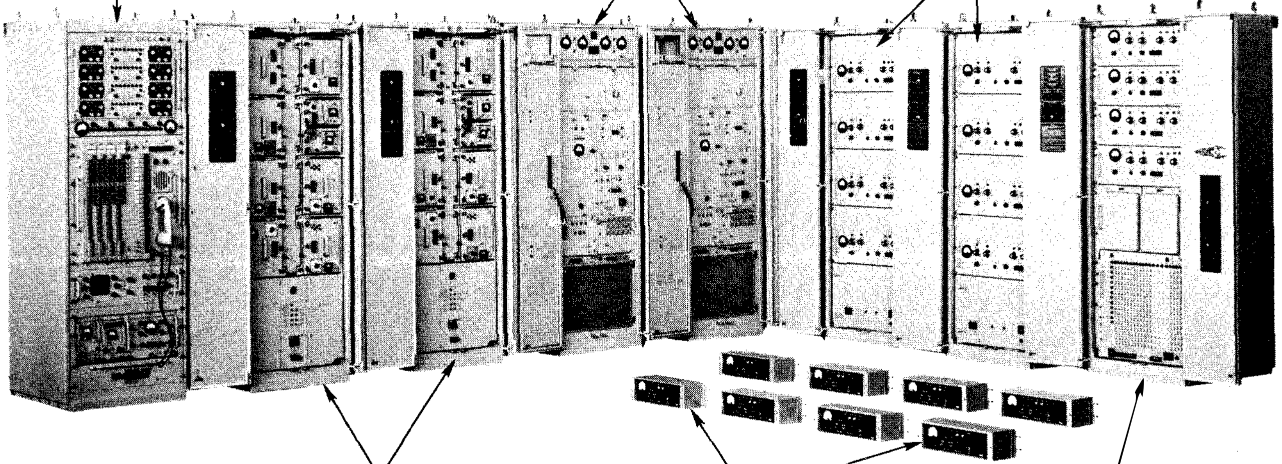

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Figure 12-8.—Communications Central AN/SRC-16 (doors open).

the same rack or cabinet. The same antenna may be utilized for the transmitter-receiver arrangement, but the capability for independent operation of the equipment still exists. Both terms are used in descriptions of equipment that follow.

In physical size, shore based transmitters are usually several times larger than shipboard transmitters. However, the power output of shore based transmitters is many times greater than shipboard transmitters. This high power output is necessary to provide reliable long-haul broadcast and point-to-point communications.

AN/URC-32 RADIO SET

One of the Navy's most versatile modern communication equipments is the AN/URC-32 (fig. 12-6). It is a transceiver operating in the 2- to 30-MHz high-frequency range, with a transmitter peak envelope power of 500 watts.

The AN/URC-32 is designed chiefly for single-sideband transmission, and for reception on either the upper or lower sidebands, or on both sidebands simultaneously, with separate audio and i-f channels for each sideband. In addition to single-sideband operation, provisions are included for a-m (carrier reinserted), CW or FSK operation.

Because of its versatility and power, the AN/URC-32B is installed on most Navy ships having a requirement for communicating over long distances. It is being replaced by the AN/URT-23.

Transmitter AN/WRT-1A

The AN/WRT (fig. 12-7) is a shipboard transmitter designed for operation in the frequency range 300 to 1500 kHz. This equipment can transmit CW, RFCS, MCW and voice signals, but it has no SSB capability. When used for CW and RFCS transmissions, the transmitter has a power output of 500 watts. Voice operation, however, reduces the available power to approximately 125 watts.

Because of operating in the medium frequencies with a substantial power output, the AN/WRT-1A lends itself well for communicating over long distances during the hours of darkness. Its range is reduced to medium distances during daylight hours. Installed for MF communications and for capability of transmission on international distress frequency (500 kHz).

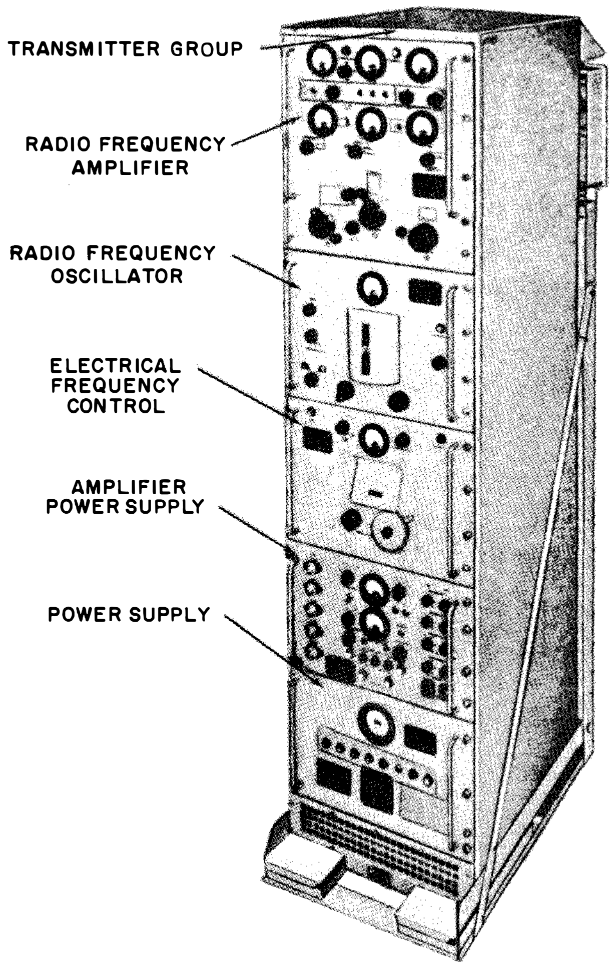

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Figure 12-9.—Radio Transmitter AN/WRT-2.

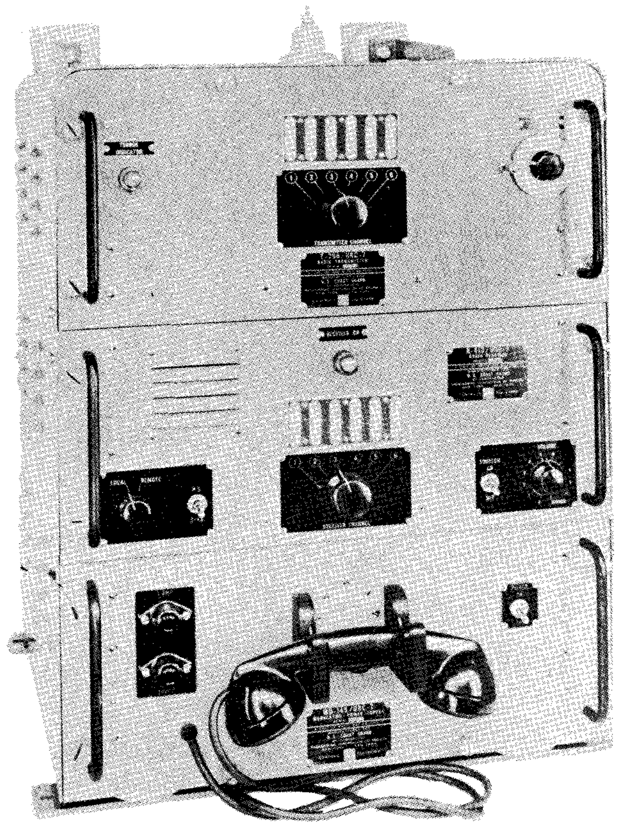

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Figure 12-10.—AN/URC-7 transmitter-receiver.

Transmitter-Receiver AN/SRC-16

The AN/SRC-16 (fig. 12-8) is a shipboard, single-sideband communications system with a frequency range of 2 to 30 MHz. In addition to the normal voice, CW, and AFTS communications, the system provides high-frequency reception and transmission for terminal equipment such as HCCS (high-capacity communications system) and NTDS (Navy Tactical Data System). The system uses dual single-sideband equipment and both sidebands are available for use independently for either voice or multitone signals. The system operates on four independent channels, each channel consisting of a single-sideband receiver, a single-sideband transmitter (exciter), and a 500-watt PEP linear power amplifier. The frequency of each receiver and transmitter is phase locked to a system primary frequency standard.

Two transmitters, two receivers, one power amplifier, and one frequency standard are located in each of the two cabinets in the communications central.

Transmitter AN/WRT-2

Radio transmitter AN/WRT-2 (see fig. 12-9) is similar in size and appearance to the AN/WRT-1A. It covers the frequency spectrum between 2 and 30 MHz, and has an average power output of 500 watts for CW, AFTS, and compatible AM modes of operation. When operating as a single-sideband transmitter, it produces 1000 watts (PEP). An additional

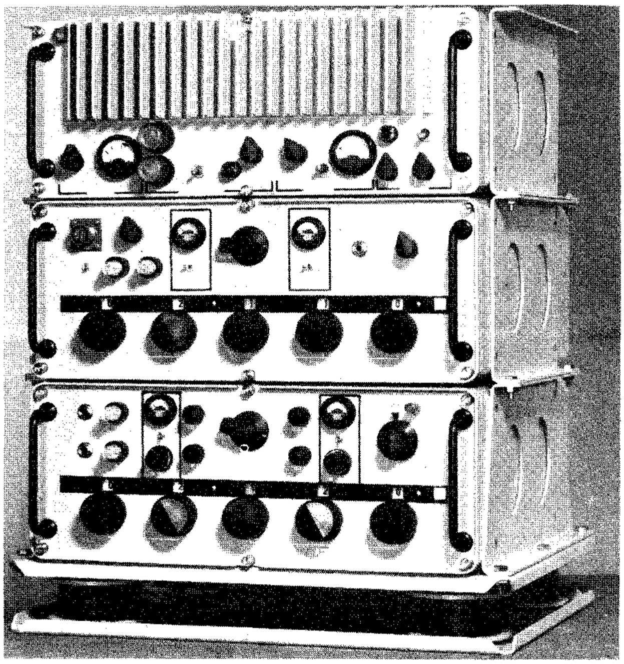

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Figure 12-11.—Radio set AN/WRC-1. Top unit: AM-3007/URT r-f amplifier; center unit: T-827/URT transmitter (exciter); bottom units: R-1051/URR receiver.

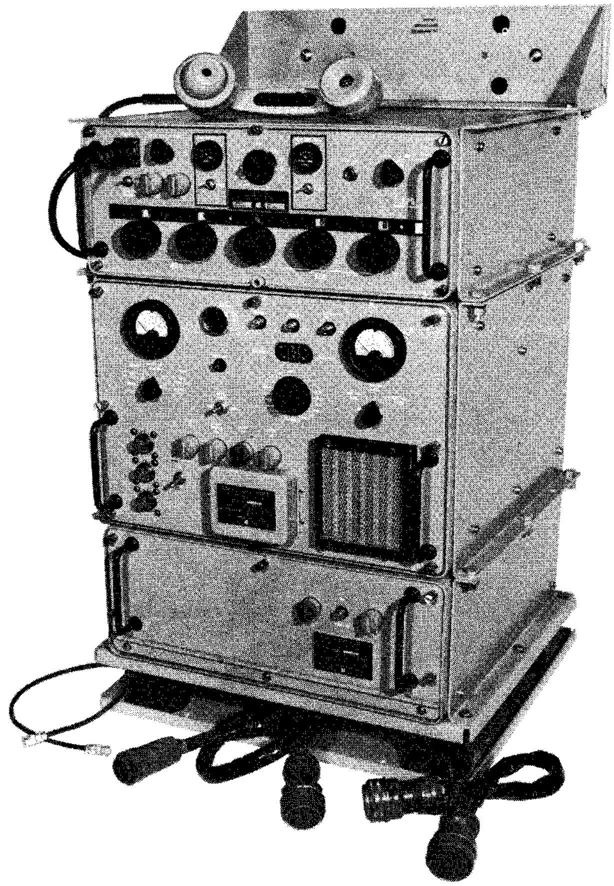

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Figure 12-12.—Radio Transmitter AN/URT-23(V) (with 60 hertz power supply).

feature of the AN/WRT-2 is that it provides independent sideband operation. This mode of operation permits simultaneous transmission of both sidebands, each one carrying separate intelligence.

Actual transmitter output values as gained from feedback from the fleet indicate that the power output levels are substantially lower than those cited above. Personnel must ensure that the transmitter is properly maintained and that optimum tuning exists for all operating modes.

As indicated by its operating frequencies and power outputs, the AN/WRT-2 is used for medium- and long-range communications.

AN/URC-7 Transmitter-Receiver

The AN/URC-7 is an amplitude-modulated radiotelephone transmitter-receiver for short- and medium-distance radiotelephone communication. Both transmitter and receiver have six pretuned crystal-controlled channels in the frequency range 2000 to 7000 kHz. The transmitter has an output power of 25 watts. The transmitter, receiver, and modulator power supply are contained in a single cabinet. (See fig. 12-10.) The AN/URC-7 is used principally in service craft and auxiliary-type ships, such as tugs, transports, tankers, and ships of the amphibious force.

AN/WRC-1 Radio Set

The AN/WRC-1 (fig. 12-11) is a single sideband radio transmitter-receiver. It is capable of transmitting on any one of 56,000 channels, spaced in 0.5-kHz increments, in the frequency range of 2 to 29.9995 MHz. This set has a maximum power output of 100 watts. Vernier (continuous) tuning enables reception on any frequency in the 2- to 30-MHz range.

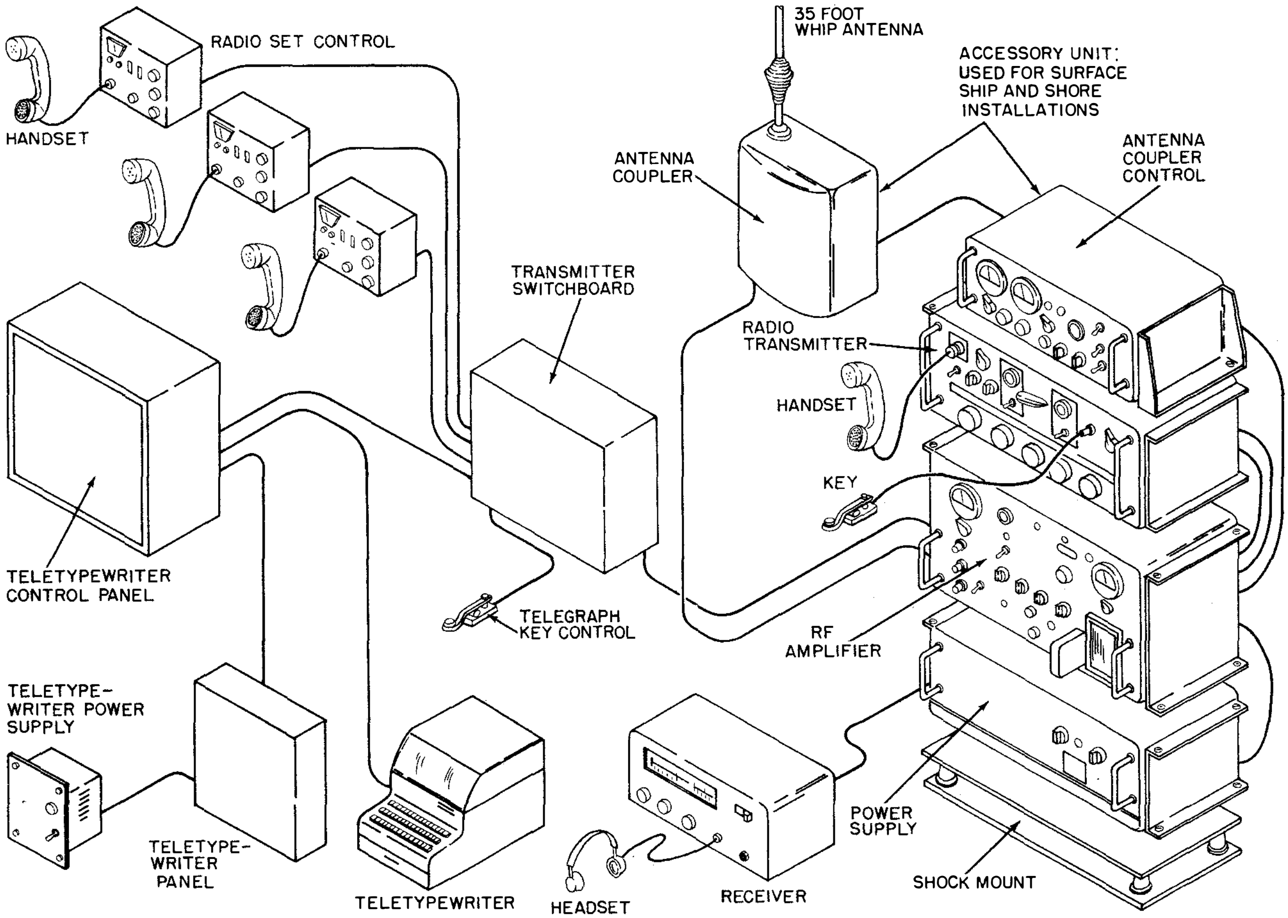

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Figure 12-13.—A complete communications system for Radio Transmitter AN/URT-23(V).

The AN/WRC-1 is capable of transmitting and receiving SSB, CW, compatible a-m, FSK, and ISB signals in either a simplex or duplex operation. Figure 12-11 shows all units of the AN/WRC-1 and how they are interconnected.

The AN/WRC-1 radio set consists of four separate units. These units are the R-1051/URR radio receiver, radio transmitter T-827/URT, r-f amplifier AM-3007/URT, and an interconnection box used to connect the other three units together. Both the receiver and transmitter contain their own power supplies and can be operated as individual units.

Transmitter AN/URT-24

When the receiver unit is removed from the AN/WRC-1( ) transmitter-receiver the remaining units form the AN/URT-24 transmitter. When used as an AN/URT-24, the top two units in figure 12-11 (RF amplifier and radio transmitter) are seated directly on the shock mount, thus eliminating the receiver unit.

The transmitter is used for short range communications.

Transmitter AN/URT-23(V)

The AN/URT-23(V) is a long and medium range transmitter which operates as a 1 KW single-sideband transmitter (fig. 12-12). The normal configuration provides voice, continuous wave, and radio teletypewriter transmissions in the 2-30 MHz frequency range. A frequency standard (either internal or external), with crystal-controlled synthesizers is used for frequency control. The transmitter is

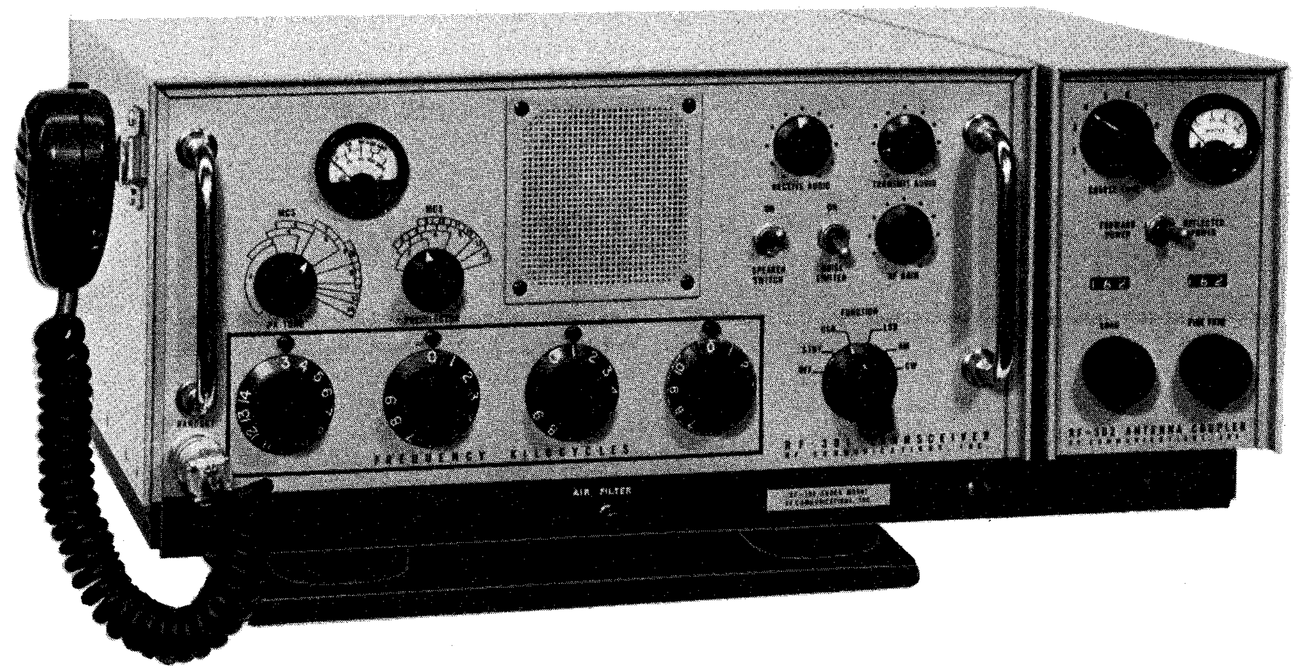

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Figure 12-14.—Radio Transceiver AN/URC-58(V).

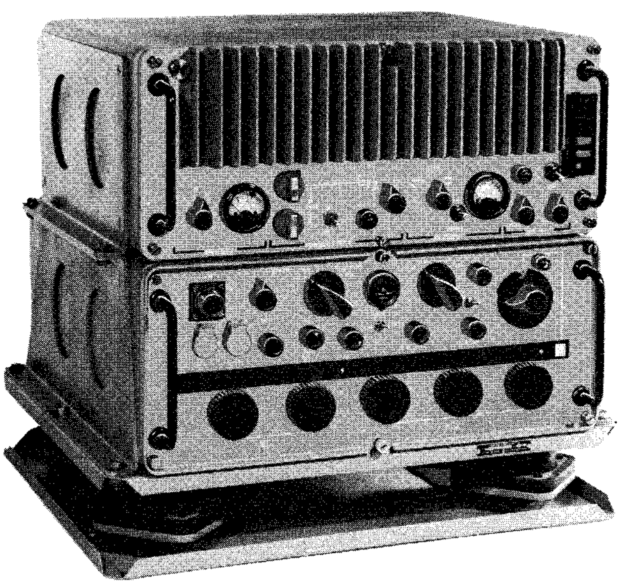

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Figure 12-15.—Radio Transceiver AN/URC-35.

equipped to provide automatic (digital) tuning to the correct frequency within a frequency band. Two optional power supply equipments permit the use of any one of three, 3-phase primary power sources: 115 volts line-to-line 400 hertz or 208 or 440 volts line-to-line 60 hertz.

The major units of the AN/URT-23(V) may be stack or rack mounted for installation aboard ship or for shore installations to form a complete communications system as illustrated in figure 12-13.

Transceiver AN/URC-58(V)

The AN/URC-58(V) radio set (fig. 12-14) is a single sideband (SSB) transceiver for general-purpose voice and CW communications and may be used for ship and shore fixed installations, semiportable applications such as in vehicles, and amphibious landing craft, and for use aboard ship.

The radio set operates in the 2 to 15 MHz frequency range and provides transmission and reception on single sideband (selectable upper and lower sideband), CW, AM (compatible) and FSK signals. This equipment operates from a nominal primary power input of 115/230 volts, 50 to 60 hertz, single phase and either 12 or 24 VDC power, providing a power output of 100 watts. Audio and keying facilities are provided for both local and remote operation. The transceiver is a triple-conversion superheterodyne receiver and transmitter tunable over the entire frequency range in 1 kHz increments.

Transceiver AN/URC-35

Designed primarily for mobile operations, the AN/URC-35 (fig. 12-15) has continuous wave transmitting capabilities, but is used chiefly for voice communications over short and medium distances. These portable sets are found aboard vehicular and small surface craft, and aboard regular Navy ships for emergency use.

The AN/URC-35 is a general-purpose HF radio set for transmitting and receiving SSB, AM, and CW signals in the 2 to 30 MHz spectrum.

The receiver and transmitter are automatically tuned to the same frequency at all times by common electronic assemblies. All components in the electronic assemblies are transistorized, except the RF amplifiers.

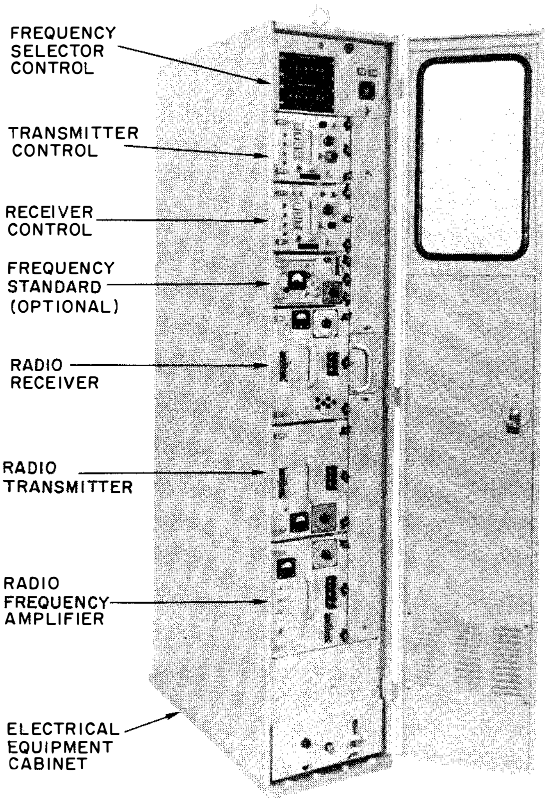

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Figure 12-16.—Radio-Transmitter-Receiver AN/SRC-23(V).

Optional power requirements are met by either internal or external 28 VDC battery supply or by 115 VAC. Three different antennas may be employed: a 15-foot probe or whip, a 25-foot whip, or a 35-foot whip type antenna.

Transmitter-Receiver AN/SRC-23(V)

The AN/SRC-23(V) (fig. 12-16) is a single channel HF transmitter-receiver communications system which operates in the 2-30 MHz range. The transmitter-receiver is automatically tuned and capable of local or remote control in either simplex or duplex modes of operation for AM, CW, USB, LSB, ISB, AFTS, voice, or data. The equipment has a 1 KW power output; however, an alternate 5 KW RF power output may be obtained using a 5 KW linear power amplifier.

Designed especially for shipboard installations, this transmitter-receiver group may also be used for shore-base installations and consists of eight basic units located within a cabinet.

The front panel of the transmitter control unit provides the controls for manually selecting the modes of operation for the transmitter and amplifier group.

Suited to smaller installations not requiring total multichannel capabilities as those of the AN/SRC-16. The basic radio set provides complete duplex channel capability, several AN/SRC-23's may be grouped to provide numerous communication channels with full multiplex capabilities.

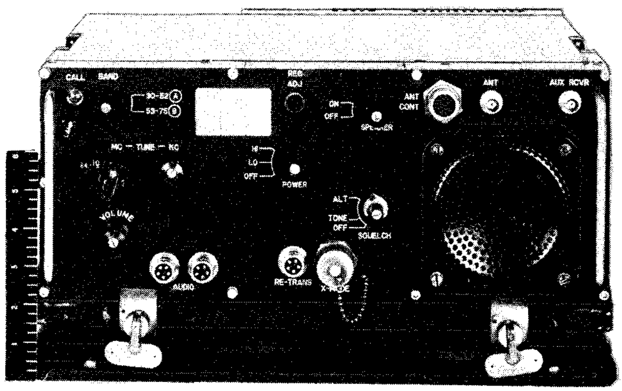

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Figure 12-17.—Radio Transceiver AN/VRC-46.

VHF TRANSMITTERS

Transmissions in the VHF range normally are restricted to line-of-sight distances. Under certain atmospheric conditions, they have been received at considerably longer distances—500 miles or more.

Shipboard installations of VHF equipments are retained for emergency communications, and for communication with allied forces that have not yet converted to UHF equipments. The VHF equipment is also being used as a backup to UHF equipment.

Transceiver AN/VRC-46

The AN/VRC-46 transceiver (fig. 12-17) was developed for Signal Corps use, but has been adopted for shipboard and amphibious naval gun fire support and joint communications with tactical Army and Marine Units ashore.

The AN/VRC-46 is a narrow-band FM transceiver capable of 24 VDC or 115 VAC operation in the 30 to 76 MHz (very high frequency) range. It is used for short-range, two-way radiotelephone communications. It replaces the older AN/SRC-10 through -15 wideband FM transceivers.

Transmitter AN/URT-7( )

The AN/URT-7( ) (fig. 12-18) is a crystal-controlled VHF transmitter that operates in the frequency range 115 to 156 MHz. Although mountings for four crystals are provided, permitting rapid selection of any one of four frequencies, the transmitter must be retuned each time the frequency is changed. With a power output of 30 watts, this equipment provides two modes of operation: radiotelephone and MCW.

UHF TRANSMITTERS

Most UHF radio transmitters (and receivers) used by the Navy operate in the 225- to 400-MHz frequency range. Actually, this range of frequencies covers portions of both the VHF band and the UHF band. For convenience, however, radio equipments operating within this frequency range are considered to be UHF equipments.

The effective range of UHF normally is limited to line of sight distances; however, under certain atmospheric conditions UHF has been received at considerably longer distances—500 miles or more.

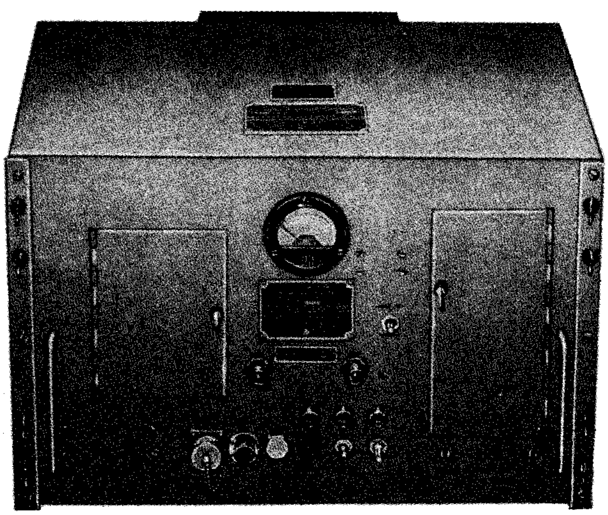

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Figure 12-18.—Radio Transmitter AN/URT-7( ).

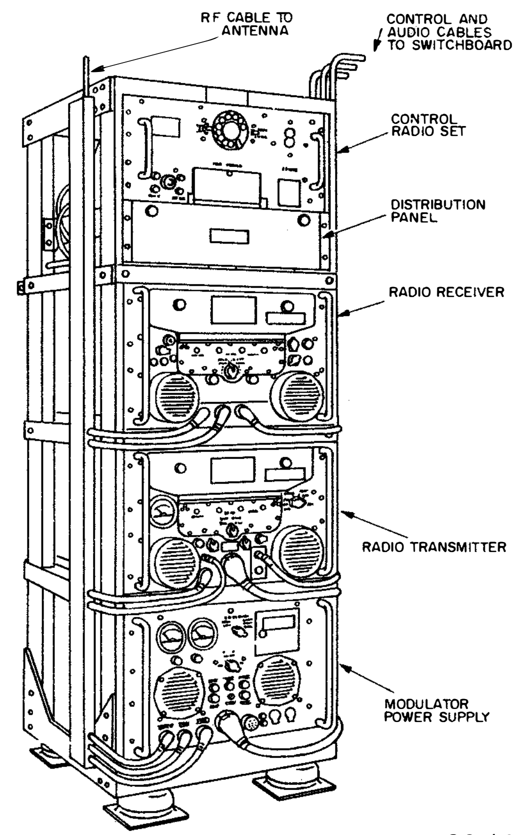

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Figure 12-19.—Radio Transmitter-Receiver AN/GRC-27A.

Transmitter-Receiver AN/GRC-27A

The AN/GRC-27A (fig. 12-19) is a UHF transmitter-receiver set covering frequencies from 225 to 400 MHz. This equipment is used for radiotelephone and MCW communications from ship-to-ship, ship-to-shore, or with aircraft. The AN/GRC-27A is installed principally in carriers and antisubmarine warfare ships, whose primary missions involve the control of aircraft.

The transmitter has a power output of 100 watts.

Radio Transceiver Sets AN/URC-9( ), AN/SRC-20( ), -21( )

Radio set AN/URC-9( ), used separately (fig. 12-20) is a UHF transceiver that provides facilities for AM radiotelephone communications in the frequency range 225 to 400 MHz. The equipment is crystal-controlled and

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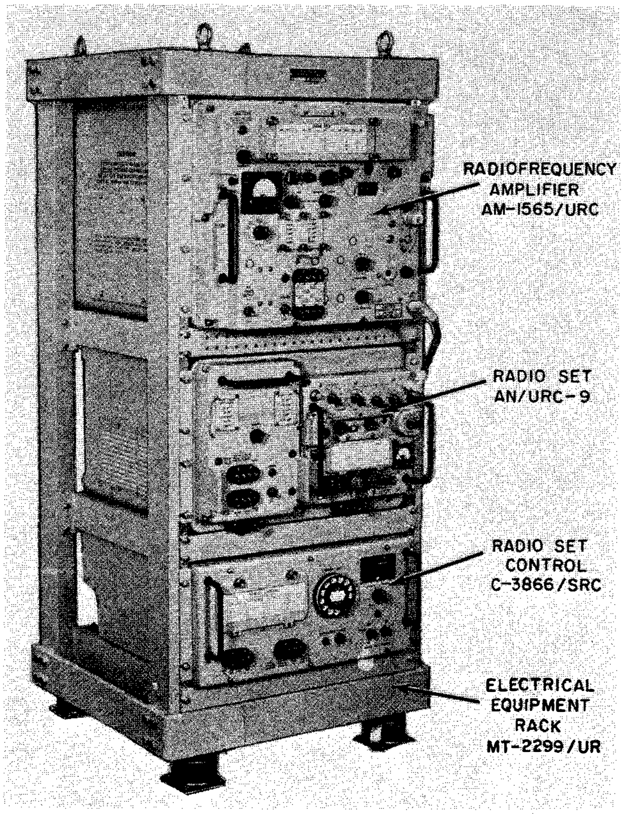

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Figure 12-20.—Radio set AN/SRC-20.

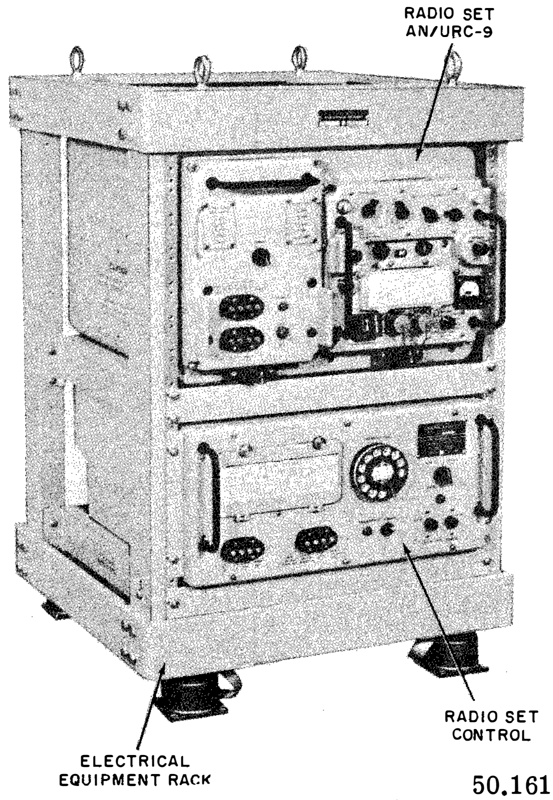
produces 1750 frequencies at 100 kHz intervals within its frequency range. Although it is capable of operating on only one frequency at a time, any 20 of the 1750 available frequencies can be preset for immediate selection from remote positions. Channel selection requires a maximum of 8 seconds. This set has a power output of approximately 20 watts.

When modified by the addition of certain units the AN/URC-9( ) is redesignated either AN/SRC-20( ), fig. 12-20 or AN/SRC-21( ), fig. 12-20A. These modified sets can be connected to similar sets so that received signals are retransmitted automatically. This feature is useful when a ship (or aircraft) is serving as a relay station between two stations that cannot communicate with each other directly.

The difference between the AN/SRC-20( ) and the AN/SRC-21( ) is that the AN/SRC-20( ) has a linear power amplifier unit that increases the 20-watt power output from the AN/URC-9( ) to a 100-watt output.

Radio Transceiver Set AN/SRC-17

Radio set AN/SRC-17 is part of the communications central AN/SRC-16. AN/SRC-17 is



50.161
Figure 12-20A.—Radio set AN/SRC-21.

used for the transmission and reception of FSK data and frequency-modulated signals in the frequency range of 225 to 400 MHz.

Radio Transceiver Set AN/SRC-31

The AN/SRC-31 is the newest equipment at the present time operating in the UHF band. It is automatically tuned for voice or telegraph communications. Primarily used for UHF NTDS (LINK 4 and LINK 11). Has single band, 3500 channels, locally selected and 10 preset channels locally or remotely selected. Requires 14 seconds to tune a given preselected channel and has power output of 300 watts for voice and 1 KW for data operation.

RECEIVERS

Modern Navy radio receivers are easy to operate and maintain. They are capable of receiving several types of signals and can be tuned accurately over a wide range of frequencies. Because they are not required to produce or handle large currents and voltages, their size is relatively small when compared to the size of most transmitters.

Unlike the receiving units of the transceivers described earlier, the radio receivers discussed in this section are separate equipments that are capable of independent operation.

FUNCTIONS OF RECEIVERS

Radio receivers must perform the following six functions (fig. 12-21):

1. Signal interception.
2. Signal selection.
3. Radiofrequency amplification.
4. Detection.
5. Audiofrequency amplification.
6. Sound reproduction.

These six functions are sufficient for a-m reception, but for CW reception an additional circuit (shown by dotted lines, fig. 12-21), called a beat-frequency oscillator, is required.

Signal Interception

The receiving antenna intercepts a small portion of the passing radio waves. The signal voltage extracted by receiving antennas is only a few microvolts, sufficient for subsequent amplification as long as the noise energy intercepted by the antenna is substantially less than this.

Signal Selection

Some means must be provided to select the desired signal from all r-f carriers intercepted by the antenna. This selection is made by tuned

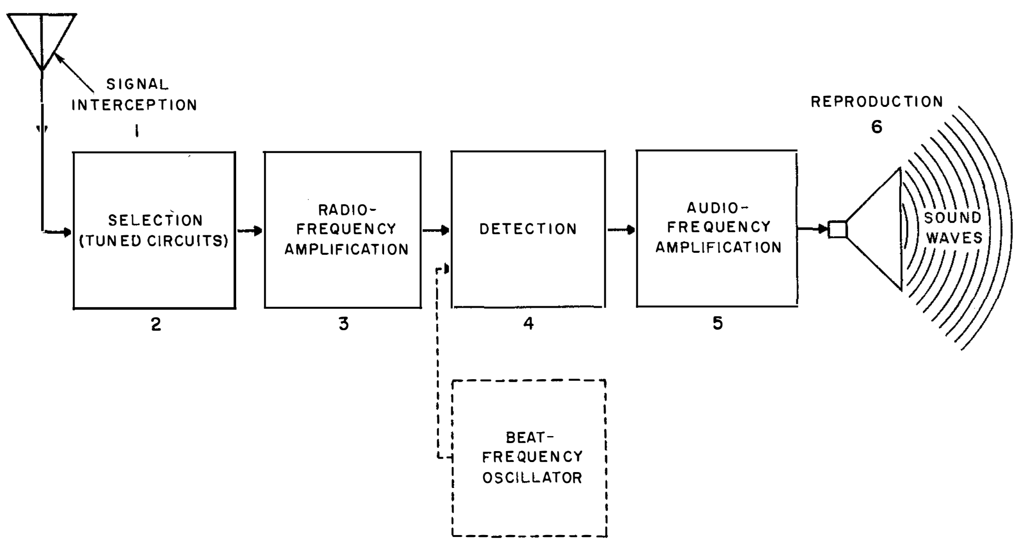


Figure 12-21.—Essentials of radio reception.

circuits that pass only their resonant frequency (frequency to which the receiver is tuned) and reject other frequencies. Thus the receiver is able to differentiate between the desired signal frequency and all other frequencies.

Radiofrequency Amplification

The weak signals intercepted by the antenna usually must be amplified considerably before the intelligence contained in them can be recovered. One or more r-f amplifiers serve to increase the signal to the required level. A tuned circuit in each r-f amplifier makes sure that only the desired signal is amplified.

Detection (Demodulation)

If the signal is amplitude-modulated, the original intelligence must be recovered from it by separating the modulation signal from the r-f carrier. The circuit that separates the audiofrequency signal variations from the r-f carrier is called the detector or demodulator. Most detectors do not operate well at very low signal levels, and this is one of the reasons why r-f amplification is required ahead of the detector.

In CW (radiotelegraphy) reception, a beat-frequency oscillator (bfo) is used in the receiver circuit. The bfo provides an r-f signal that beats or heterodynes against the frequency injected into the detector. The resultant frequency is a low-level audiofrequency.

Audiofrequency Amplification

The signal frequency in the output of the detector generally is too weak to operate a headset or loudspeaker. One or more stages of a-f amplification are therefore required to strengthen the audio output of the detector to a level sufficient to operate the headset or loudspeaker.

Sound Reproduction

The amplified a-f signal is applied to the headset or loudspeaker that translates the electrical a-f variations into corresponding sound waves. For a-m, the sound output of the speaker is a close replica of the original audio sounds at the transmitter. For CW, the sound is a tone the frequency of which depends upon the frequency of the beat-frequency oscillator. This tone is heard whenever the key is depressed at the transmitter, and, consequently, it reproduces the interruptions of the r-f carrier in accordance with the Morse code.

SENSITIVITY

The sensitivity of a receiver is a measure of how well it can amplify weak signals. Communication receivers are highly sensitive and can operate on far weaker signals than a home radio.

In an area of strong local interference, a receiver needs a strong signal to give good reception. If the local interference has a field strength of 100 microvolts per meter, a signal strength of from 500 to 1000 microvolts per meter is required to drown the noise. The same receiver, free of local interference, may give good reception on a signal strength of 10 microvolts per meter. It is hard to state the exact minimum field strength needed to operate a receiver satisfactorily, but many sets under ideal conditions can function on a signal strength of from 1 to 3 microvolts per meter. To bring such a signal to an audible level requires an amplification of many millions of times.

SELECTIVITY

Selectivity is the ability of a receiver to respond to one particular signal and to reject all others. A very selective receiver is said to tune sharply.

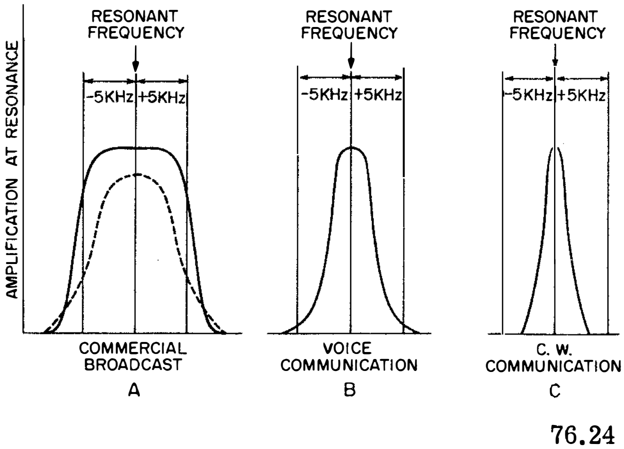


Figure 12-22.—Tuning curves of three types of radio receivers.

Some types of receivers are more selective than others. A radiotelephone communication receiver tunes more sharply than a commercial broadcast receiver, and a CW communication receiver is even more selective. You can compare the three tuning curves in figure 12-22.

You will remember the analysis of amplitude modulation treated earlier in this chapter. It showed how the intelligence transmitted was contained in the sideband frequencies.

Carrier waves from commercial broadcast stations contain sideband frequencies that extend 5 kHz on either side of the carrier frequency. If a station is transmitting on 1140 kHz, the complete carrier wave contains frequencies from 1135 to 1145. If a receiver tunes too sharply, some of the sideband frequencies are lost, with a corresponding sacrifice of fidelity. The commercial broadcast receiver tuning curve shown in figure 12-22 is OPTIMUM—"at its best." The top is broad and flat and the sides are steep. Actually, most a-m broadcast receivers have tuning curves resembling the broken line, and many frequency components of voice and music contained in the signal are not reproduced by the set.

Although sharp tuning in a home radio would make for poor listening, it is desirable for military sets for the sake of frequency economy and reduction of interference. Radiotelephone messages can be sent on frequencies that extend only 2 kHz on either side of the carrier frequency. The voice may sound unnatural, like a voice on the telephone, but it can be understood.

The CW sets tune so sharply that, unless an operator is careful, he can turn his dial through the signal without even hearing it.

BASIC SUPERHETERODYNE RECEIVER

The basic stages for a-m superheterodyne reception are shown in figure 12-23 in the order in which a signal passes through the receiver. The illustration also shows the changes in waveshape of the signal as it passes through the receiver. The operation of the superheterodyne receiver for the reception of a-m signals is as follows:

1. Modulated r-f signals from many transmitters are intercepted by the antenna. They are fed to the first stage of the receiver, which is a variable-tuned r-f amplifier.

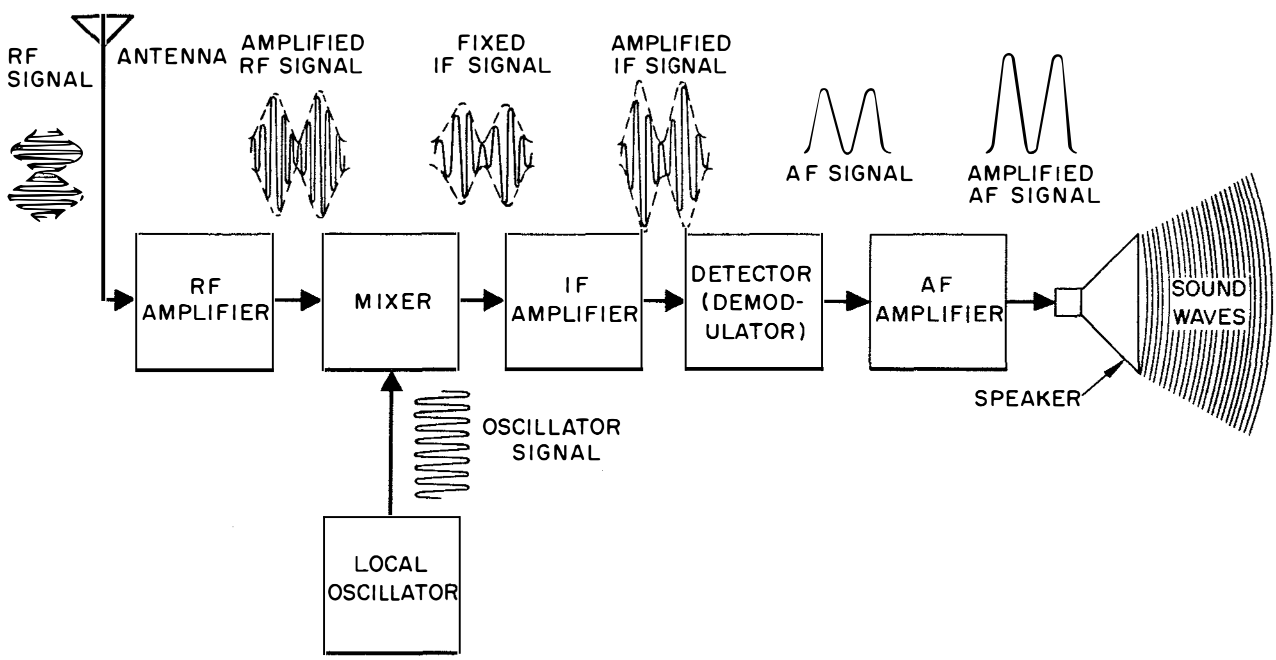


Figure 12-23.—Superheterodyne receiver, showing signal waveshape.

2. The desired r-f signal is selected by the tuning circuit of the r-f amplifier. This signal is amplified, and all other signals are rejected to some degree.

3. The amplified r-f signal is coupled to the mixer stage, where it is combined with the output of the local oscillator. In this process of heterodyning (mixing), two new frequencies are produced. One is equal to the sum of the incoming signal and the local oscillator; the other equals the difference between the incoming signal and the local oscillator frequencies. Most receivers are designed with selective circuits to reject the sum frequency; the difference frequency is used as the intermediate frequency (i-f). It contains the same modulation as the original r-f signal.

4. The i-f signal is amplified in the fixed-tuned i-f amplifier stages and is coupled to the detector.

5. The detector stage removes the audio modulation contained in the i-f signal and filters out the i-f carrier, which no longer is needed.

6. The resulting audio signal is amplified to the level required by the loudspeaker.

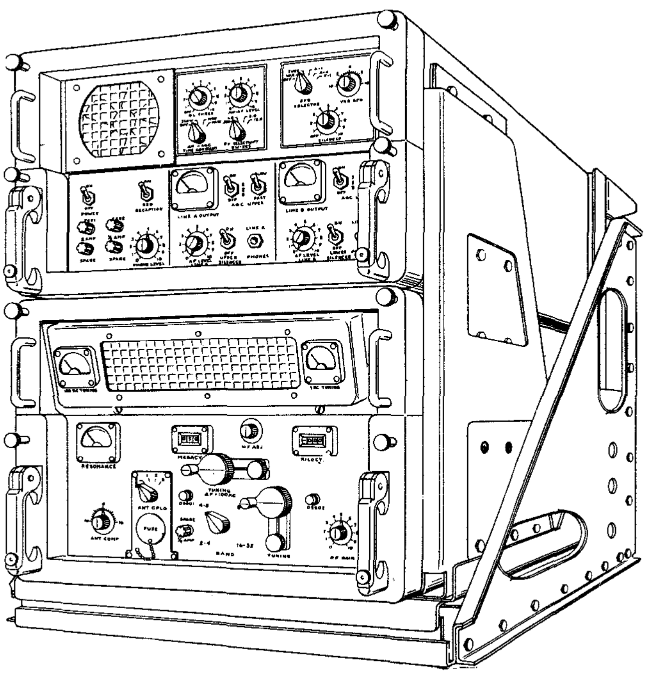


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Figure 12-24.—Radio Receiver AN/WRR-2B.

7. The electrical audio variations are converted into the corresponding sound waves by the loudspeaker (or headphones).

REPRESENTATIVE RECEIVERS

Most radio receivers operating in the VLF, LF, MF, and HF bands of the frequency spectrum are of the continuous tuning type. They are tunable to any frequency within their frequency range, and they usually cover this range in several tuning bands. Switching from one band to another changes the receiver's frequency-determining components, permitting more accurate tuning than is possible if the entire frequency range were covered by a single set of components.

Radio Receiver AN/WRR-2B

A shipboard radio receiver for use over the MF/HF bands is the AN/WRR-2B (fig. 12-24). The same receiver, with rack mounting for shore station use, is called AN/FRR-59.

The AN/WRR-2B is a triple-conversion superheterodyne receiver. It covers the frequency range 2 to 32 MHz. This modern receiver is intended primarily for the reception of single-sideband transmissions with full carrier suppression. It can be used also to receive conventional amplitude-modulated signals of various types, including CW, MCW, voice, facsimile, and radioteletype.

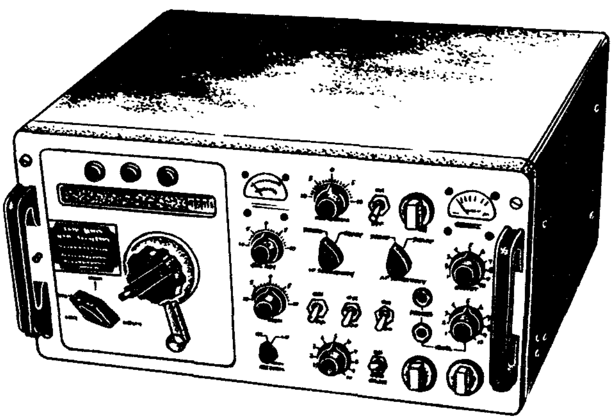

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Figure 12-25.—Radio Receiver AN/WRR-3B.

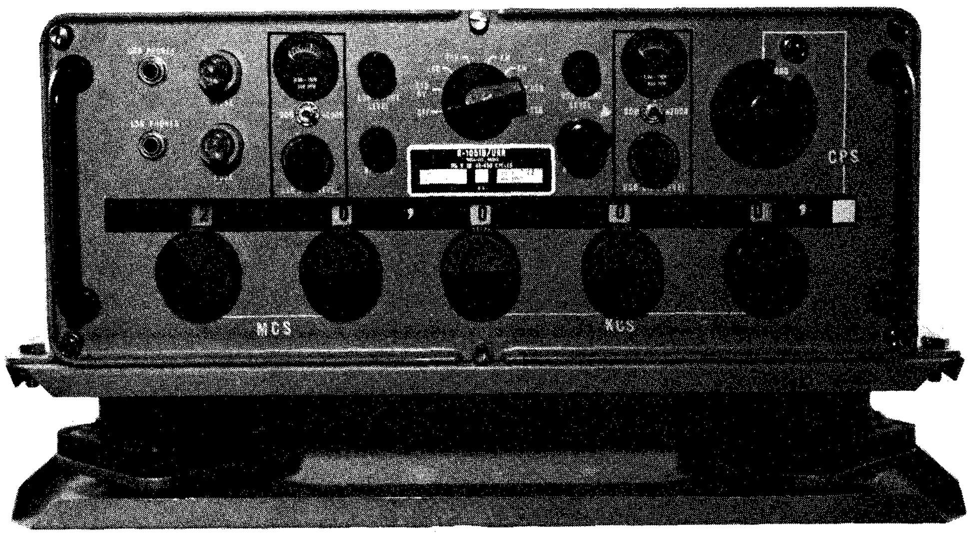

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Figure 12-26.—Radio Receiver R-1051B/URR.

In order to meet strict frequency tolerances, a frequency standard, having a low frequency and very stable oscillator, generates a very accurate fundamental frequency (and harmonics) to provide frequency reference check points throughout the 2 to 32 MHz frequency range. This facilitates accurate tuning and a high degree of stability over long periods of operation. Both upper and lower sideband channels can be used simultaneously for receiving two different channels of intelligence or to receive the same intelligence.

Other features of the receiver also contribute to its high performance. Any error in frequency resulting from drift in the local oscillator is removed before the last conversion by a drift-canceling circuit. Receiver tuning is in 0.5 kHz steps. Through the use of an interpolation oscillator, each 0.5 kHz increment is scanned either continuously or in 1 kHz steps. Counter type tuning dials permit accurate presetting to any desired frequency.

The frequency range of 2 to 32 MHz is covered in four bands: band 1, 2.0 to 4.0 MHz;

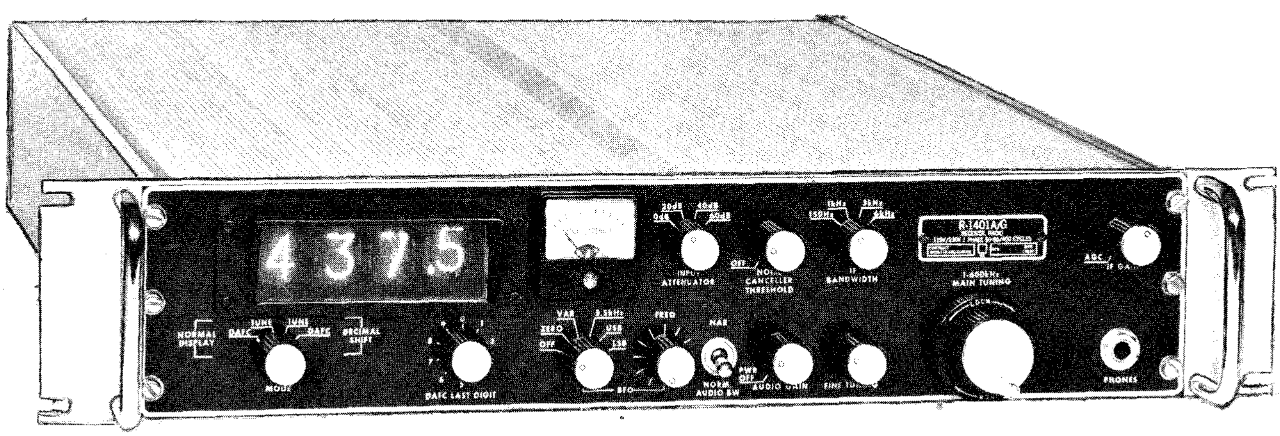

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Figure 12-27.—R-1401A/G VLF receiver.

band 2, 4.0 to 8.0 MHz; band 3, 8.0 to 16.0 MHz; and band 4, 16.0 to 32.0 MHz.

Radio Receiver AN/WRR-3B

Radio receiver AN/WRR-3B (fig. 12-25) is a dual-conversion superheterodyne receiver for surface craft and submarine installations. It receives CW, MCW, and radioteletype signals.

The receiver covers the frequency range from 14 to 600 kilohertz in five bands. They are—

Band 1, 14 to 30 kHz
Band 2, 30 to 63 kHz
Band 3, 63 to 133 kHz
Band 4, 133 to 283 kHz
Band 5, 283 to 600 kHz

The frequency to which the receiver is tuned is read directly from drum type dials.

An internal calibration circuit provides calibration points at each 10 kHz tuning point within the tuning range of the receiver.

R-1051/URR

The R-1051/URR (fig. 12-26) is one of the newest radio receivers. It is a versatile superheterodyne receiver capable of receiving any type of radio signal in the frequency range 2 to 30 MHz. It can be used as an independent receiver. Or, in conjunction with a transmitter, it can be used to form a transmitter-receiver combination, such as radio set AN/WRC-1 described previously (see fig. 12-11).

Basically a crystal-controlled equipment, the R-1051/URR employs a digital tuning scheme for automatic tuning to any one of 56,000 operating channels. A display window directly above each control provides a readout of the digits to which the controls are set. The R-1051/URR has 0.5 kHz tuning whereas the R-1051B/URR tunes in 0.1 kHz increments or 2 to 30 MHz with continuous vernier tuning between 1 kHz increments.

This receiver is designated as standard equipment for use aboard all ships. Although presently available in limited numbers only, it is being procured for distribution throughout the fleet.

R-1401A/G

The R-1401A/G VLF receiver (fig. 12-27) is tunable over the frequency range of 1 kHz to 600 kHz in one band. It may be used for the reception of a-m, CW, MCW, SSB or FSK signals. A direct-reading digital readout is used to indicate the frequency to which the receiver is tuned. The frequency is normally displayed with an accuracy of 100 hertz per second. A front-panel switch permits expanding the readout by a factor of 10, so that the frequency may be read to an accuracy of 10 hertz per second. A fine-tuning control is provided so that the receiver can be easily tuned to this accuracy. Four i-f bandwidths are provided: 150 hertz per second, 1 kHz, 3 kHz, and 7 kHz with two audio outputs. Selection of the desired bandwidth is by means of a front-panel switch. The intermediate frequency is 2 MHz.

R-390A/URR

Operating in the frequency range 500 kHz to 32 MHz radio receiver R-390A/URR (fig. 12-28) is a continuous tunable, high performance general purpose receiver for both shipboard and shore station use. It can receive CW, MCW, a-m radiotelephone, and frequency shift radioteletype and facsimile signals. When used in conjunction with single-sideband converter CV-591( )/URR, it also is an excellent SSB receiver.

The receiver is a superheterodyne type, with multiple-frequency conversion. In the frequency range from 500 kHz to 8 MHz, it uses

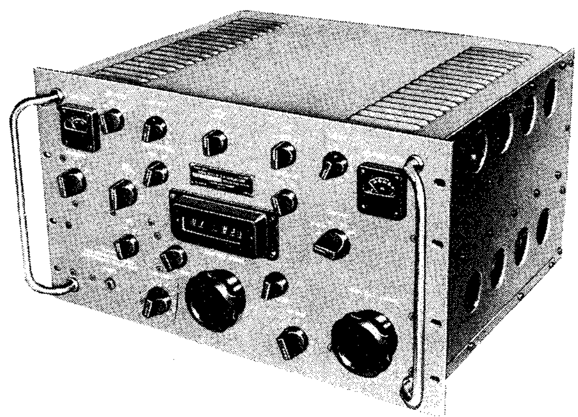

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Figure 12-28.—Radio receiver R-390A/URR.

triple conversion. Double conversion is used in the range from 8 to 32 MHz.

The tuning knob turns a complex arrangement of gears and shafts to indicate the frequency to which the receiver is tuned on a very accurate counter-type dial. The dial is calibrated in kilohertz, and the frequency reading accuracy of this tuning dial permits use of the receiver as an accurate frequency meter.

Radio Receiver AN/BRR-3

Radio receiving set AN/BRR-3 consists of radio receiver R-988/BRR-3, connectors, clamps, and mounting hardware. The receiver is designed for general application aboard all types of U.S. Navy vessels. It covers the frequency range from 14 to 30 kHz and is normally used to receive either on-off keying (ICW or A1) or radioteletype (RFCS or AFTS) types of transmission. The receiver also has the capabilities of receiving facsimile signals (FAX or F4) when provided with additional terminal equipment, and of being used as a homing device when equipped with a Loop Antenna. It is a superheterodyne receiver, the output of which is supplied at a headphone jack for audio monitoring of Interrupted Continuous Wave (ICW) signals. Figure 12-29 shows the radio receiving set and accessory equipment.

Radio Receiver AN/SRR-19A

The AN/SRR-19A is a low frequency multichannel shipboard radio receiver for the 30-300 kHz frequency range (fig. 12-30). This dual-conversion superheterodyne receiver is intended for single sideband, multichannel radio teletypewriter broadcasts, AM and CW reception.

Receiver operation is characterized by extreme stability, permitting long periods of unattended operation. Counter type tuning dials facilitate accurate tuning to a desired frequency, and frequency errors caused by drift in the local oscillators are removed by drift-cancellation circuits. The receiver can be incrementally tuned in steps of 10 hertz or continually tuned (between increments) with partial drift-cancellation during continuous tuning.

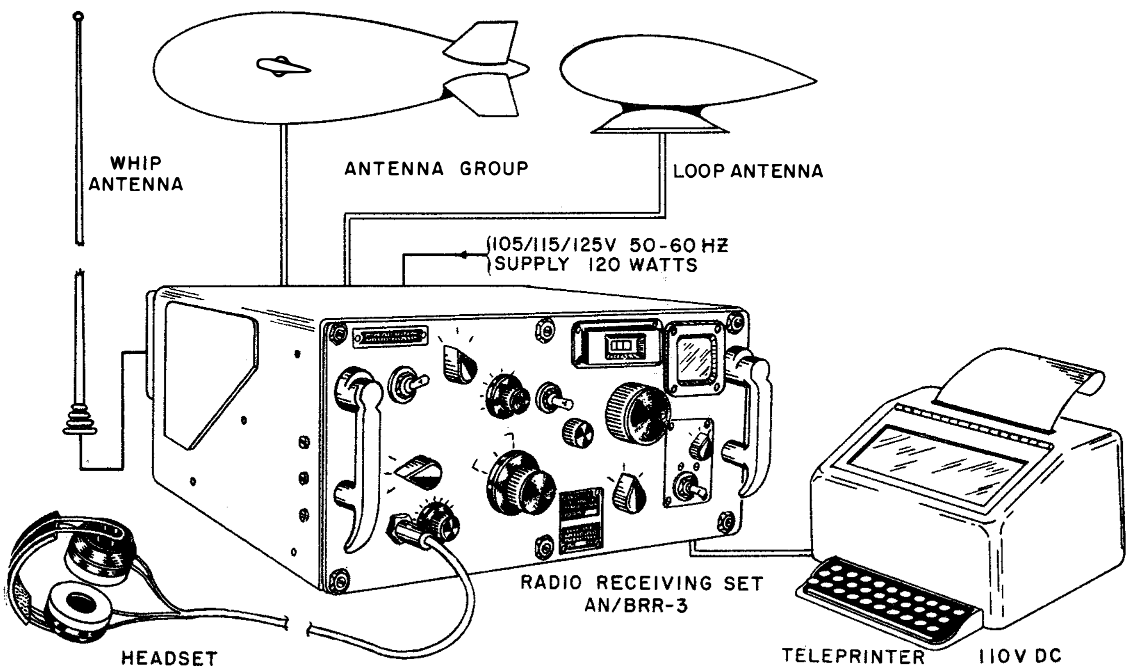

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Figure 12-29.—Radio Receiving Set AN/BRR and accessory equipment.

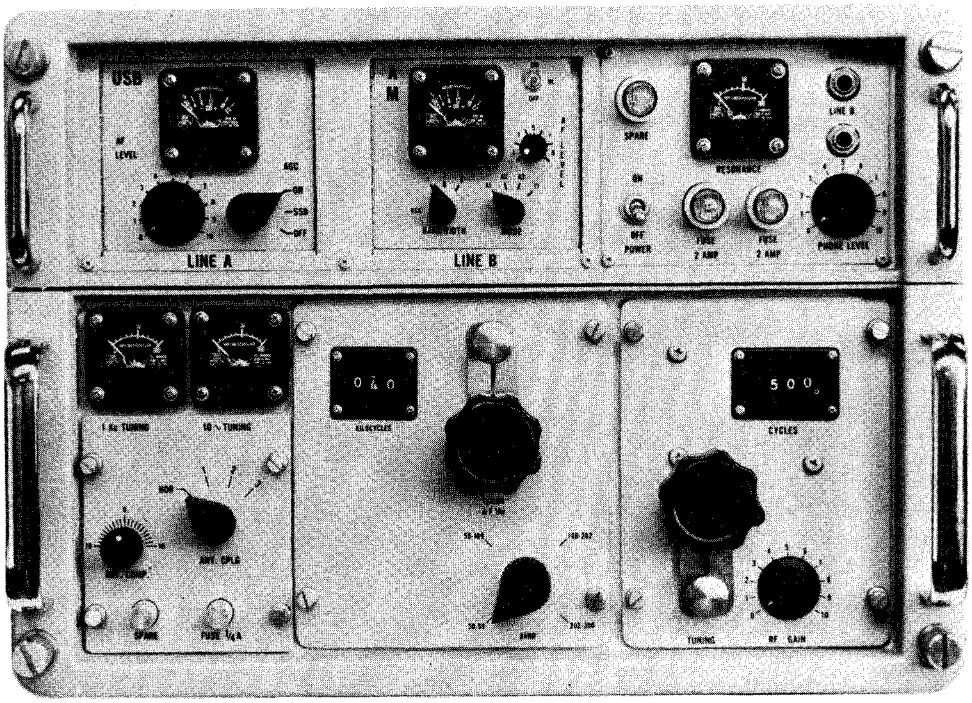

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Figure 12-30.—Radio Receiver AN/SRR-19A.

VHF AND UHF RECEIVERS

In most instances, radio receivers covering the VHF (and UHF) range are operated as crystal-controlled equipments. They are tuned easily and quickly. Once tuned, they operate efficiently for long periods of time without further attention. The trend is that modern transceivers will probably be replacing more radio receivers of this frequency range in the future.

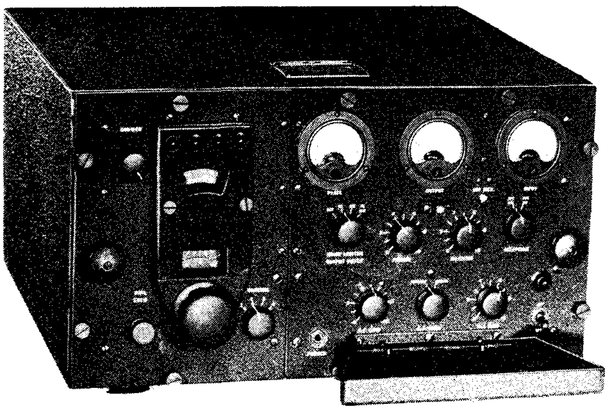

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Figure 12-31.—Radio Receiver AN/URR-21( ).

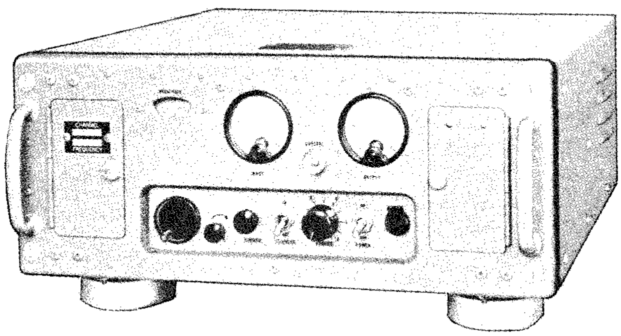

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Figure 12-32.—Radio Receiver AN/URR-27( ).

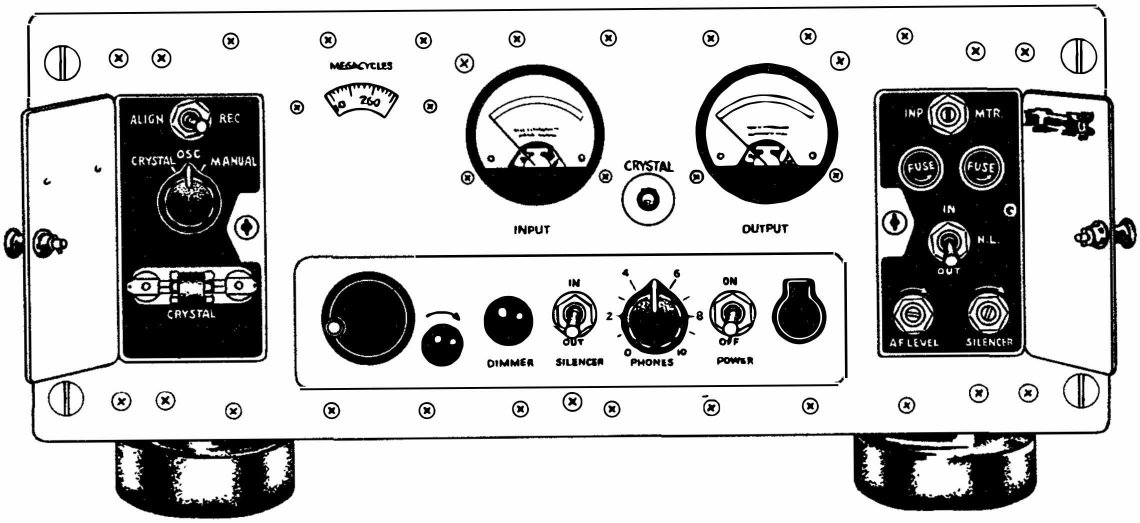

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Figure 12-33.—Radio Receiver AN/URR-35C.

Radio Receiver AN/URR-21( )

The AN/URR-21( ) receiver (fig. 12-31) is used for receiving amplitude-modulated radiotelephone signals, in a portion of the VHF band, from 115 to 156 MHz. It is a crystal-controlled superheterodyne receiver. Although the receiver dial is calibrated continuously, only four channels can be tuned within the frequency range for a given set of four individually selectable crystals. The four crystals are plugged into a crystal holder on the receiver chassis inside the cabinet. Special features include a front panel dial detent mechanism for rapid selection of channels, and continuous tuning of all RF circuits by means of a single tuning control.

Radio Receiver AN/URR-27( )

Radio receiving set AN/URR-27 (fig. 12-32) provides for reception of amplitude-modulated voice and MCW transmission in the 105 to 190 MHz frequency range. You will note that this range of frequencies slightly exceeds that of the VHF transmitters, which cover a band from 115 to 156 MHz.

120.7

Figure 12-34.—Radio Transceiver SCR-536( ).

The AN/URR-27( ) is a superheterodyne receiver, designed chiefly for operation as a pretuned, single-channel, crystal-controlled receiver. Continuously variable manual tuning is also available. A single tuning control is used for tuning to any frequency for either crystal-controlled or manual tuning operation.

Radio Receiver AN/URR-35C

Radio receiver AN/URR-35C (fig. 12-33) is equipped for radiotelephone and MCW reception for use in tactical communications aboard ship. Although the frequency range of 225 to 400 MHz includes the upper portion of the VHF band, the receiver is commonly called UHF equipment. Designed mainly for single channel, crystal-controlled operation, it may also be used as a continuously variable manual tuned receiver. This receiver is easy to tune and features single tuning controls for tuning to any frequency within its range, for either crystal-controlled or manual tuning. It is a double conversion, pretuned, single-channel, superheterodyne receiver.

The AN/URR-35C receiver is commonly employed with the TED transmitter. This combination is commonly referred to by operators and technicians as a TED/RED group.

PORTABLE AND PACK RADIO EQUIPMENT

Because portable and pack radio sets must be lightweight, compact, and self-contained, they usually are powered by 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.

Transceiver SCR-536( )

Radio transceiver SCR-536( ), (fig. 12-34) is a low-power, battery-operated transceiver used for voice communication over very short distances (1 to 3 miles). The equipment is crystal-controlled, and operates on a preset frequency in the range of 3.5 to 6 megahertz. The operating frequency is varied by changing the crystal and certain other frequency-determining components within the set. Usually, these changes are made by a technician.

The set is energized by extending the telescopic antenna. When thus energized, it functions as a receiver. Applying pressure on the press-to-talk switch (located on the side of the set) shifts the equipment from a receive condition to a transmit condition. The set remains in the transmit condition as long as the switch is held depressed.

Weighing only 5-1/2 pounds, this portable set comes equipped with a carrying strap. Often the set is used as a means of communication by personnel moving about on foot, as while on shore patrol. Also, it serves as a means of communication between small boats and their parent ships.

Transceiver AN/PRC-10( )

The AN/PRC-10( ) portable radio set (not illustrated) provides voice communications for amphibious operations. These are man-pack FM equipment sets.

Total frequency coverage of the AN/PRC-10( ) is between 38 and 54.9 MHz with an output power of approximately 1 watt. These portable sets have an effective range of approximately 5 miles.

Transmitter AN/CRT-3A

Radio transmitter AN/CRT-3A, 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 12-35. No receiving equipment is included.

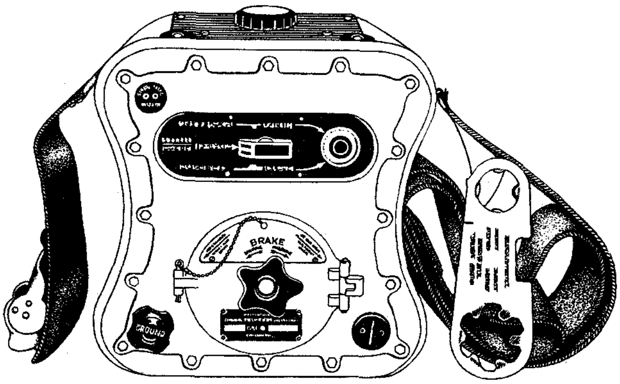

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Figure 12-35.—Emergency lifeboat Radio Transmitter AN/CRT-3A.

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 aluminum cabinet that is airtight and waterproof. 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 sequence 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 make use of 8364 kHz, whereas aircraft or ships locally engaged in search and rescue missions make use of the 500 kHz signals.

Besides the automatic feature, the transmitter can be keyed manually, on 500 kHz only, by means of the pushbutton telegraph key.

Additional items (now 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.

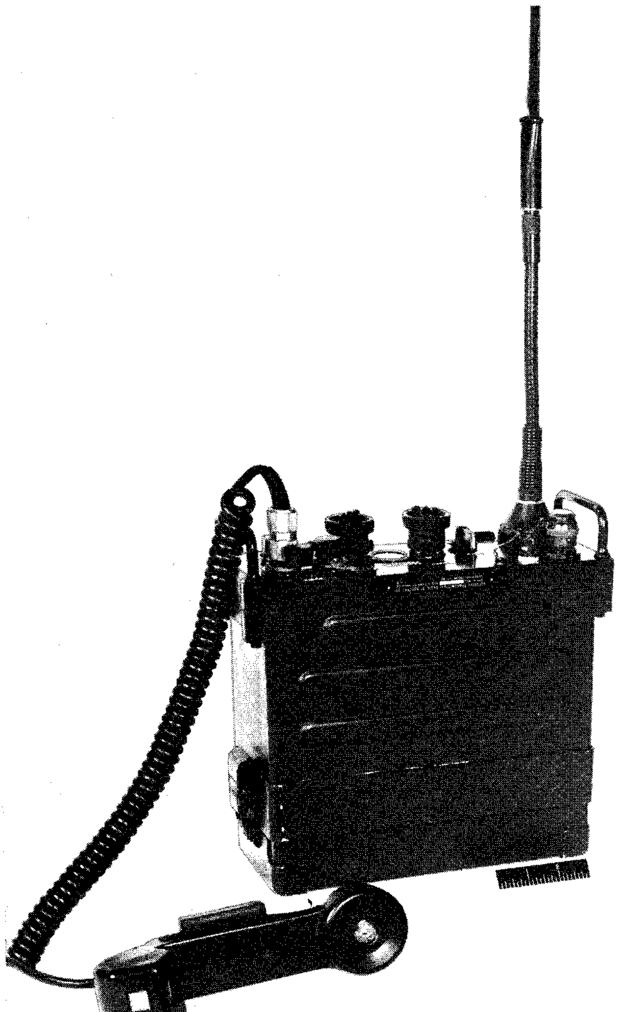

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Figure 12-36.—Radio Transceiver AN/PRC-25.

120.6

Figure 12-37.—Radio Transceiver AN/URC-4.

The equipment floats, and is painted brilliant orange-yellow to provide greatest visibility against dark backgrounds.

Transceiver AN/PRC-25

The AN/PRC-25 is a VHF man-pack miniaturized radio set (fig. 12-36) now being used. It weighs only 22 pounds with batteries, and replaces three sets (AN/PRC-8-9-10) that cover a frequency range of 20 to 55 megahertz. The AN/PRC-25 is an FM transceiver that operates in the 30- to 76-megahertz range and provides 920 channels spaced at 50 kilohertz intervals, with a power output of 2 watts. Stable frequencies are generated for both the transmitter and receiver by a frequency synthesizer.

The unit is transistorized throughout, with the exception of one tube in the transmitter power output stage. A future version will be completely solid state. With 25 modular plug-in subassemblies, the set is easy to service.

Transceiver AN/URC-4( )

The AN/URC-4( ) (fig. 12-37) is a compact, portable transceiver. It is small enough to allow the combined transmitter and receiver to be grasped and held with one hand. This unit is connected by a short cable to its battery case, which is approximately the size of the transceiver.

The complete set is intended to be carried in a special vest type garment worn by airmen while they are on flight missions. It also may be dropped by parachute to personnel in distress. The principal use of this set in the Navy is for extremely short-distance distress communication between lifeboats (or liferafts) and searching rescue aircraft or ships.

This transceiver is a crystal-controlled equipment that provides voice and MCW transmissions over two frequency ranges within the VHF band. Frequencies covered are between 120 and 130 MHz and between 240 and 260 MHz. The operating frequency of the set is determined by a single crystal, which must be changed each time the frequency is changed. The set is pretuned, and can be operated by anyone familiar with its purpose.

Transceiver AN/PRC-41

Radio set AN/PRC-41 (fig. 12-38) is a watertight, lightweight, portable UHF equipment 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, which it supplies at an average output power of 3 watts. Although designed principally for manpack operation, the set also may 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.

EQUIPMENT TUNING

The communications equipment used in the Navy is designed to cover a wide range of frequencies and therefore needs to be adjusted (tuned) to each operating frequency. Communications transmitters and receivers differ from

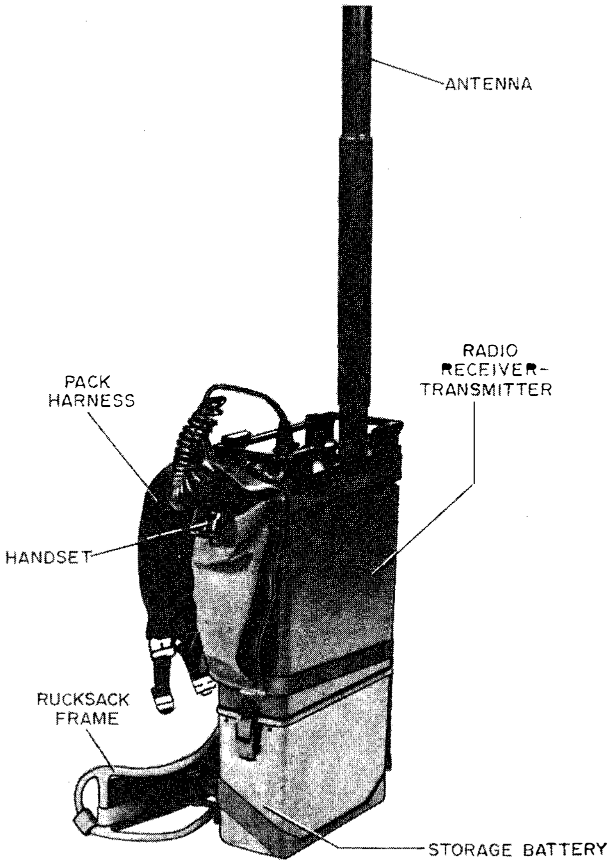

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Figure 12-38.—Radio Transceiver AN/PRC-41.

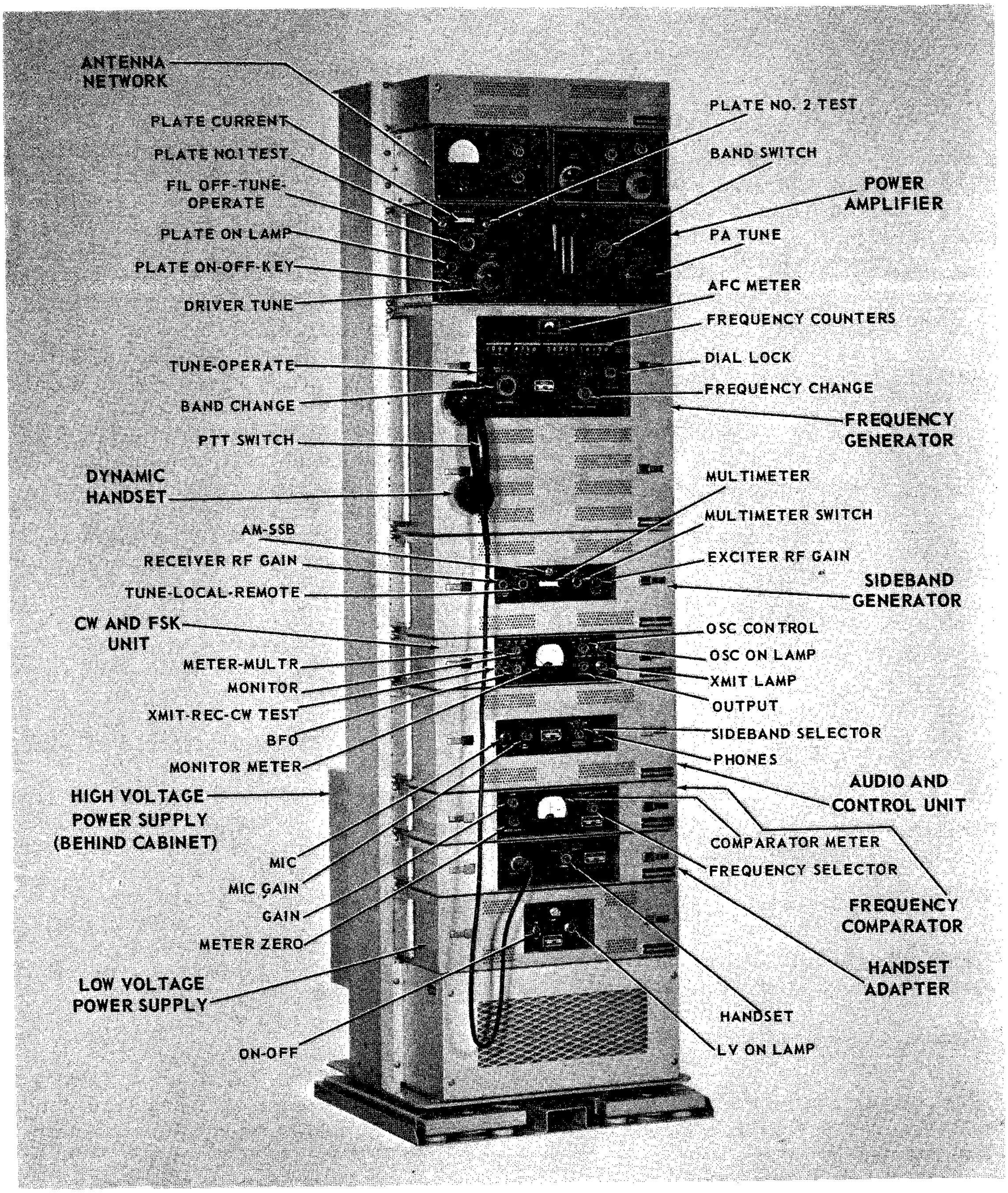

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Figure 12-39.—Radio Set AN/URC-32, relationship of units and operating controls.

each other in design, performance, and general overall appearance. The differences between equipments are readily visible but, the adjustment of each type will generally follow the same pattern. This manual cannot cover the tuning procedures for each piece of equipment in use in the Navy and, therefore will cover the tuning procedures of a "typical" communications transmitter and receiver.

TRANSMITTER TUNING

The operating characteristics of the Radio Set AN/URC-32 has been discussed earlier in this chapter. Since this unit is one of the common transmitter types used in the fleet we will cover the tuning procedures for this equipment.

Operating Procedure

The following preliminary steps must be performed before turning on the equipment. (Refer to figure 12-39 for location of controls.)

Low-voltage power supply	ON-OFF switch to OFF.
Power amplifier	FIL OFF-TUNE-OPERATE switch to FIL OFF. PLATE switch to OFF.
Sideband generator	RECEIVER RF GAIN control counterclockwise. EXCITER RF GAIN control counterclockwise. TUNE-LOCAL-REMOTE switch to LOCAL.
Frequency comparator	FREQUENCY SELECTOR switch to OFF.
CW and FSK unit	XMIT-REC-XMIT TEST switch to REC. OSC CONTROL switch to OFF.
Audio and control	MIC GAIN control counterclockwise. SIDEBAND SELECTOR switch to OFF.

Turning on Equipment.—The following procedure is observed to apply power to the equipment. If equipment is to be used only as a receiver, perform only steps 1 and 2.

1. Set OFF-ON switch on low-voltage power supply to ON position. The indicator lamp on low-voltage power supply will light when air pressure is present in the cooling system.
2. Set meter selector switch on sideband generator to the -90, +130, and +250 positions and check that meter reads between 35 and 50 db in each position.
3. Turn FIL OFF-TUNE-OPERATE switch on power amplifier to OPERATE position. Wait 30 seconds before performing step 4.
4. Depress PLATE switch on power amplifier to KEY and check that PLATE CURRENT meter on power amplifier reads 150 ma of plate current. PLATE lamp on power amplifier HV ON lamp on high-voltage power supply, and XMIT lamp on CW and FSK unit should light while switch is depressed.
5. Depress PLATE switch to KEY and alternately depress PLATE-NO. 1 TEST switch and PL NO. 2 TEST switch on power amplifier, checking that PLATE CURRENT meter reads between 60 and 90 ma of plate current for each tube.
6. Operate PLATE switch on power amplifier to ON. PLATE LAMP on power amplifier and HV ON lamp on high-voltage power supply should light.

Tuning procedure.—The tuning procedure for setting the AN/URC-32 to a new operating frequency follows.

1. Set PLATE switch on power amplifier to OFF.
2. Set BAND CHANGE switch on frequency generator to the desired frequency band. The band indicator lamp will light over the selected frequency counter. The AN/URC-32 frequency bands are—

Band 1	2.0 to 3.7 mHz
Band 2	3.7 to 7.7 mHz
Band 3	7.7 to 15.7 mHz
Band 4	15.7 to 30.0 mHz

3. Release DIAL LOCK on frequency generator. Set desired operating frequency on the lighted frequency counter, using FREQUENCY CHANGE control. When selecting a frequency that is not on the band 7.7-15.6 mHz, or 15.7- to 30.0-mHz frequency counters, set frequency counter to the next lower frequency on the counter and set BAND CHANGE switch to ADD 1, ADD 2, or ADD 3. With BAND CHANGE switch in ADD 1 position, 1 kHz is added to the frequency indicated on frequency counter. In the ADD 2 position, 2 kHz

are added, and in the ADD 3 position, 3 kHz are added. When the desired operating frequency is on the frequency counter, set BAND CHANGE switch to ADD 0. Example: to select an operating frequency of 23.699 mHz, set BAND CHANGE switch to BAND 4, set 15.7- to 30.0-mHz frequency counter to 23.696 mHz using FREQUENCY CHANGE control, and reset BAND CHANGE switch to BAND 4 ADD 3. When setting up a frequency on any band, make certain the white index line on the last dial of the 15.7- to 30.0-mHz frequency counter is centered in the window.

4. Reset DIAL LOCK and momentarily depress the TUNE-OPERATE switch on frequency generator to TUNE. This action prevents the stabilized master oscillator from locking on spurious signals. The AFC meter shows the amount of correction being supplied to the master oscillator from the stabilization circuits. Hence it should not be expected to read 0 unless master oscillator is exactly on frequency and no correction is required.
5. Adjust RECEIVER RF GAIN control so that automatic gain control (AGC) does not increase gain excessively between characters in CW and FSK or between words in single-sideband voice reception. The RECEIVER RF GAIN control normally is set so that sideband generator meter (AGC) "kicks up" about 15 db with meter switch in TGC-AGC position. If speaker, handset, or remote audio output level is inadequate, set SPEAKER GAIN control (under dust cover of audio and control unit) for desired output level. On FSK operation, adjust BFO control for proper operation of FSK converter. This action completes tuning of the receiver portion of the AN/URC-32.

NOTE: Before performing the following steps, the AN/URC-32 must be connected to an antenna system containing an antenna tuner control and a dummy load, such as the AN/SRA-22. This type of antenna tuner contains a directional wattmeter and a switch for selecting the antenna or the dummy load.

6. Set ANT-LOAD switch on antenna tuner control to LOAD. Set FIL OFF-TUNE-OPERATE switch on power amplifier to TUNE. Set meter selector switch on sideband generator to RF OUT. Set TUNE-LOCAL-REMOTE switch on sideband generator to TUNE.

NOTE: In the following steps, key to transmit by depressing PLATE switch on power amplifier to KEY.

7. With EXCITER RF GAIN control in the maximum counterclockwise position, key to transmit and turn EXCITER RF GAIN control clockwise until meter on sideband generator reads approximately 40 db.
8. Key to transmit and adjust DRIVER TUNE control on power amplifier within desired band limits to peak the PLATE CURRENT meter reading, and adjust EXCITER RF GAIN control as necessary to maintain a PLATE CURRENT meter reading of approximately 200 ma. The red index on DRIVER TUNE control must fall within the proper band limits marked on panel. If a power output reading is observed on power output meter of antenna tuner, detune P.A. TUNE control until no power output is indicated. This action effectively disables the r-f feedback so that optimum adjustment of driver plate circuit can be obtained. Reducing EXCITER RF GAIN control for a decrease in PLATE CURRENT meter reading, as necessary, results in a sharper indication of driver tuning.

NOTE: After completing step 8, make no further adjustments on DRIVER TUNE control for the remainder of tuning procedure.

9. Set P.A. TUNE control on power amplifier within desired frequency band limits. Key to transmit and adjust P.A. TUNE control for a dip in PLATE CURRENT meter reading.
10. Set EXCITER RF GAIN control maximum counterclockwise. Set FIL OFF-TUNE-OPERATE switch on power amplifier to OPERATE.
11. Key to transmit, turn EXCITER RF GAIN control clockwise until 500 watts of forward power is indicated and redip PLATE CURRENT meter reading, using P.A. TUNE control. PLATE CURRENT meter reading should not exceed 500 milliamperes. (Caution: Do not operate ant-load switch while AN/URC-32 is keyed to transmit.)

12. Set ANT-LOAD switch on antenna tuner control to ANT and adjust antenna tuner controls for minimum reflected power. For this procedure see operating procedures in antenna tuner control technical manual.
13. Key to transmit and adjust EXCITER RF GAIN control for a forward power output meter reading of 500 watts. Reflected power meter reading should be under 10 watts. PLATE CURRENT meter reading should be between 450 and 550 ma.
14. Key to transmit and adjust EXCITER RF GAIN control for a forward power output of 125 watts.
15. Key to transmit and check the following meter readings:

PLATE
  CURRENT
    meter . . . . . . approximately 300 ma.
Forward power
    output . . . . 125 watts.
Reflected power . . . . . less than 3 watts.
Sideband generator
    meter RF OUT . . . . 10 to 20 db.
Sideband generator
    meter TGC . . . . 0 db.

16. Set TUNE-LOCAL-REMOTE switch on sideband generator to LOCAL. On AM transmit operation, readjust EXCITER RF GAIN control for 125 watts forward power. Set PLATE switch on power amplifier to ON. This step completes the tuning procedures.

RECEIVER TUNING

The operating characteristics of the R-390A/URR Radio Receiver has been discussed earlier in this chapter. The R-390A/URR being a representative receiver will be covered here for receiver tuning.

Operating Procedure

Haphazard operation or improper setting of receiver controls can result in poor reception. It is important, therefore, to know the function of every control. Although much of the Navy's communication equipment is set up or tuned automatically, an operator still must do a lot to

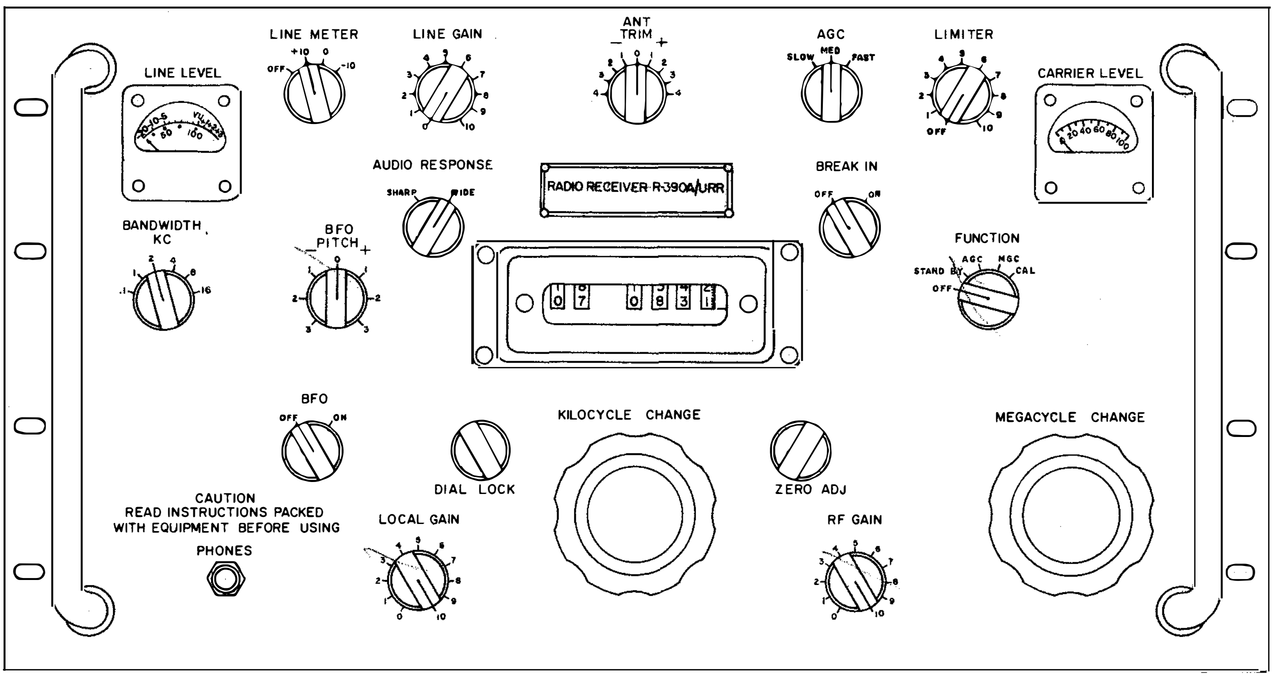

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Figure 12-40.—Front panel of R-390A/URR.

obtain proper operation from the equipment. (Most mechanical or electrical equipment is only as good as the person operating it.) Refer to figure 12-40 when studying the following descriptions of switches and controls.

- Function switch: The function switch serves several purposes. It has a number of positions, each of which is discussed. Its OFF position (self-explanatory) simply turns off power to the receiver.

When the function switch is in STANDBY position, filament supply voltages are energized, but plate supply voltages are not applied to the tubes. This condition readies the receiver for instant use without a long warmup time.

The abbreviation AGC stands for automatic gain control. Placing the function switch in the AGC position activates the circuitry, which automatically adjusts the RF and I-F amplifier gain to compensate for variations in the level of the incoming signal. In connection with the AGC function, notice that the AGC switch at the top of the panel has three positions marked SLOW, MEDIUM, and FAST. This AGC switch adjusts the rate at which the AGC circuitry responds to a change in the signal level. The correct position of the AGC switch depends on the type of signal received.

The abbreviation MGC stands for manual gain control. When the function switch is in the MGC position, the AGC circuitry is not activated, and the gain is controlled manually by means of the r-f gain control.

When the function switch is in the calibrate (CAL) position, a stable crystal oscillator introduces a signal at the input circuitry of the receiver. This signal allows the operator to calibrate his receiver; that is, to ascertain that the reading of the tuning dial corresponds to the frequency received. The calibration circuitry of the R-390A permits the operator to calibrate the receiver at each 100-kHz point throughout the tuning range of the receiver. In connection with calibration, notice the ZERO ADJ knob near the frequency dial. When turned clockwise, this knob disengages the frequency indicator from the KILOCYCLE CHANGE tuning control. The calibration procedure consists essentially of the following steps:

1. Tune the receiver to a point where the frequency indicator dial shows an exact multiple of 100 kHz.
2. Turn the ZERO ADJ knob clockwise to disengage the tuning controls from the frequency indicator.
3. With the function switch in the CAL position, turn the KILOCYCLE CHANGE control to give the maximum response to the calibration signal.
4. Turn the ZERO ADJ knob counterclockwise to reengage the tuning control to the frequency indicator.

- Tuning controls: Two front panel knobs provide the tuning control of the R-390A. They are the MEGACYCLE CHANGE knob and the KILOCYCLE CHANGE knob. The MEGACYCLE CHANGE knob selects any 1-mHz bandwidth of the tuning range. Turning this knob changes the reading of the first two digits of the frequency indicator. The KILOCYCLE CHANGE knob tunes the receiver to any desired frequency within the megahertz band selected by the MEGACYCLE CHANGE control. The last three digits of the frequency indicator dial provide the kilohertz reading. The tuning controls actually adjust the tuning circuits in the RF stages and in the local oscillator in order to select the desired station frequency and to provide simultaneously the desired I-F signal to the I-F portion of the receiver. The DIAL LOCK knob is associated with the tuning controls. This knob locks the KILOCYCLE CHANGE control so that the frequency setting will not be changed accidentally.

- Bandwidth control: Some transmissions use narrower bandwidths in the RF spectrum than others. Receivers are therefore provided with a control that allows the operator to adjust the pass band of the receiver so that only the desired bandwidth is received. On the R-390A receiver, this control is achieved by the BANDWIDTH KC switch. It adjusts the tuned circuits of the I-F portion of the receiver, thereby controlling receiver selectivity. Proper adjustment of this control helps to eliminate noise and interfering signals. If the bandwidth is set too narrow, part of the incoming signal will, of course, be lost.

- Beat frequency oscillator: Some radio transmissions, such as Morse telegraphy and FSK teletype contain no audio frequency information when they are received. The R-390A is equipped with a Beat Frequency Oscillator (BFO) to produce an audible output if required. The BFO is activated by the BFO On-Off switch and the pitch of the audio output can be adjusted by the BFO Pitch Knob.

- Gain control: The R-390A has three front panel gain controls. The RF GAIN control permits manual adjustment of the gain of the RF and i-f sections of the receiver. The LOCAL GAIN and LINE GAIN knobs control the gain of the a-f circuits. The LOCAL GAIN controls adjust the level of the output to the phone jack. The LINE GAIN controls the level of the audio output used to operate terminal equipment.
- Antenna trimmer: The front panel control labeled ANT TRIM adjusts the input circuit in such a manner that optimum coupling from the antenna to the receiver can be achieved at each frequency.
- Audio response: The AUDIO RESPONSE control, which adjusts the bandwidth of the audio circuits, has two settings: SHARP and WIDE. The setting of this control depends on the type of signal received.
- Limiter: When the control labeled LIMITER is activated, the operator can control the amplitude of the audio output circuits to predetermined limits. The setting of the limiter control depends on the type of signals received. A low setting of the control, for example, would be desirable to prevent loud crashes of static in the output when monitoring voice signals. If the received signal is fsk-modulated, it may be desirable to remove all amplitude variations by using a high setting on the LIMITER control. For many types of reception, however, the LIMITER should not be activated.
- Break-in: The ON-OFF switch labeled BREAK IN is used when a receiver and transmitter are operated together as a radio set. In the ON position, circuits are activated for removing the antenna from the receiver and for grounding the antenna and receiver audio circuits whenever the transmitter is energized.

- Indicators: Three indicators are mounted on the front panel of the R-390A. The frequency indicator dial indicates the frequency to which the receiver is tuned. This dial is of the digital-counter type, which permits frequency to be read directly with little chance of misreading.

The CARRIER LEVEL indicator—a meter—measures the level of the RF signal appearing at the input of the receiver. The operator will find this meter valuable in tuning to the exact frequency that gives the strongest signal. It is also used to indicate proper adjustment of the antenna trimmer. The indicator labeled LINE LEVEL monitors the level of the line audio out used to drive the terminal equipment. This meter is placed across the output circuit by the LINE METER switch. The three available values of meter sensitivity (voltage required for full-scale deflection) are determined by the setting of the LINE METER switch. This meter is valuable in maintaining the proper output level when making tape recordings.

CHAPTER 13
COMMUNICATIONS SYSTEMS

This chapter presents the principles of communications systems both in narrative and graphic form. A communication system contains an information source, an information user, and a communications link for exchanging information or intelligence between the source and user. Figure 13-1 shows a block diagram of a basic communications system. The blocks may be defined in terms of the functions to be performed and the equipment or devices used to carry out these functional requirements.

FUNCTIONAL COMPONENTS

As shown in figure 13-1, any communications system is a combination of equipments connected together to provide a signal path from the source to the user. The equipments you have already studied in chapters eleven and twelve of this manual are the construction components of the typical communications system.

INFORMATION SOURCE

The information source represents the person or device generating the original information to be transmitted by the communications system to the information user. It may be a human voice, a message from a teletypewriter keyboard, a computer's memory bank, or a photograph from a satellite.

SOURCE TRANSDUCER

The source transducer is any device capable of being actuated by waves or a source of energy and of supplying waves or energy related to the input. The waves or energy entering the transducer may produce an output which is of the same or different type. Examples of source transducers are microphones, video cameras, perforated tape readers, magnetic head tape readers, and photoelectric cell scanners.

CHANNEL ENCODER

The channel encoder may be defined as a device which accepts the electrical signals from the source transducer and transforms or conditions these signals into a form suitable for transmission through the selected transmission medium. Examples of channel encoders are relay repeaters, amplitude or frequency-shift modulators, voice multiplex and microwave modulators, synchronous telegraph time-division multiplex, and error-detection and correction logic equipments.

TRANSMISSION MEDIUM

There are four mediums by which electrical signals generated by the source transducers may be transferred to the user transducers; they are:

(a) Wire
(b) Atmosphere
(c) Space
(d) Water

CHANNEL DECODER

The channel decoder may be defined as a device that accepts the signal delivered by the transmission medium and transforms or conditions this signal into a form suitable to the user transducer. Examples of channel decoders are polar relays, voice channel separation networks; amplitude; phase- or frequency-detectors; or a receiving multiplex terminal.

USER TRANSDUCER

The user transducer may be defined as a device that transforms the signal delivered by the channel decoder. This device is able to deliver electrical, optical, acoustical, mechanical, and perhaps other forms of energy, called for by the information user. A user transducer normally supplies a replica of the original signal, but the final intelligence delivered to the information user may be intentionally converted to a different form.

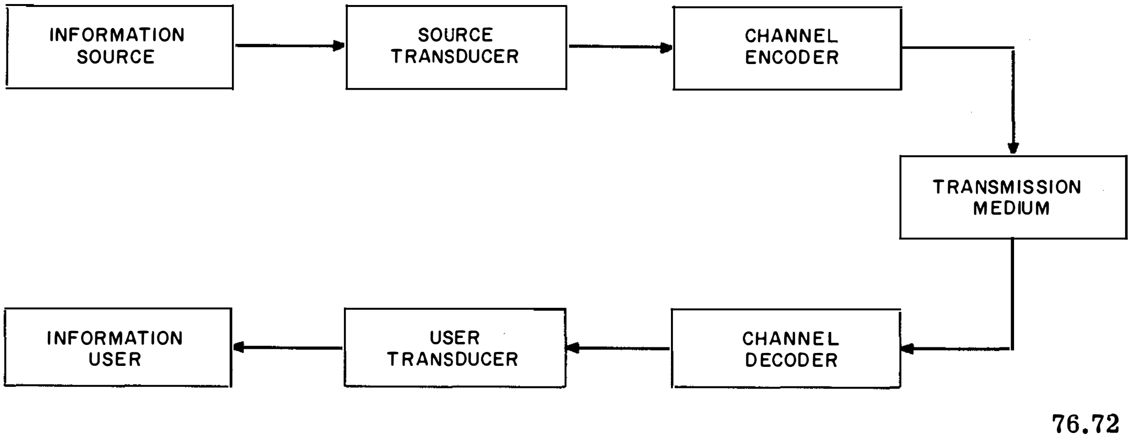

Figure 13-1.—Basic Communications System.

SYSTEMS DESCRIPTIONS

The sole purpose of any communications system is the efficient transmission and reception of information from one place to another. The intelligence signal is the means by which this is done. When a basic understanding of the effect each component in the system has on this signal is acquired, the need for systems quality monitoring and control procedures become evident. The following section, therefore, is composed of block diagrams and narrative descriptions of typical shipboard communications systems. They are not intended to be technically complete in details such as specific equipment nomenclature, but are intended to acquaint the shipboard communicator with the "Systems" concept in analyzing shipboard communications problems.

It is recommended that communications personnel insert their own ships communications equipment nomenclature into the systems block diagrams. By doing this, Quality Control training can be facilitated because Radiomen will be able to relate individual equipments into the communications system concept.

Every ship is provided with communications systems based on the ship's mission. Communications systems can vary from the simple to the complex. For instance, a radiotelegraph receive system consists of an antenna, receiver, and headphones or speaker. A multichannel broadcast-receive system may consist of antennas, receivers, terminal equipment, several pieces of crypto equipment, an assortment of page printers, reperforators, and patching facilities.

When circuit outages occur, the prime concern is to restore the circuit as soon as possible. Circuit outages are caused by failure of the radio path or failure of the system. When the system fails, the faulty equipment must be located and replaced. Replacement of equipment may be limited by patching facilities. For example, if patching facilities prohibit replacement use of auxiliary equipment, it may be necessary to remove physically the faulty equipment and replace it with a good unit. It is necessary, therefore, that the Radioman be aware of his unit's patching capabilities and limitations.

NON-SECURE SYSTEMS

Radio communications is the least secure communications method. Any person possessing the necessary equipment may receive messages transmitted by radio. Although this situation exists there is still a great need for communications between units of the Navy using unclassified systems.

AM/FM Voice System

In this system either amplitude or frequency modulation can be employed, but all units in a net must use the same mode of emission. It is not possible to communicate on an AM circuit with FM equipment and regardless of whether the emission is AM or FM the same principles will apply. A typical non-secure voice system consists of one or more radiotelephone remote units and/or loudspeakers patched to transmitter and receiver equipments (or transceiver) via the transmitter transfer switchboard and audio transfer switchboard. See figure 13-2.

The system signal flow is as follows: The mechanical energy, generated by the operator's voice, is changed to electrical energy in the handset. The push-to-talk button on the handset closes the DC keying circuit to the transmitter placing the transmitter on the air. The audio signal and DC keying voltage from the handset are patched via the transmitter transfer switchboard to the transmitter or transceiver. The audio signal amplitude or frequency modulates the RF signal generated by the transmitter. The modulated RF signal is then radiated by the antenna. On the receiver side, the RF signal is picked up by the antenna and fed via the coupler or multicoupler to the receiver where demodulation is accomplished, resulting in an audio signal output. This audio signal output from the receiver is patched via the audio transfer switchboard to the remote radio telephone unit and/or loudspeaker. The audio

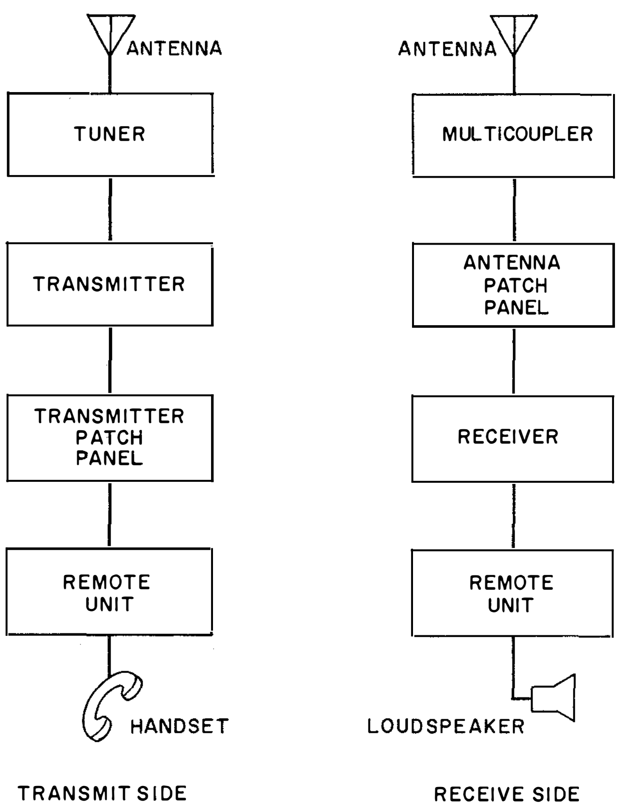

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Figure 13-2.—AM/FM Voice System, Block Diagram.

signal is changed from electrical energy to mechanical energy by headphones, handsets, or speakers. For HF operation, antenna selection is important when the system is used for long range communication circuits.

HF Single Sideband Voice System

A typical SSB voice system consists of the transmitting and receiving antennas patched through their associated couplers or multicouplers to a transceiver or separate transmitter and receiver. The transmitting and receiving equipment is patched to remote units and/or speaker amplifiers via the audio transfer switchboard and the transmitter transfer switchboard. See figure 13-3.

The system signal flow is as follows: The SSB signal is received from the transmitting station with a fully suppressed carrier with only the upper or lower sideband appearing on the air. This RF signal is picked up by the antenna and passed through a multicoupler to the receiver where it is demodulated. The resulting audio signal is then patched to one or more remote radiotelephone units, via the audio transfer switchboard. On the transmit side, the operator's voice generates an audio signal in the handset which is patched to the transmitter via the transmitter transfer switchboard. In order to place the transmitter on the air the operator depresses the push-to-talk button on the handset. This button closes the DC keying circuit in the transmitter placing the transmitter on the air. The DC keying signal and audio signal are patched via the transmitter transfer switchboard to the transmitter where the audio signal amplitude modulates the RF carrier generated by the transmitter. One of the sidebands and the RF carrier is filtered out with only the remaining sideband being transmitted. The RF SSB signals are patched to the antenna through tuners where the signal is radiated.

CW System

CW circuits are usually limited to providing back-up capabilities for other modes of transmission, i.e., SSB, RATT, etc. A typical CW system consists of a LOP (Local Operating Position) which houses a telegraph keying unit and audio phone jacks. The LOP is patched to the transmitter and receiver (audio) patch panels. The transmitter and receiver are usually connected to their respective antennas via couplers and multi-couplers.

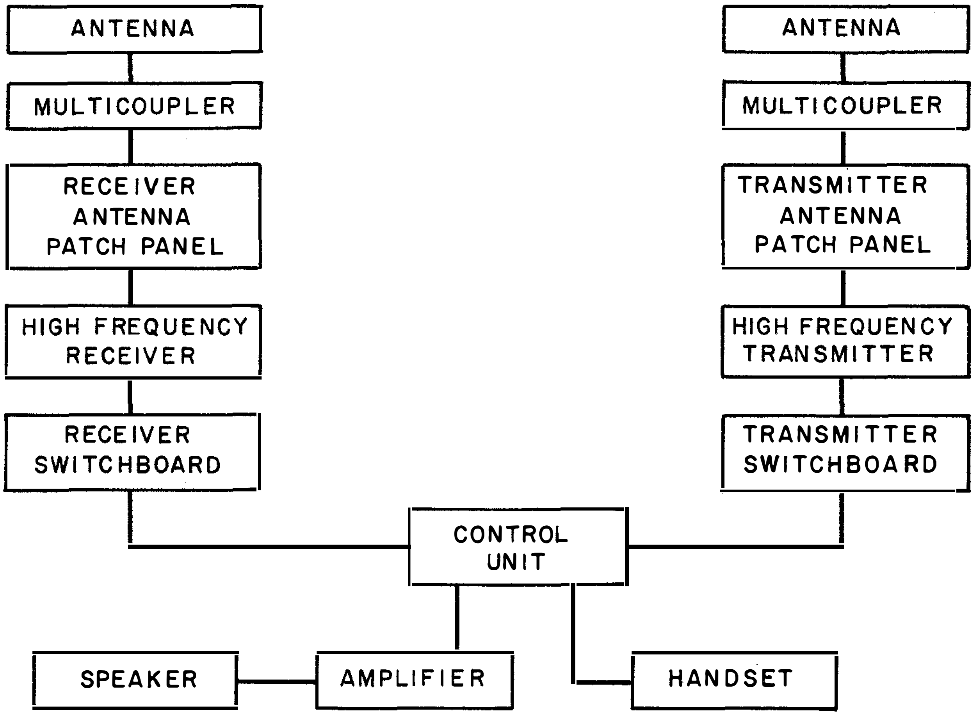

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Figure 13-3.—Voice-HF SSB Circuit, Block Diagram.

The system signal flow is as follows: The operator interrupts the transmitter carrier by turning the transmitter carrier on and off with the telegraph key. The key contacts close and activate a DC keying loop which is connected to a keying relay in the transmitter via the transmitter transfer switchboard. As the carrier is turned on and off, corresponding to the international Morse code, the carrier is generated by the transmitter and radiated by the transmitting antenna. On the receive side, the RF signal picked up at the antenna is patched via couplers to the receiver. The RF signal is demodulated by the receiver and, through a heterodyning process within the receiver, a resulting audio signal is produced. This audio signal output (Morse code) is patched via the audio transfer switchboard (panel) to the LOP.

Facsimile Receive System

This system is generally used to receive weather maps transmitted by certain shore based facilities. The system consists of the receiving antenna system, an HF receiver, a facsimile converter and finally, the facsimile recorder. See figure 13-4.

The system signal flow is as follows: The facsimile signal is transmitted as a frequency-shifted signal. The RF carrier frequency is shifted 400 Hz above and below the nominal carrier frequency for a total shift of 800 Hz. The signal received at the antenna is coupled to the receiver, which may be normal-through or patched to a facsimile converter. The receiver is tuned to the proper frequency and demodulates the RF carrier shifted signal. The result is an audio signal with a "black" signal frequency of 1500 Hz and a "white" signal frequency of 2300 Hz. This audio signal is patched to a converter via the receiver transfer switchboard. The converter changes the audio frequency signal to an amplitude modulated DC voltage. This voltage is normally "hard-wired" (no patching required) to the facsimile recorder where the amplitude variations cause the recorder to "print" a picture which duplicates the transmitted picture.

SECURE SYSTEMS

To greatly improve the security of radio communications, crypto devices are employed

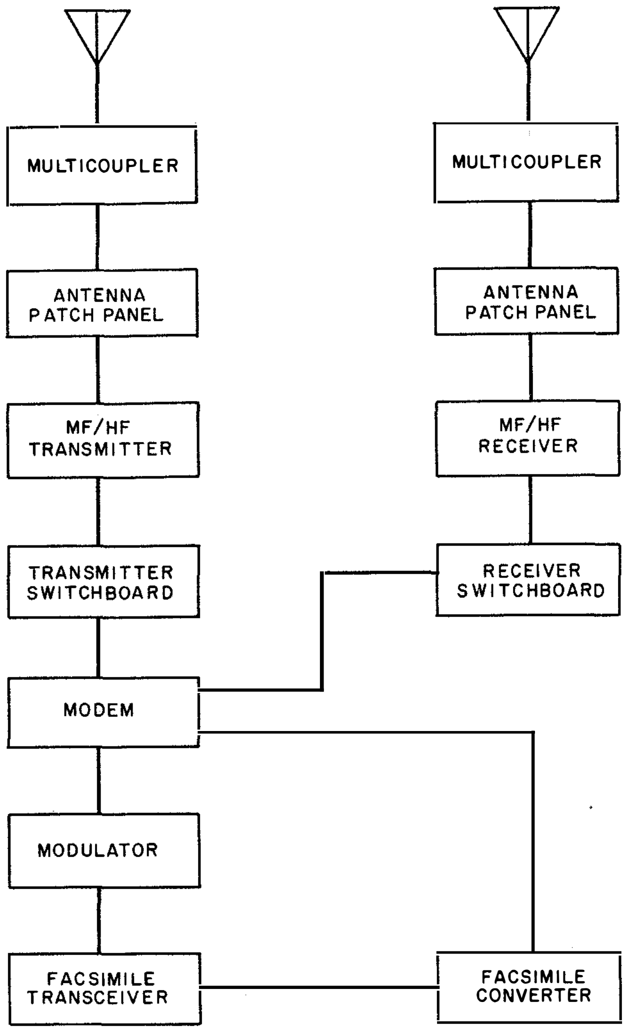

Figure 13-4.—Facsimile Circuit, Block Diagram.

which automatically encrypt or decrypt messages as they are transmitted through the communications system. Depending upon which crypto device and ancillary equipments are employed will determine the type of system. Communications systems employed throughout the Navy have been identified by using letter designations A through Z and some double letters. Discussion of these systems is classified and, therefore, will not be covered in this manual. Every Radioman, however, is encouraged to learn the systems utilized aboard his command.

QUALITY CONTROL MONITORING

Quality monitoring (or technical monitoring, system testing, etc.) has as its goal the determination of communication circuit quality. There is another distinct type of testing which looks at each component of the communication system as a black box. This is called performance testing; the familiar POMSEE program, or its successor, the PMS program. Neither one is a substitute for the other. With quality monitoring you are looking at an operational circuit and grading it by some of the characteristics that relate to quality. In its most simple form, ships have used the signal-strength/readability quotient of QSA/QRK which depends on a seat-of-the-pants judgment. During BASE LINE II (an in-depth study of communications) aboard the USS Eldorado (AGC-11) the Navy installed a half-million dollars worth of test equipment to do quality monitoring. Somewhere in between these two approaches is something that every ship can do—today.

With performance testing we are trying to determine whether a piece of equipment or group of equipments is operating within specified performance standards. In order to do a thorough job of performance testing you should have the following types of test equipment:

- Teletype distortion analyzers
- Audio and RF spectrum analyzers
- Audio and RF noise generators
- Frequency and phase difference meters
- Synthesized frequency generators
- RF and field strength meters
- Various calibrated attenuators
- Fixed filters
- Isolation devices

All of the equipments mentioned above are not generally found aboard ships. There are many pieces of equipment that are on board ship and many others that are now being delivered. Table 13-1 lists test equipment that is, or soon will be, available aboard most ships and could be used for performance testing. Figures 13-5 and 13-6 are two diagrams which show how a ship may use existing equipment to substitute for the frequency generators and meters that must be accurate to within ±1 cycle.

As soon as the type of testing equipment mentioned in Table 13-1 is introduced into the fleet, then the procedures under the PMS maintenance program can be revised into simpler

Table 13-1.—Test Equipment for Performance Testing

TEST EQUIPMENT	ASSOCIATED EQUIPMENT	WHAT IT DOES
DT-603-3 DISTORTION ANALYZER	MUX EQUIP RED, BLACK, TTY LOOPS	MEASURES DISTORTION
TS-1060A DISTORTION ANALYZER	MUX EQUIP, RED, BLACK	MEASURES DISTORTION
AN/URQ FREQUENCY STANDARD	UQC-1, URC-32, URR-7 R-1051, ETC.	MEASURES FREQUENCY
CAQI-522B, AN/USM-207 ELECTRONIC COUNTER	UQC-1, URC-32, WRT-2 R-1051	COUNTS FREQS
CAQI-5245L, CAWI-5253B FREQUENCY CONVERTER	UCC-1, URC-32, URR-2 R-1051	EXTENDS FREQ RANGE OF 522B TO 5000 MHZ
AN/USM-117, USM-105A O-SCOP	ALL	MEASURES WAVE FROM AC/DC VOLTAGE (COMPLEX)
TS-1379/U, AN/URM-35 SSB SPECTRUM ANALYZER	URC-32, WRT-2, R-1051	DISPLAYS A SPECTRUM PICTURE OF AMPLITUDE VERSUS FREQUENCY
CPN-REC-1	TS-1379/U	EXTENDS FREQUENCY RANGE OF TS-1379/U SPECTRUM ANALYZER BELOW 2 MHZ
SG-376 AUDIO TWO-TONE GENERATOR	URC-32, WRT-2	PROVIDES AUDIO TUNES FOR AUDIO AND FSK CIRCUITRY ALIGNMENT
AN/URM-144 RF TWO-TONE GENERATOR	URC-32 (Receiver)	MEASURES SSB DIST.
AN/URM-127 SIGNAL GENERATOR	ALL	GENERATES FREQUENCIES 20 HZ TO 200 KHZ
AN/WGM6V TELETYPE TEST SET	ALL TTY	MEASURES BIAS-DISTORTION
SG-582U OUTPUT TERMINATION	RK-51	GENERATED 75 KHZ TO 30 MHZ
AN/URM-42 RADIO INTERFERENCE MEASURING SET	ALL	MEASURES AMOUNTS OF RFI
TS-2446/UG	ALL TTY	MEASURES VARIOUS TYPES OF TTY DISTORTION

Table 13-1.—Test Equipment for Performance Testing—Continued

TEST EQUIPMENT	ASSOCIATED EQUIPMENT	WHAT IT DOES
LM OR LR	ALL TRANSMITTER AND RECEIVERS	FREQUENCY METER
AN/URM-50	ALL TRANSMITTERS	MEASURES FIELD STRENGTH
AN/FRM-1	ALL TRANSMITTERS	MEASURES FIELD STRENGTH

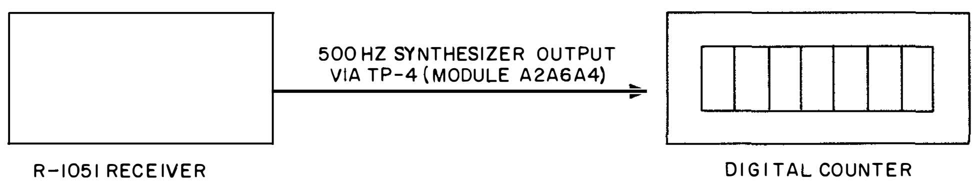

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Figure 13-5.—Frequency Meter with ±1 Cycle Accuracy.

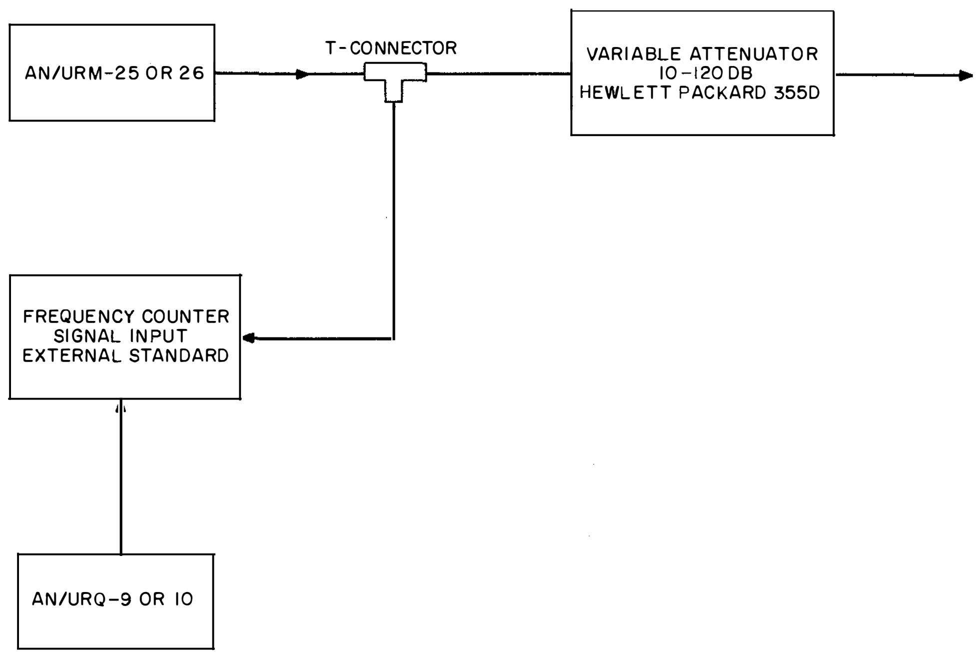

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Figure 13-6.—Signal Generator with ±1 Cycle Accuracy.

and more valid tests. These tests could tend more to the testing of entire systems instead of individual equipments. The basic concepts of the 3M program with the PMS as one element give the fleet a bright hope of being able to locate and maintain defective equipment effectively.

Performance testing will not do the things that a quality monitoring program will do. A good quality monitoring capability could do the following:

a. Assist the Net Control Station by insuring that Transmitting Stations are not degrading a circuit;

b. Detect, identify, and control interference or jamming on a circuit. With fingerprinting techniques it would be possible to identify stations which are practicing deception or violating circuit discipline;

c. Assist maintenance personnel by trouble-shooting malfunctioning transmitter equipment through analysis of transmitted signals;

d. Permit ships to evaluate performance of their receivers by observing the quality of transmitting stations;

e. Reduce the confusion in setting up communication equipment for circuits by eliminating seat-of-pants evaluations of circuit performance by non-technical personnel and substituting quantitative assessment of circuit performance by technical personnel. These technical personnel would be armed with instrumentation instead of opinions; operators could determine their procedures are correct by an immediate evaluation of the results of each procedure.

The same test equipment that is required for performance testing may be adapted for use in quality monitoring. The reason is that the same parameters that give indication of equipment performance also give indication of circuit performance. The difference is that with circuit performance the allowable value and range of these parameters are different. With equipment it is almost a go/no-go situation that any capable technician can measure; with quality monitoring of circuits there is a requirement to interpret the cause and effect of measured values. Additionally, the man doing these interpretations must have the knowledge and experience to determine the action which could be taken to improve circuit quality. This type of man is called a technical controller at shore communication stations and is specially trained and identified by a NEC Code. Each ship would have a man on watch who is either designated or acting as a technical controller. Aboard small ships this same man may also be charged as the watch supervisor. Aboard large ships he may be freed of the requirements to oversee the message processing and distribution functions.

The technical controller, in addition to monitoring the quality of circuits would make all decisions for equipment utilization. In order to perform this function he must be located in the area where circuits are patched and he must also be able to communicate with all equipment spaces and have the authority to order appropriate action by the personnel manning the equipment.

The technical controller will be ineffective unless he can determine circuit quality and thereby check equipment performance. The AN/URM-50 is a field strength meter that has been installed aboard many ships for monitoring radio signals. If your ship does not have a URM-50, you can build one. A field strength meter is nothing more than a receiver with a calibrated attenuator in the antenna lead. Additionally it will have a meter that is calibrated to the AGC voltage. Many ships have an LM frequency calibrated receiver. The one additional piece of equipment which would be useful for quality monitoring would be a calibrated spectrum analyzer. Five hundred spectrum analyzers are now being delivered to the fleet so let's consider this equipment in our quality monitoring installation. Figure 13-7 shows a configuration of equipment that can be built by most ships and used by the technical controller.

If a ship had a complete installation as shown in the figure, the following is a list of what could be accomplished:

a. measure frequency of transmitters to ±1 cycle;

b. measure SSB voice to ±20 cycles;

c. detect and measure over modulation of SSB transmitters;

d. determine own ships transmitter performance;

e. determine own ships receiver performance;

f. detect presence and identification of RFI;

g. determine receiver antenna system performance;

h. detect presence and magnitude of interfering signals on frequencies.

FREQUENCY MEASUREMENT

The R-1051 receiver, when used with a URQ-9 input, is accurate to ±1 cycle, but only

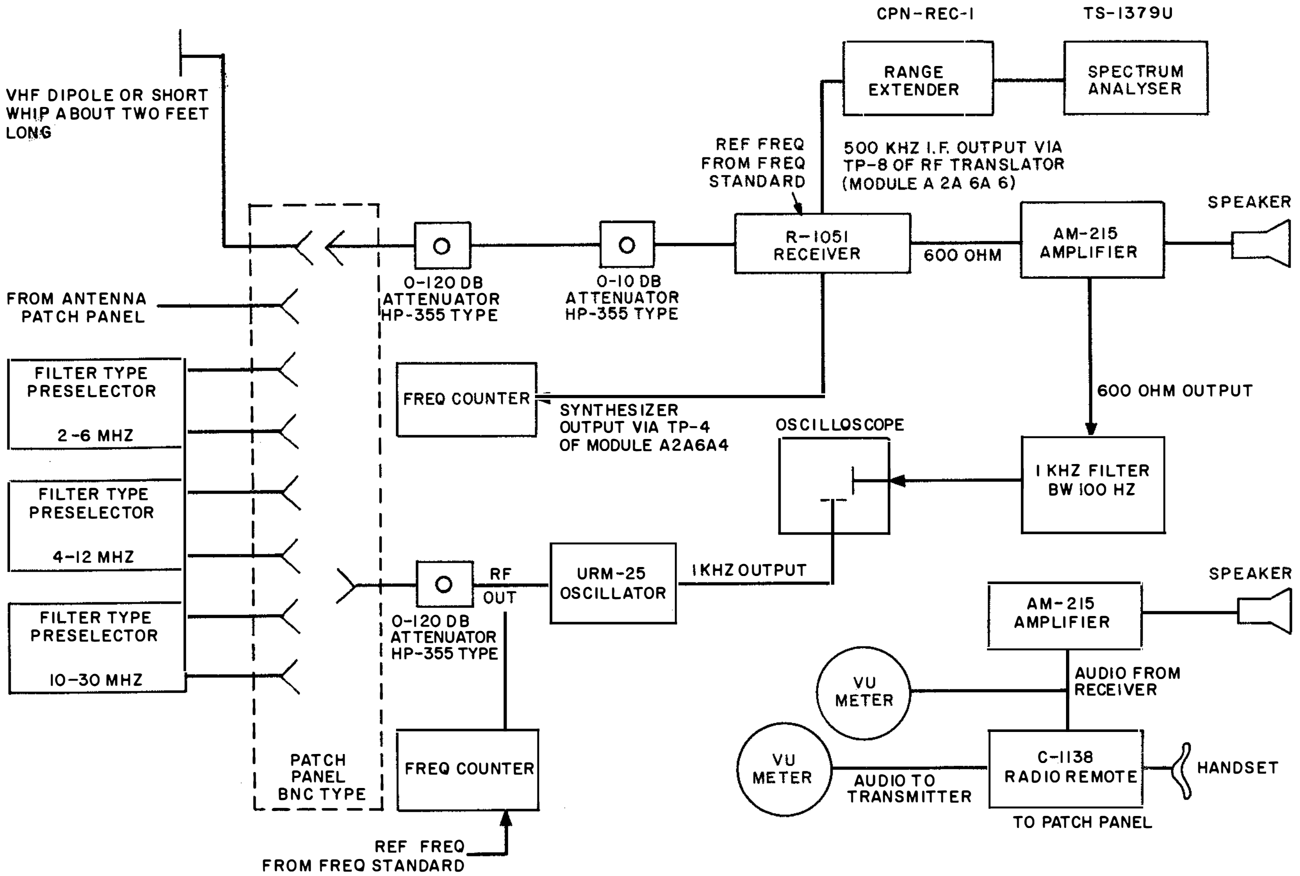

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Figure 13-7.—Quality Monitoring Equipment Arrangement.

in the synthesized mode. If the receiver is in the vernier position the frequency counter operating from the 500 Hz synthesizer can be used to determine frequency.

To determine frequency of the R-1051, subtract 11 kHz from the frequency counter reading and add this to the dial indication on the receiver. The range of the frequency being added as above will be between approximately 200 Hz and ±1200 Hz. If a 1 kHz filter of approximately 50-100 Hz bandwidth is used, an oscilloscope may be used to set the receiver until a stationary circular lissajous pattern is derived on the oscilloscope. This pattern is the result of the signal from the receiver matching the frequency of the 1 kHz from the URM-25 oscillator. The measured tone from the receiver is now 1 kHz higher than the receiver center frequency counter reading. An alternate method is to calibrate the spectrum analyzer display with the URM-25 for either 5 kHz or 10 kHz total sweep-width. The spectrum analyzer can now resolve frequencies to approximately 100 Hz or 200 Hz.

TRANSMITTER PERFORMANCE

Ships that have AN/URM-50 field intensity meters already have a method to check transmitter performance as pertains to power output. The meter indications are a measure of transmitting power output when compared to a meter indication taken immediately after the transmitter was correctly tuned.

The best measure of transmitter performance would be that given by a spectrum analyzer using either a direct sample of the transmitter output or using the I-F frequency output of a receiver. Many types of improper transmitting performance may be detected through spectrum analysis. The use of a spectrum analyzer is also the only foolproof way of either aligning or tuning a single sideband transmitter.

An alternate to the URM-50 is to use a receiver as shown in figure 13-5. In order to prevent the receiver from being overdriven by the adjacent transmitter, the receiver should use an inefficient antenna and an attenuator inserted into the antenna input line of the receiver. The reason for this attenuator is that the RF gain control of the receiver will not prevent overdriving a receiver in the presence of such a strong signal. Two calibrated variable attenuators should be connected in series with the antenna. One attenuator should have a range of 0-10 DB in 1 DB steps and the other 0-100 DB in 10 DB steps. Each attenuator should have a minimum power rating of 5 watts. These attenuators in the antenna lead will permit setting the receiver RF gain control to be around the mid position.

Using the receiver, you can detect overmodulation of the ships transmitters on voice circuits by its characteristic "mushy" sound.

Using the monitor receiver you can determine whether the transmitter is on frequency by setting the receiver to the assigned frequency.

Overmodulation of own ships single sideband transmitters (no matter what emission is actually being used) can be checked by looking for the presence of a large amount of signal due to intermodulation products in the opposite receiver sideband. To accomplish this measurement the receiver should be set for independent sideband reception. The attenuator in the antenna lead should be adjusted so that the receiver front end is not being overloaded. A transmitter should be set for single sideband operation with correct modulation levels being transmitted (no overmodulation). With audio level control for each channel in the same position the difference of audio levels between the two sidebands should be noted as the indication of correct transmitter operation. This difference should be approximately 30 db. The measured difference of audio levels between sidebands for various types of modulation should be noted and used as limiting criteria to determine correct modulation of single sideband transmitters. These same type readings can be taken directly off a spectrum analyzer display if a spectrum analyzer is available.

The position of the attenuator setting on the transmitter frequency gives an indication of power output in the same way as was previously explained for the AN/URM-50.

The case of undermodulation of any transmitter is difficult to determine except as provided by meter indications on the transmitter. To determine whether these transmitter meter indications are correct, a procedure may be used wherein the modulation level is increased until overmodulation is determined by a spectrum analyzer.

The transmitter audio level input may be monitored by instrumenting a remote control unit with a VU meter which has a high input impedance. Over and undermodulation of transmitters may be controlled through a number of remote control units. This is particularly the case where many different types of handsets are being used.

RECEIVING ANTENNA SYSTEMS

Receiving antenna performance can be best checked by comparing one antenna against another while receiving the desired signal. To accomplish this measurement, the calibrated variable attenuator placed in the antenna input of the receiver should be adjusted to produce equal receiver output indications using different antennas. The difference between these attenuator settings gives indication of relative performance of different antennas. Differences of 6 to 10 db can be expected due to such things as antenna patterns, length of antenna coax cable, number of receivers on the antenna, and varying frequency response characteristics of various antenna types. Differences of above 10 db should cast suspicion on the receiving antenna.

RECEIVER SYSTEMS

The same monitor receiver as used in previous procedures can be used as a standard against which other receivers may be checked. Since this receiver is used as a standard its sensitivity and alignment should be checked on a periodic basis.

The attenuator in the antenna lead can be used to determine if any observed distortion is being caused by desensitization of the receiver due to adjacent transmitted frequencies.

The filter type preselectors may be used to evaluate causes of receiver interference. The method used is to notice if the filter reduces interference detected by the receiver. If this is the case the interference is being caused by inter-modulation within the receiver. This condition would be most likely due to the strength of signals coupled from the ship's transmitting antenna. If the filter does not have a significant effect on interference detected by the receiver, then the ship's transmitters should be turned off for an instant to determine if RFI is being generated in the topside environment of the ship.

SPECTRUM ANALYSIS

By using a spectrum analyzer a knowledgeable operator can determine the quality and reasons for improper communication circuits. Some examples are:

a. Excessive "hash" appearing adjacent to the received signal indicates overmodulation of the transmitter;

b. Missing channel in MUX signals show up as gaps in the spectrum;

c. Attenuation within the passband of a transmitter can be measured as difference in level across the spectrum;

d. Improper level adjustment of the re-inserted carrier in Amplitude Modulation Equivalent (AME) and A3B emissions can be detected;

e. Interference of various types have characteristic displays and therefore can be identified;

f. Rough frequency measurements can be measured;

g. Emission modes may be identified;

h. Amount of frequency shift of FSK signals can be measured;

i. Signal + noise divided by noise ($S + N \div N$) value of received signals can be estimated;

j. Instability in transmitted frequencies can be detected.

TELETYPE SIGNAL QUALITY

The quality of received teletype signals may be determined by using a teletype distortion meter on the Black teletype loop. Distortion readings on the classified portion of a teletype net will not give indication of received signal quality. The distortion meter must be set for the correct baud rate and readings of average bias distortion and peak bias distortion should be made. Good circuits will have average distortion of 10%, or less. Peak distortion readings in excess of 40% are indications of "hits" on the circuit.

TELETYPEWRITER DISTORTION

As pointed out earlier in the chapter, the technical controller's primary responsibility is to provide the highest quality circuit performance possible. To do this, he must learn to interpret circuit performance through distortion measurements of teletypewriter signals.

The primary consideration, of teletypewriter signals, is that the signal element must arrive at the receiving device at precisely the correct time. An ideal teletypewriter circuit reproduces signals at the receiving end exactly as they are impressed at the sending end. Unfortunately, this seldom happens under actual operating conditions, for signal units have a way of lengthening and shortening as they travel. This lengthening and shortening of marks and spaces occurring during transmission reduces the quality of the signal, and is called distortion.

Fundamentally, there are four types of distortion which adversely affect the fidelity of teletypewriter signals; these are bias, fortuitous, characteristic, and cyclic distortion.

BIAS DISTORTION

Bias distortion is the uniform lengthening or shortening of the mark or space elements, one at the expense of the other. This means that the total time for one mark and one space never changes; only the length of the mark or space element changes. If the mark is lengthened, the space is shortened by the amount the mark is lengthened. Bias distortion may be caused by maladjusted teletypewriter line relays, detuned receivers, or a drift in frequency of either the transmitter or receiver.

FORTUITOUS DISTORTION

Fortuitous distortion is the random displacement, splitting or breaking up of the mark and space elements. It is caused by cross-talk interference between circuits, fading, atmospheric noise, momentary battery fluctuations, poorly soldered connections, lightning storms, dirty keying contacts and such similar random disturbances. Actually, any minor break in signal elements is properly called fortuitous distortion, but the duration or length of such breaks may be so short as to go unnoticed.

CHARACTERISTIC DISTORTION

Characteristic distortion is distortion which is characteristic of either line trouble or equipment trouble. Line characteristic distortion is the result of the received signal impulses being affected by changing current transitions in wire circuits. Equipment characteristic distortion is the repetitive displacement or disruption peculiar to specific portions of the signal; normally caused by maladjusted or dirty contacts of the sending equipment. Equipment characteristic distortion can also be introduced at a regenerative point or the receiving point.

Characteristic distortion is often mistaken for fortuitous distortion, but characteristic distortion is repetitive, not random. An example would be the repeated characteristic splitting of the third code element of a teletypewriter signal—as opposed to the random splitting of several or all of the elements of a signal.

CYCLIC DISTORTION

Cyclic distortion is produced by a variety of causes. Although this type of distortion is periodic in nature, it is most likely to be recognized as fortuitous distortion. Cyclic distortion is often one of the most difficult types to eliminate. Some of the causes are poor filtering of AC components from power supplies, crosstalk from adjacent channels and arcing of relay contacts at repeated intervals.

TROUBLESHOOTING

Troubleshooting techniques are based upon a systematic approach to a given problem. When circuit outages occur, the prime concern is to restore the circuit as soon as possible. Circuit outages are caused by failure of the radio path or by failure of equipment. When equipment fails, the faulty equipment must be located and repaired or replaced. Replacement of equipment may be limited by patching facilities. For example, teletypewriter equipment is frequently hard-wired (permanently wired) to the crypto equipment. If either equipment fails, it must be physically removed and replaced with similar equipment or a patch made to substitute a different teletypewriter/crypto combination. It is necessary, therefore, that Technical Controllers know their patching capabilities.

CHAPTER 14
MAINTENANCE

As a Radioman you are not expected to do the type of maintenance performed by an Electronics Technician. You must, however, be able to record inventory data, complete work logs and reports, and assist in obtaining part and stock numbers from applicable technical publications. Moreover, you are required to perform routine maintenance on teletypewriters and typewriters.

Basically there are two types of maintenance. (1) Preventive Maintenance includes regularly scheduled actions taken to reduce or eliminate failures and to prolong the useful life of equipment. (2) Corrective Maintenance includes the repair of failures which have occurred because of aging components, through accident or other causes.

Maintenance is further divided into levels. The department of defense, including the Navy specifies three separate levels of maintenance.

1. Organizational level.—Organizational level maintenance is performed by the using activity. In some cases (i.e., small craft) the organizational level maintenance is performed through outside assistance and yet retains the organizational level catetory.
2. Intermediate level.—Intermediate level maintenance is that maintenance which is performed by tenders and shore repair facilities. A user may also be designated to perform its own intermediate level maintenance. An example of this would be a tender using its own repair department to effect ship repairs.
3. Depot level.—Depot level maintenance is performed by Naval Ship Yards or civilian repair activities. The specific difference between Intermediate and Depot level maintenance is that at Depot level you are referring to facilities who have the capability to undertake major overhaul work beyond the ability of a tender or repair facility.

Although the line is not always clearly drawn between the three levels of maintenance, and there may be certain exceptions, it is intended that organizational level maintenance be performed by personnel assigned to the organization and other maintenance work be accomplished by employing the services of specialists.

As a Radioman your hand in maintenance will be limited to operational use, manipulation, and operational maintenance of electronic equipment associated with the technical specialties of your rate. These portions of preventive maintenance will be of a nature as not to require equipment alignment after maintenance has been accomplished.

All other maintenance will be handled by the specialists having the adequate facilities to undertake the specific job.

PREVENTIVE MAINTENANCE

Preventive maintenance is defined as the care and servicing by personnel for the purpose of maintaining equipment and facilities in satisfactory operating condition by providing for systematic inspection, detection, and correction of failures, either before they occur or before they develop into major defects. This form of maintenance consists principally of cleaning, lubricating, and periodic testing aimed at discovering conditions which, if not corrected, may lead to malfunctions.

To realize optimum results from the regular functional tests, a careful record of the performance data on each equipment must be kept. Comparison of data taken on a particular equipment at different times may reveal slow, progressive drafts that may be too small to show up significantly in any one test. While the week-to-week changes may be slight, they should be followed carefully so that necessary replacements or repairs may be effected before the margin of performance limits is reached. Any marked variations should be regarded as abnormal and should be investigated immediately.

Such an approach to preventive maintenance leads to maximum operational readiness of the equipment aboard your ship. Your contribution to the preventive maintenance program will be made through the 3-M System.

THE 3-M SYSTEM

The growing complexity of electronic equipment, increased tempo of fleet operations and the constant decline of available resources made it impossible for previous PM systems to control and accomplish required maintenance. The Maintenance, Material and Management (3-M) system was implemented in the Navy in an attempt to solve these problems and to provide a more adequate system of collecting information required to support equipment improvement projects. The 3-M system was designed to function as an integrated system which would improve the management of maintenance and provide for the collection and dissemination of maintenance related information. It is emphasized that 3-M is not a passive system and will not operate by itself. The key to success is active and aggressive supervision at all levels in order to achieve a high degree of combat operational readiness.

The 3-M system is composed of two subsystems, the PMS (Planned Maintenance Subsystem) and the MDCS (Maintenance Data Collection Sub-system); and will contribute significantly toward achieving improved readiness with reduced expenditure of resources.

The planned Maintenance Sub-system (PMS) pertains to the planning, scheduling and management of resources (men, material and time) to perform those actions which contribute to the uninterrupted functioning of equipment within its design characteristics. It defines uniform maintenance standards and prescribes simplified procedures and management techniques for the accomplishment of maintenance. The Maintenance Requirement Card (MRC) scheduals, describes and lists tools, materials and test equipment necessary to perform the minimum maintenance required on a specific piece of equipment. The Maintenance Data Collection Sub-system (MDCS) provides a means for recording the expenditures of resources (men, material and time) associated with certain categories of maintenance action. MDCS success is dependent on the accuracy, adequacy and timeliness of the information reported into the system by the radiomen. In addition, the system provides data concerning the initial discovery of a malfunction, how the equipment malfunctioned, how many man-hours were expended, which equipment was involved, what repair parts and material were used, what delays were incurred, the technical specialty or work center that performed the maintenance. MDCS reporting on OPNAV Form 4790/2K incorporates the use of coded data elements, for data standardization and facilitating automatic data processing. These codes and other amplifying information are contained in the 3-M Documentor's Handbook OPNAV 43P5.

ANTENNA MAINTENANCE

The worst enemy of shipboard antenna installations is ignorance of simple, basic facts concerning common sense care and maintenance. Generally, antennas require not more care than the body and paintwork of a fine automobile. Common enemies are salt spray and stack soot. They cause corrosion that eats into the antennas, mounting brackets, and associated hardware. They also cover the installations with salt and soot deposits, which, if allowed to accumulate, may short the antennas to ground by providing a path for current flow across insulators.

Careless painting is another cause of trouble in antenna systems. Paint that has a metallic base is a good conductor of electricity, and if enough of this paint is smeared or spattered on an insulator, it will short the antenna in the same manner as salt and soot deposits.

Antenna maintenance consists mainly of simple visual inspections for physical damage and resistance tests for leakage resistance or insulation breakdown.

VISUAL INSPECTIONS

At frequent intervals (usually during upkeep periods), lower all wire antennas to the deck and inspect them thoroughly for damage. Pay particular attention to points that are subjected to strain and chafing. These points are where supporting clamps attach to the antennas, and where the antennas connect to trunks or transmission lines. Insulators also are subjected to considerable strain and must be checked for cracks and other signs of deterioration.

While the antennas are down, they should be cleaned to remove salt and soot deposits. Uninsulated transmitting antennas are wire-brushed, whereas insulated-type receiving antennas are merely wiped clean with a cloth. (Insulator cleaning is discussed under a separate topic.) Take care not to nick or kink the antennas because this condition weakens them.

After each cleaning, uninsulated antennas should be coated with a corrosion-preventive compound. All antenna fittings, such as ringbolts, shackles, and turnbuckles, also should be coated with the compound. Satisfactory compounds are Hard-Film Corrosion Preventive and Gun Slushing Compound, Grade B.

Whip antennas usually can be inspected without being lowered. Look for rust spots, loose mounting bolts, and loose or frayed connections. As with wire antennas, check all insulators for chips, cracks, and cleanliness.

Most whip antennas are hollow and may collect moisture inside, depending upon how they are mounted. This condition does not affect their efficiency, but it does contribute to their physical deterioration. To prevent whip antennas filling with water, a normal procedure is to drill a small drainage hole near their bases.

Maintenance of VHF and UHF antennas is complicated by their inaccessibility. Often it is necessary to climb masts or stacks to inspect them properly for damage. For this reason, they sometimes are neglected until a major casualty occurs. These antennas are as susceptible to rust, loose mountings, and broken connections as are other antennas, and therefore must be inspected regularly.

Technical manuals for the various types of VHF/UHF antennas are available, and should be utilized when checking and maintaining antennas. These manuals are relatively simple to follow. A few moments guidance from a senior PO will "make you an expert." Do not forget your basic hand tool knowledge.

Rusty Bolt Effect

The shipboard environment possesses all the necessary elements required to produce a harmonic generating and mixing system. The elements are present in the complex ship structures, appendages, and other objects that are found in the topside areas in which intense 4-f fields are present. The r-f signal produces standing waves on portions of the structures, and, if a corroded joint or oxidized fastening exists, rectification occurs to some extent. Intermodulation products created by the nonlinear junctions existing in the ship structures are commonly called the "rusty bolt" effect.

The rusty bolt effect can be reduced considerably by a combination of good design and maintenance practices. A primary electronic design consideration is to make the topside areas a single conducting structure, devoid of miscellaneous obstructions such as stanchions, metal or pipe-rack holders, metal storage bins and cabinets, metal spare parts boxes, booms, vehicles, and all metallic objects not absolutely essential to ship operation. These considerations ensure an effective ground plane for the antennas and also tend to keep induced hull currents and voltages at the same potential. Required appendages such as rigging, lifelines, handrails, stanchions, and ladders, which are exposed to the weather elements, should be constructed of suitable nonmetallic materials, where applicable. Nonmetallic materials are impervious to r-f voltages and, in general, to the rigors of weather corrosion. Where structures must be metallic, permanent joints should be welded or brazed to keep the structure at hull potential. If flexibility of the joint is required, a good bonding strap must be installed across the joint. These items should be checked during shipyard repairs or modifications. Hull and superstructure maintenance should be aimed at keeping the hull and structures free of corrosion formations and loose joints.

CLEANING INSULATORS

Antenna insulators have a glazed surface to which foreign material does not adhere readily. The glazed surface tends to wash clean during rainstorms. Although helpful, an occasional rain cannot be depended upon to keep insulators free of salt spray, soot, and dirt. For this reason, antenna insulators should be cleaned at least once a month, and more often when conditions warrant—as after a prolonged period at sea.

Cleaning insulators is a simple process. Use a sharp knife and a small amount of paint thinner to remove any paint that may be on the insulators. Wash them with soap and water, and follow with several rinsings with clean, fresh water. Insulators then should be polished with a dry, soft cloth to restore their glaze.

Although the cleaning is a simple process, the importance of doing a thorough job cannot be overstressed. Only one dirty insulator is needed to render an antenna useless.

PAINTING ANTENNAS

The main purpose of painting antennas and antenna hardware is to protect them against corrosion. If the paint is permitted to deteriorate, its purpose is defeated and rust soon takes over. Usually, an occasional touchup job is all that is necessary to keep rust from getting the upper hand.

Isolated rust spots should be treated as follows: (1) wire-brush the spots to remove all rust and loose paint; (2) wipe the surrounding surfaces clean of all soot, salt, and dirt; (3) apply one coat of wash primer pretreatment to the bare metal surfaces; (4) apply one coat of zinc-chromate primer over the pretreatment paint; and (5) cover the preceding coats with not less than two coats of outside haze-gray No. 27.

The foregoing procedure applies also when the extent of damage warrants complete repainting. When only the finish coat is damaged, and there is no sign of corrosion, a thorough cleaning and application of one or two coats of the outside haze-gray paint is sufficient to repair the damage.

Never paint an antenna with a metallic paint. Paint containing metallic flakes attenuates (weakens) electromagnetic energy. Alone the same line of thought, never paint, varnish, shellac, or grease any insulating material forming a part of an antenna system--especially insulators. As pointed out previously, metallic paint provides a path for current flow across the insulating material, or attracts foreign substances.

ANTENNA COLOR CODING

Generally accepted throughout the Navy is the system of antenna color coding. All transmitting antennas are identified by the color red and receiving antennas by the color blue. Most ships paint the mounting brackets for the antenna insulator with the appropriate color.

SAFETY PRECAUTIONS WHILE WORKING ON ANTENNAS

Chapter 9670 of the Naval Ships Technical Manual calls for the following precautions to be observed when working on antennas.

1. Personnel shall not be permitted to go aloft while antennas are energized by electronic equipment except by means of ladders and landings rendered safe by grounded hand rails or similar structures unless it is definitely determined in advance by suitable tests that no danger exists. This will prevent casualty resulting from involuntary relaxation of the hands which might occur if a spark is drawn from a charged piece of metal or section of rigging. The spark itself might be quite harmless. The voltages, or resonant circuits, set up in a ship's structure or section of rigging will cause shock to personnel or produce open sparks when contact is broken, or when momentarily in contact with a metallic object. Personnel of the deck force or others working on rigging shall be warned regarding the hazards which may exist and the precautions to be observed. Safety belts shall be employed when working aloft to guard against falls.

2. The above precautions should be observed when other antennas in the immediate vicinity are energized by electronic transmitters unless it is definitely known that no danger exists. Other antennas may be interpreted to mean any antennas on board another ship moored alongside or across the pier or at a nearby shore station.

3. There is serious danger to man aloft from falls caused by radar or other antennas which rotate or swing through horizontal or vertical arcs. Motor switches controlling the motion of radar antennas shall be tagged and locked open before men are allowed aloft within dangerous proximity to such antennas. It also must be borne in mind that deenergizing main supply circuits by opening supply switches, circuit breakers, or circuit switches will not necessarily disable all circuits in a given piece of equipment. A source of danger that often has been neglected or ignored, sometimes with tragic results, is the inputs to electronic equipment from other sources, such as synchros, remote control circuits, and the like. For example, turning off the antenna safety switch will disable the antenna, but it may not turn off the antenna synchro voltages from the ship compass or stable elements. Moreover, the rescue of a victim shocked by the power input from a remote source often is hampered because of the time required to determine the source of power and turn it off.

4. No non-Navy radio should be connected to a shipboard antenna. Many cases of burned-out receiver antenna coils have been a result of someone connecting a commercial receiver to a ship receiving antenna. By this means, it is possible to put the ship antenna at 120 volts above ground, thus creating a threat to someone's life and a hazard to equipment. The placement of a capacitor in series with the

commercial antenna will not prevent the voltage from reaching the shipboard antenna because an a-c voltage is involved. Also, commercial receivers are likely to radiate and thus create an interference problem.

STACK GAS WARNING

Personnel servicing equipment aloft are further cautioned to guard against the poisonous effects of smoke pipe gases. Besides smoke particles and noxious fumes, stack gases also contain carbon monoxide. Although the possibility is remote that this gas would build up to high concentrations in the open, the results of prolonged exposure to even small concentrations can be lethal. Stack gases sometimes give no warning and can cause illness, loss of consciousness, or even death as a result of a fall from the mast. To prevent personnel from being overcome by these gases, certain precautions should be observed.

1. Warning signs should be posted and located so that they are in full view of personnel required to service equipment. It is recommended that one sign be located below, near the access ladder, and another aloft at the servicing platform.
2. Oxygen breathing apparatus should be used. Because of its small size and weight, the type-B oxygen breathing apparatus, NavShips No. S-23-B 69855 is best suited for this work. Personnel who are required to service equipment aloft in the vicinity of stack gases and who are unfamiliar with oxygen breathing equipment should be instructed in its use by trained personnel.
3. As a further precaution, a telephone chest or throat microphone set should be worn for communication with others in the working party. The working party should always include at least one man (stationed below) who is required to wear his phones and stand watch on the sound-powered telephone circuit as long as a man is working aloft.
4. Make sure to obtain all necessary equipment before going aloft.

SAFETY PRECAUTIONS FOR MAST WORKERS

A safety belt should be worn at all times by mast workers. The safety belt should be of the approved type, and should be tested periodically for its rated load. These belts should be attached to a strong permanent support, preferably the mast itself. A tool belt should be worn, and care should be taken to prevent tools from falling. It is recommended that all handtools be tied to the belt with a length of wire or string of sufficient length to permit ease in working. Wherever possible, work should be done from a scaffold or working platform. If a small job is to be performed on the mast, it may be found that the use of a "bosun's chair" is a safer and more economical method than construction of a scaffold.

CLEANING ELECTRONIC EQUIPMENT

All electronic equipment should be cleaned, not just for appearance, but to assure good performance. Before starting any kind of cleaning be sure to secure power to equipment and discharge all capacitors to ground. The safest and best method of cleaning inside transmitters and receivers is to use a vacuum cleaner with a nonmetallic hose. A small typewriter brush is handy for getting dust out of congested areas where the vacuum cleaner will not reach. A hand bellows can be used for blowing out dust particles, but is not as satisfactory as the vacuum cleaner because of the likelihood of blowing dust into inaccessible spaces where it is harder to remove.

During routine transmitter cleaning periods, the contacts of rotating inductors should be checked, as well as the surface of these parts. Poor operation of contacts is disclosed sometimes by erratic "jumping" of the plate current meters as the circuit is tuned through resonance. Both the contacts and the surface of the inductors must be clean and smooth. A tiny amount of petroleum grease may be applied if necessary to prevent scoring the copper surface.

Steel wool or emery in any form must not be used on electronic equipment. Sandpaper and files may be used only on competent guidance, or not at all.

Uses of solvents and their necessary safety precautions are discussed in chapter 15.

MAINTAINING AIR FILTERS

The cleaning of air filters is exceedingly important for the proper operation of electronic equipment. For some reason (perhaps their importance is not fully recognized), filters often are neglected or disregarded until excessive heating causes a breakdown of the equipment.

Forced air cooling is used in most modern transmitters and receivers. This type of cooling system moves a large volume of air over the hot portions of the equipment. The air is filtered to keep dust and other foreign particles out of the equipment. If the filters are efficient, they remove most of this foreign material from the air that passes through them. Dust and dirt tend to clog the filter and prevent the air from moving through. The result is that the equipment becomes overheated and may be ruined.

An analysis of the failures of parts in electronic equipment indicates that the majority of failures can be traced to excessive heat caused by dirty air filters. Obviously, then, the maintenance man can reduce his workload substantially by ensuring that air filters are serviced properly.

TELETYPEWRITER PREVENTIVE MAINTENANCE

Use of the equipment technical manual is required for proper preventive maintenance on teletypewriters. The scope of the information contained in the technical manual is indicated in ensuing topics.

Preventive maintenance is applied for the purpose of detecting and correcting troubles before they develop to the point of interference with satisfactory operation of the teletypewriter equipment. Proper lubrication--but not overlubrication—is an important preventive maintenance measure. When work on equipment is necessary, use care to avoid introducing trouble.

A thorough visual inspection of equipment during periodic checks may uncover conditions that could possibly cause trouble later. Appearance of oxidized (red) metal dust adjacent to any bearing surface indicates insufficient lubrication. Adjustable clearances of working parts should be observed also.

A visual examination should be accompanied by a manual test. Connections at terminal boards should be checked for tightness. Vibrations sometimes loosen these connections just enough to give intermittent troubles that are difficult to locate. Nuts and screws that lock adjustable features should be observed carefully for looseness, and should be tightened if necessary. While cleaning the units, care should be exercised to avoid damage or distortion to delicate springs that might weaken their tension. Electrical contact points should be kept free and clear of dirt, oil, corrosion, or pitting. Check that operating clearance is maintained when a contact is cleaned.

LUBRICATION

More than 60 pictures and diagrams in the equipment technical manual illustrate lubrication points of the AN/UGC-6 teletypewriter. In addition to points to be lubricated, technical manual pictures show the type and quantity of lubrication to use. A new teletypewriter should be lubricated before it is placed in service for the first time. After a few weeks in service, relubricate to make certain that all points are lubricated adequately.

Lubrication Schedule

A teletypewriter must be lubricated more frequently as operating speed increases. Thus, a machine geared for operating speed of 100 wpm requires lubrication more often than one operating at 60 wpm. Here is the recommended lubrication schedule:

Operating speed (words per minute)	Lubricating interval (whichever occurs first)
60	3000 hours or 1 year
75	2400 hours or 9 months
100	1500 hours or 6 months

Regarding the lubrication interval, an important point to remember is the words "whichever occurs first." To illustrate, a machine in continuous use at 100 wpm will accumulate 1500 operating hours in only 2 months. For machines used occasionally or intermittently, some kind of log is needed to keep track of total operating hours.

OPERATOR'S EMERGENCY MAINTENANCE

Even though some teletype operators may have received no maintenance training, they can be authorized to perform emergency maintenance to the extent of replacing fuses and lamps.

Symptoms of Fuse Failure

Maintenance lamps	Keyboard motor	Reperforator motor	Blown fuse	Value (amps)	Comments
Out	Off	Operating	F800	6.25	In power distribu-tion panel.
On	Operating	Off	F2300	4	On typing reperfora-tor base.

WARNING: Never replace a fuse with one of higher rating except in emergency or battle condition when continued operation of equipment is more important than possible damage.

If a fuse burns out immediately after replacement, do not replace a second fuse until the cause is corrected.

Fuse Location

Reference designation symbol	Location	Protects	Amps	Volts
F800	In power distri-bution panel	Main a-c supply	6.25	250
F2300	On typing re-perforator base	Reperfora-tor a-c supply	4	250

Lamp Replacement Data

Reference designation symbol	Function	Location	Volts	Watts	Amps	Base
I4250	Maintenance and copy illumination	Left of right front cabinet dome door.	6-8	6	1.14	Bayonet, double contact
I4251	. . . . do	Right of right front cabinet dome door.	. do .	. do .	. do .	Do.
I4252	. . . . do	Left front door of cabinet dome.	. do .	. do .	. do .	Do.
I4350	. . . . do	Right front end of cabinet dome.	. do .	. do .	. do .	Do.

Fuses

Power circuits of the AN/UGC-6 teletypewriter are protected by two cartridge-type fuses. The main fuse for the basic equipment is on the right end of the power distribution panel under the cabinet dome behind the keyboard. A separate fuse for power circuits of the typing reperforator is located on the terminal board bracket to the left of the printing unit on the typing reperforator base. Fuse location and symptoms of failure are summarized in the accompanying tables.

Lamp Replacement

Four bayonet-type lamps for the AN/UGC-6 teletypewriter are located beneath the cabinet dome. Maintenance and copy illumination lamps are 6-volt lamps in a circuit supplied by a transformer at the rear of the cabinet. These lamps are installed on either side of the right front dome door and above the typing perforator (three lamps) and the margin indicator or end-of-line lamp (one lamp) at the extreme right of the dome. All lamps are accessible when the dome is raised. The accompanying lamp replacement data table gives the location and electrical characteristics of lamps.

TYPEWRITER PREVENTIVE MAINTENANCE

Your typewriter may be heavy and rugged looking, but it is really a delicate instrument. Treat it like one and give it daily care. A machine in first class condition is easier and quicker to operate and turns out better-looking work.

Observe the following routine procedures:

- Be sure your typewriter is properly placed on the desk, or secured to the well type of desk, so that it will not fall.
- In lifting a typewriter, grip it by its case, NEVER by its carriage.
- Keep your typewriter covered when not in use. Always cover it or close it into the desk at the end of the day.
- Keep it clean by wiping the outside with a soft dry cloth and dusting the inside with a long-handled brush.
- Clean the type daily with a stiff brush, and it seldom will be necessary to use chemicals.
- Take care in erasing to move the carriage to one side so that erasure crumbs will not fall into the mechanism.

At regular intervals you should give the typewriter a more thorough cleaning. Frequency of these cleanings will depend on the amount of use the typewriter receives and the amount of dust in your office atmosphere. In general, it is recommended that the following procedures be carried out weekly:

- Clean the carriage rails and marginal stop bar, using a cloth slightly moistened with oil. Move the carriage back and forth in the process.
- Clean the platen or cylinder. Remove, if possible, and wipe with a cloth moistened with a very small amount of denatured alcohol or cleaning fluid. Do not wipe off; allow fluid to evaporate.
- Clean type, using a short-bristled type brush. Tap lightly with the points of the bristles to loosen the dirt; then brush up lightly.
- Brush type bar segments and dust the interior of the machine. Use a long-handled brush, brushing toward the front of the machine. By elevating a few type bars at a time, you can reach into the mechanism. DO NOT FORCE THE BARS. Use a soft cloth alternately with brush.
- Wipe the sides and back of the machine. Always clean the typewriter before cutting a Mimeograph stencil. If the typewriter ribbon lever is set for stencils (usually a white dot on the machine), both the type and the ribbon will be cleaner than otherwise.

If operating instructions for your typewriter are available, they will help you identify parts and give you additional information about care.

If further oiling or repair work is needed, the machine should be turned over to a typewriter mechanic.

Maintaining Headphones and Microphones

The best way to maintain headphones and microphones is to ensure that they are handled properly. Proper handling includes hanging up headphones by their straps, not by the cord; removing a plug from a jack by grasping the plug, not the cord; avoiding kinks or other strains in in the cord; avoiding rough handling of microphones and headphones; and avoiding exposure to moisture. Carbon microphones may be dried out with heat lamps; periodic heating may prevent accumulation of moisture.

NOTE: Do not blow into a microphone. This practice is resorted to much too often when testing a microphone. This practice should be avoided to ensure longer life for the microphone.

Repair of headphone and microphones consists largely of replacing or repairing plugs, jacks, and cords. Always try to repair defective equipment first. If you are unable to repair defective equipment, tag it as defective and then use ready spares. When time permits, see that defective phones are repaired.

Repairs to microphones are simple if one knows how to solder. The proper techniques of soldering is covered in detail in Basic Hand Tools, NavPers 10085 and Basic Electricity, NavPers 10086. Consulting the technical manual for a particular headset or microphone to determine the proper pin hookup will also aid in repairing phones.

CHAPTER 15

SAFETY

When working with radio, or with any electronic equipment, one rule that must be stressed strongly is: SAFETY FIRST. Dangerous voltages energize much of the equipment with which you work. Power supply voltages range up to 40,000 volts, and radiofrequency voltages are even higher.

Special precautions are also necessary because electrical fields, which exist in the vicinity of antennas and antenna leads, may introduce fire and explosion hazards, especially where flammable vapors are present. Additional precautions are needed to warn personnel working aloft to prevent injuries from falls and stack gases.

Safety precautions outlined in this chapter are not intended to supersede information given in instruction books or in other applicable instructions for installation of electronic equipment. Additional safety information is contained in NAVSHIPS Technical Manual, and Test Methods and Practices (EIMB), NAVSHIPS 0967-000-0130 (section 1-15).

Check these sources before touching the equipment. If at any time there is doubt about the steps and procedures you should observe while working on electronic equipment, consult the technician or Radioman in charge.

Danger signs and suitable guards are provided to warn and prevent personnel from coming into accidental contact with high voltages. The warning signs shown in figure 15-1 are posted on or near every radio transmitter, transmitting antenna lead-in trunks, and in radar rooms and other electronic spaces throughout the ship. The signs are painted red to make them more conspicuous. Additional signs warn against such hazards as explosive vapors and effects of stack gases aloft. Look for warning signs and obey them. Notify your supervisor if a dangerous condition exists for which no warning sign is posted.

FUNDAMENTALS OF ELECTRIC SHOCK

One of the greatest safety hazards for Radiomen is electric shock. In order to avoid this hazard, an understanding of its causes and effects is necessary.

If a 60-hertz alternating current is passed through a man from hand to hand or from hand to foot, the following effects occur when current is increased gradually from zero.

1. At about 1 milliampere (0.001 ampere) the shock can be felt.
2. At about 10 milliamperes (0.010 ampere) the shock is severe enough to paralyze muscles so that the man is unable to release the conductor.
3. At about 100 milliamperes (0.100 ampere) the shock is fatal if it lasts for 1 second or longer.

The resistance of the human body is insufficient to prevent fatal shock from 115-volt or even lower voltage circuits. About 50 percent of shipboard electrocutions are caused by circuits of these types. Remember that current, rather than voltage determines the severity of an electrical shock.

CONDITIONS FOR SHOCK

Two conditions must be met for current to flow through a man. First, some part of his body must form part of a closed circuit; and second, there must be a voltage to cause current to flow through the circuit. If these two conditions exist, and in addition, the potential difference between the points of contact is high enough (115 volts is more than high enough), the body resistance is low enough, and the current path goes through some of the man's vital organs, he will be shocked fatally. There are also secondary effects e.g., surprise from receiving a small shock could cause you to fall from high structures. For these reasons a man should see to it that his body does not form part of a closed circuit through which current can flow.

Don't go aboard ship with a casual regard for the deadly potentialities of electric current. Few people would handle electric appliances

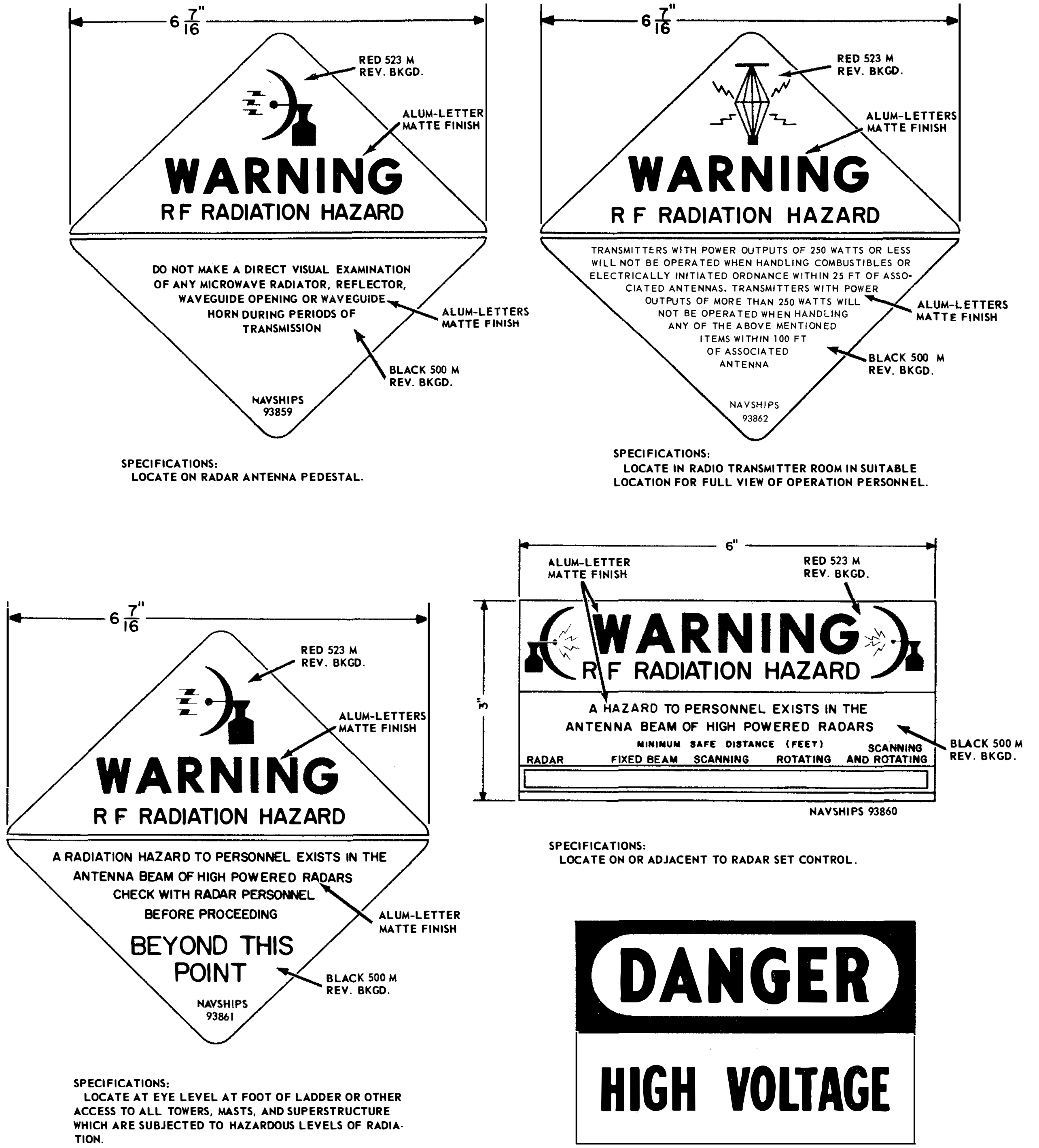

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Figure 15-1.—Hazard warning signs.

while in a bathtub. Nor would they stand ankle-deep in a flooded basement and fumble for a light switch. What is not so well recognized by many Navymen is that the hull of a ship—which, of course, floats in salt water—is an excellent conductor, and that for all practical purposes the man afloat is "standing in a bathtub" all the time.

SOME NOTES ON HUMAN ERROR

Most accidents are avoidable. So that you can see for yourself how avoidable they are, here are the causes of 22 shipboard electrocutions, all of which were traceable to human error.

Causes	Deaths
1. Accidentally touched equipment or conductor, which man knew to be energized	13
2. Unauthorized modifications to equipment or use of unauthorized equipment.	3
3. Failure to test equipment before working on it to see whether it was energized.	2
4. Failure to repair equipment that had given warning of an unsafe condition by one or more nonfatal shocks prior to the fatal shock.	2
5. Failure to test equipment for insulation resistance and correctness of ground connection AFTER making repairs, and BEFORE trying gear for operability or putting it to use.	2

Men are also electrocuted ashore. In one instance a man erecting an antenna tied a rock to the end of a bare copper wire and threw it over a 3300-volt powerline. Another died when he climbed a pole on a transmission line to capture a monkey sitting on one of the wires. A third walked out of a warehouse with a companion, saw a wire hanging from a pole, said "There's the wire that was popping yesterday," and, before his companion could stop him, walked up and grabbed the wire to throw it out of the way. These are not fairy tales. They are true summaries of reports on the deaths of three men who were either ignorant or contemptuous of the lethal capabilities of electric current.

Intentionally taking a shock from any voltage is always dangerous and is strictly forbidden. When necessary to check a circuit to find out if it is alive, use a test lamp, voltmeter, or other suitable indicating device.

TAGGING SWITCHES

When repairing or overhauling any electronic equipment, make sure the main supply or cutout switches, in each circuit from which power could possibly be fed, are secured in the OPEN (or SAFETY) position and tagged. Switches should be secured by locking, if possible. The tag should read: "This circuit was ordered open and shall not be closed except by direct order of ----" (usually the person making, or in charge of, the repairs). After the work is completed, tags are removed by the same person. If more than one party is working, a tag for each working party is placed on the supply switch. Each party removes only its own tag as it completes its share of the work.

If switch-locking facilities are available, the switch should be locked in the OPEN (safety) position and the key retained by the man doing the work.

When circuits are grounded for protection of personnel engaged in installation or overhaul, such grounds should be located in the vicinity of the working party and should be secured properly to prevent accidental removal. If the grounding point is not near the working party, the tagging procedure just described should be followed, changing the wording on the tags.

FUSES

As applied to electrical equipment, Fuses are Safeguards. They are basically a piece of metal within a container which will allow current to flow through them.

If for some reason the current becomes too great, the wire melts, thus breaking the circuit. This protects the equipment.

Fuses should be removed and replaced only after the circuit has been completely deenergized. A blown fuse is replaced with one of the same rated ampere capacity. You are permitted to replace a blown fuse with one of a higher rating only under emergency or battle conditions when continued use of the equipment is more important than consequences of possible damage to equipment. When possible, a circuit should be checked before a fuse is

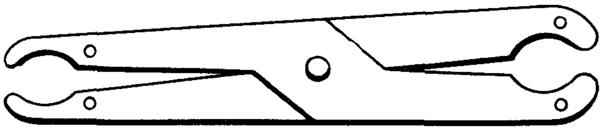

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Figure 15-2.—Fuse puller.

replaced, because a blown fuse usually indicates a circuit fault.

Never change a knife or cartridge-type fuse with your bare hands. Use an approved fuse puller (fig. 15-2). These pullers are made either of laminated bakelite or fiber, and can handle a range of fuses up to 60 amperes. Grasp fuse firmly with puller (using end that best fits fuse size) and pull straight out from fuse cabinet.

Plug-type fuse holders are used extensively in modern electronic equipment. The fuses are removed easily and safely by unscrewing the insulated plug.

Unless work is being done on them, fuse boxes, junction boxes, lever-type boxes, and the like are kept closed.

WORKING ON ENERGIZED CIRCUITS

Insofar as possible, work on energized circuits is not undertaken except in time of emergency, and then only under proper supervision. Proper supervision is considered to mean supervision by experienced electronics maintenance personnel. In all such work, care must be taken to insulate a workman from ground and to observe every known safety precaution. Some of these safety precautions are given in the accompanying list.

SAFETY PRECAUTIONS

1. Provide ample illumination.
2. Remove metal objects from pockets and clothing.
3. Insulate worker from ground with dry wood, rubber matting, several layers of sandpaper or dry canvas, or a sheet of phenolic insulating material.
4. Cover metal tools with insulating rubber tape (not friction tape).
5. Work with one hand only.
6. Wear rubber gloves if nature of work permits; if not, a glove should be worn on hand not holding tools.

SAFETY PRECAUTIONS—Continued

7. Have men stationed by circuit breakers or switches ready to cut the power in case of emergency.
8. Have a man qualified in first aid standing by during entire period of repairs.
9. Never trust insulating material too far when working with live circuits.

SWITCHES AND CIRCUIT BREAKERS

As a general rule, use one hand to open and close switches and circuit breakers. Keep the other hand clear so that, if an accident occurs, current will not trace a path up one arm, through your heart, and out the other arm. Touch one switch at a time. Before closing a switch, make sure that—

1. The provisions for tagging, described previously, are met.
2. The circuit is ready, and all parts are free.
3. Proper fuses are installed for protection of the circuit.
4. Men near moving parts are notified that the circuit is to be energized.
5. The circuit breaker is closed.

To close a switch with maximum safety, ease it to a position from which the final motion may be completed with a positive and rapid action. To open a switch carrying current, the break should also be positive and rapid. Be sure your hand is dry so that it will not slip off the switch handle and make contact with high voltage. A dry hand also offers better resistance.

All parts of a circuit breaker except the operation handle usually are good conductors of electricity. When working with circuit breakers, remember the safety rules in the accompanying list (see following page).

HIGH-FREQUENCY OPERATING HAZARDS

Aside from danger of shock, hazards incident to operating electronic equipment in the high-frequency range may be divided into three categories: (1) radiation hazards to personnel (RADHAZ), (2) hazards of electromagnetic radiation to ordnance (HERO), and (3) hazards associated with volatile liquids (SPARKS).

SAFETY RULES
(when working with circuit breakers)

1. Use only one hand.
2. Keep hands clear of parts except operating handles.
3. Touch only one breaker handle at a time.
4. Positive and negative breakers with two handles should not be closed simultaneously.
5. Close breaker first; then close switches.
6. Trip circuit breakers before opening switches.
7. Never disable a circuit breaker.
8. Keep your face turned away while closing open-type circuit breakers.
9. Never stand over a circuit breaker that is energized.

RADHAZ

In general, the possibility of biological injury from radiation is slight at operating frequencies of most radio communication equipment. But, your duties may bring you into close proximity of radar antennas, and here the radiation hazard is very real.

Overexposure to r-f radiation is thermal in nature, and is observed as an increase in overall body temperature or as a temperature rise in certain organs of the body. Your body is comprised of skin tissues that form the outer surface, a layer of fat tissue that lies immediately underneath the skin, and a central mass of deeper tissues consisting of muscles, high water content tissues, and bone formations. While working aloft (or in the vicinity of radar transmitting equipment) you may enter a field of electromagnetic radiation. The electromagnetic energy is absorbed in the tissues of your body, thus heat is produced in them. If the organism cannot dissipate this heat energy as fast as it is produced, the internal temperature of the body rises. This increase in temperature results in damage to the body tissue and, if the rise is sufficiently high, in your death. You must remember that electromagnetic radiation is not visible, you cannot normally feel this radiation, and its presence must be measured by instruments. Proper warning signs are located at various points to warn you when you are entering an area that may be a radiation hazard.

HERO

Another danger of r-f radiation is the risk of premature firing of rockets or missiles, or the explosion of their warheads. The hazard to electronic explosive devices (EEDs), such as missiles, rockets, and VT fuses, occurs because of the heat associated with a current passed through the sensitive wires surrounded by a temperature-sensitive explosive. If energy is dissipated into the wires, current will flow and the explosive becomes hot and an explosion can result.

Normally, the circuitry of EEDs is shielded in containers, and if properly shielded, there is little danger of an accident. But, to be safe, there should be no ordnance in any personnel hazard zone nor within 25 feet of any radiating antenna.

SPARKS

Aboard ship, shock hazards and sparks exist on rigging, cables, transmitting and receiving antennas, and other structures that are resonant to a radiated frequency. The position of the radiating antenna in relation to these objects determines the amount of induced voltage. If the induced voltage in an object is large enough, arcs and sparks may be drawn when contact is made or broken by personnel, tools, or other conductive devices. Extreme care must be exercised, consequently, by working personnel during refueling operations, arming aircraft, and handling ammunition or volatile liquids and gases. Additionally, all transmitting equipment should be deenergized. As a safety precaution—if impossible to remove power—a separation must be maintained between the work area and an energized antenna. Separation must be at least 25 feet for transmitters rated at 250 watts or less, and 100 feet for transmitters over 250 watts.

RUBBER MATTING

Aboard ship a gray, fire-retardant, rubber matting with a diamond-shaped surface is cemented to the deck in all electronic spaces. Rubber matting insulates the operator from the steel deck, and the diamond-shaped surface pattern is easy to keep clean and provides safe,

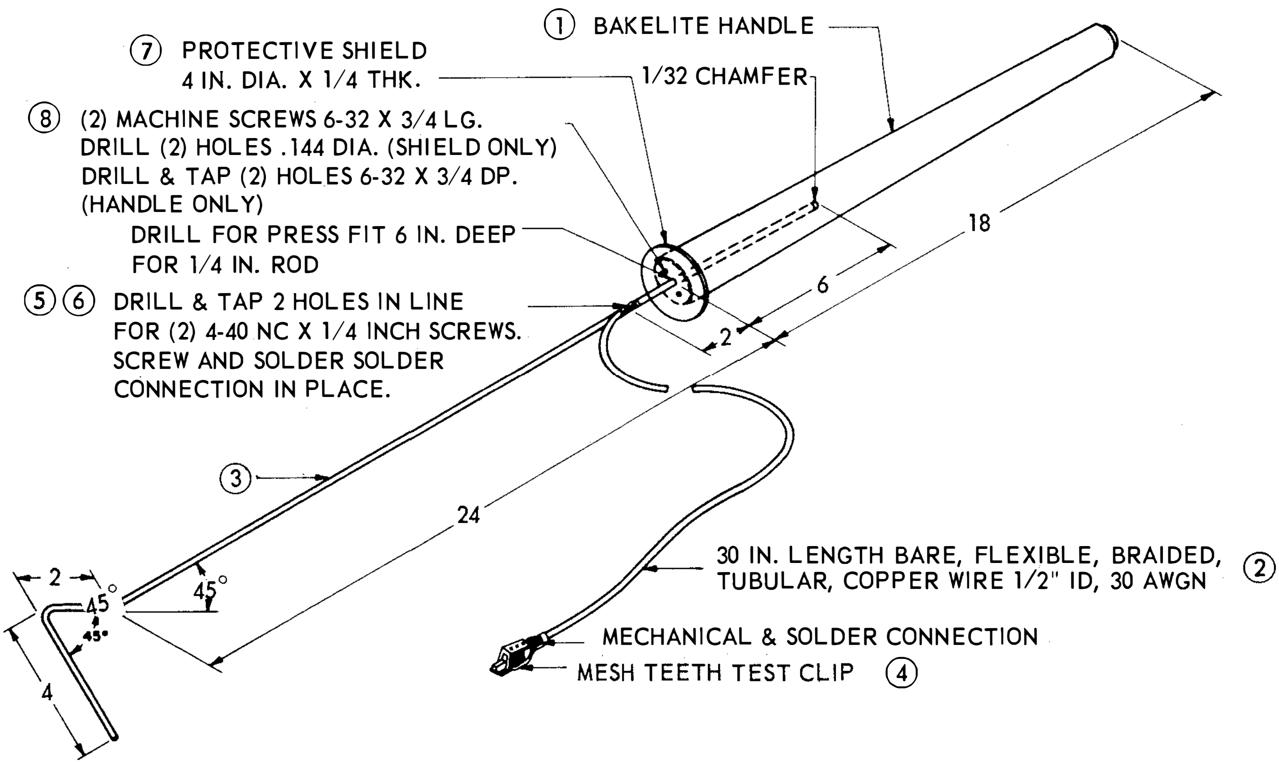

Figure 15-3.—Shorting/grounding bar.

nonskid footing. At shore stations, rubber matting is installed around electronic equipment to protect personnel who service or tune the equipment. Usually the matting does not cover the entire deck area.

SHORTING/GROUNDING BAR

Discharge and ground the circuit components before you work on them. Even when secured, electrical and electronic equipment may retain a charge sufficient to cause a severe shock. Be safe!

The shorting/grounding bar shown in figure 15-3 provides a safe method for grounding deenergized circuits. Connect the flexible lead to a grounded part of the cabinet or chassis by means of the alligator clip. Always make this ground connection first. Then, holding only the insulated handle, touch the copper probe to the circuit or part you want to discharge to ground. Repeat this discharge operation several times.

Before touching a capacitor that is connected to a deenergized circuit, or one that is disconnected entirely, short-circuit the terminals with the shorting bar. Repeat this operation several times to make sure the capacitor is fully discharged.

SOLDERING IRONS

Soldering iron is a fire hazard and a potential source of burns. When soldering cables or wires, keep the iron holder in the open where danger is minimized. Disconnect the iron when leaving work, even for a brief absence.

When using the iron, keep the ends of wires and cables in such a position that they do not provide a source of injury to the face or eyes. Keep your head away from the iron. Don't flip the iron to dispose of molten solder accumulated on the tip; a drop may strike someone's eye.

HANDLING CATHODE RAY TUBES

Cathode ray tubes used in communication equipment are not as large as those required for radar and TV. Nevertheless, handling the relatively small cathode ray tubes found in teletype converters and test equipment presents certain hazards. The following safety precautions apply in handling all cathode ray tubes.

- Wear safety goggles to protect your eyes from flying glass in the event of envelope fracture, a sudden concussion might cause implosion due to the high vacuum within the tube. Recommended goggles provide side and front protection and have clear lenses designed to withstand a fairly rigid impact.
- Be sure that no part of your body is directly exposed to possible glass splinters caused by implosion of the tube. The inside fluorescent coating on some tubes is poisonous if absorbed into the bloodstream. For these reasons, heavy gloves should be worn when handling tubes.
- Remove the tube from its packing box with caution. Take care not to strike or scratch the envelope. Insert the tube into the equipment socket cautiously, using only moderate pressure. Do not jiggle the tube. The neck of the tube is made of thin glass. If the tube should break, particles from the neck may scatter with enough force to cause severe injury.
- The foregoing precautions also apply when removing tubes from equipment sockets.

PAINTING

When you paint radio rooms or use insulating varnish, lacquer, paint thinner, or other volatile liquids in radio spaces, make sure there is adequate ventilation. Use both exhaust ventilators and power blowers arranged to ensure rapid removal of explosive, combustible, or toxic vapors. Vapors should be exhausted in such a way that they will not drift into other areas or be sucked into the ship's supply vents.

If paint vapors or fumes are suspected of being explosive, do not allow anyone in the vicinity to use portable electrical equipment of a type that might set off an explosion. Do not permit smoking in the danger area, nor allow any type of work that may produce flames or sparks. See that firefighting equipment is handy.

Practice good housekeeping. See that unnecessary objects are picked up and kept out of the way. Any rags, sweepings, and waste that may be contaminated with paint should be placed in a covered metal container or in a bucket of water.

Never eat, drink, or store food in a compartment where painting is in progress. Remove the coffee mess. Keep your hands out of your mouth. Paint is a poison, and ingesting any amount can be serious.

CLEANING ELECTRONIC EQUIPMENT

Clean electronic equipment helps to insure good performance. Before cleaning, certain precautions are necessary to protect the equipment as well as the operator.

- Turn off the power switches and ground capacitors with the shorting bar.
- A vacuum cleaner with a nonmetallic hose is safe and useful but will not reach all areas where dust accumulates.
- The preferred method for cleaning inside electronic equipment is to use a brush, such as a typewriter cleaning brush, together with the vacuum cleaner to remove dirt as it is loosened by the brush.
- A hand bellows may be used to blow dirt from equipment. Compressed air lines are available aboard ship but are not recommended for cleaning radio equipment because the air pressure may be so strong as to cause damage to delicate electronic parts.
- Do not use steel wool or emery paper for cleaning electronic equipment. Tiny particles of these conducting materials cause troublesome and dangerous short circuits.

RESCUE FROM ELECTRICAL CONTACT

At some time it may be necessary to rescue a shock victim before you can begin first aid treatment. Rescuing a person who is in contact with an electrical circuit is likely to be difficult and dangerous. Extreme caution must be exercised to avoid being electrocuted yourself. Speed is important, of course, but a brief pause to evaluate the situation may make the difference between life and death—for you as well as for the person you are trying to rescue.

If the victim still is in contact with the conductor, the first procedure is to stop current flow through his body. You can shut off power by opening switches or circuit breakers, or by cutting the conductor with a wooden-handle ax or hatchet or with insulated pliers. To lift or pull the man away from the conductor, if circumstances are such that power cannot be shut off quickly, use some dry material such as line, cloth, canvas, rubber, or wood. DON'T TOUCH THE MAN. DON'T USE METAL OR MOIST MATERIALS. A neckerchief or belt can be used to pull a person from an electrical circuit. The belt buckle must be removed first, however. When you are trying to break an electrical contact, stand on any dry, nonconducting material such as wood or rubber, to prevent the current from reaching ground through your body.

ARTIFICIAL RESPIRATION

A victim of electrical shock who has stopped breathing is not necessarily dead, but he is in immediate and critical danger. The method by which a person can be saved after breathing stops is called artificial respiration. The same methods of artificial respiration are used for victims of electrical shock as for drowning or gas asphyxiation cases.

The purpose of artificial respiration is to force air from the lungs and into the lungs, in rhythmic alternation, until natural breathing is restored. Artificial respiration should be given only when natural breathing ceases. It must not be given to any person who is breathing naturally on his own. Do not assume that a person's breathing has stopped merely because he is unconscious, or because he has been rescued from contact with an electrical circuit. Remember: Do not give artificial respiration to a person who is breathing naturally.

If possible, send for a medical officer or a Hospitalman; but don't go yourself if you are alone with the victim. Speed in beginning artificial respiration is essential in any instance in which breathing has stopped. Every moment's delay cuts down the victim's chance of survival. Do not take time to move the victim to a more comfortable location, unless he is in such a dangerous position that he must be moved in order to save his life.

If another person is present while artificial respiration is being administered, he can be very helpful. Have him remove false teeth, chewing gum, or other matter from the victim's mouth; at the same time he can bring the victim's tongue forward. He also can loosen the clothing around the victim's neck, waist, and chest. If you are alone, you must attend to these details yourself before beginning artificial respiration.

Artificial respiration must be continued for at least 4 hours unless natural breathing is restored before that time or a medical officer declares the person dead. Some people have been revived after as much as 8 hours of artificial respiration.

Three methods of artificial respiration are described in this manual. They are the mouth-to-mouth method, the back-pressure arm-lift method, and the back-pressure hip-lift method.

In addition to the foregoing procedures, there are several other methods of artificial respiration. If you have had training in first aid, it is possible that you learned one of the older methods, but they no longer are considered the most effective way. It is your responsibility to learn the best techniques.

Mouth-to-Mouth Resuscitation

Mouth-to-mouth resuscitation, shown in figure 15-4 is recommended by the National Academy of Sciences, National Research Council, the American Red Cross, and the Armed Forces as the preferred and most effective way of providing artificial respiration. All other procedures are considered alternate methods for use only when mouth-to-mouth resuscitation is not practicable.

Mouth-to-mouth resuscitation is particularly recommended for use aboard ship in cases of electric shock. Investigations of shipboard electric shock fatalities indicate that, despite the good intentions of rescuers, valuable seconds are sometimes lost in first moving the patient from an awkward, cramped, wet, or isolated location to a roomier, drier place before applying resuscitation measures. Familiarity with this new method enables the man nearest the patient to start revival action readily while sending or yelling for medical help. Commencing artificial respiration can thus be reduced to a matter of a few seconds after freeing the patient from his contact with electricity.

The following steps are easy to learn. Refer to figure 15-4 as you read them.

1. Place the patient on his back. Loosen collar and belt.
2. Clear his mouth of any foreign matter with your fingers or a cloth wrapped around your fingers.

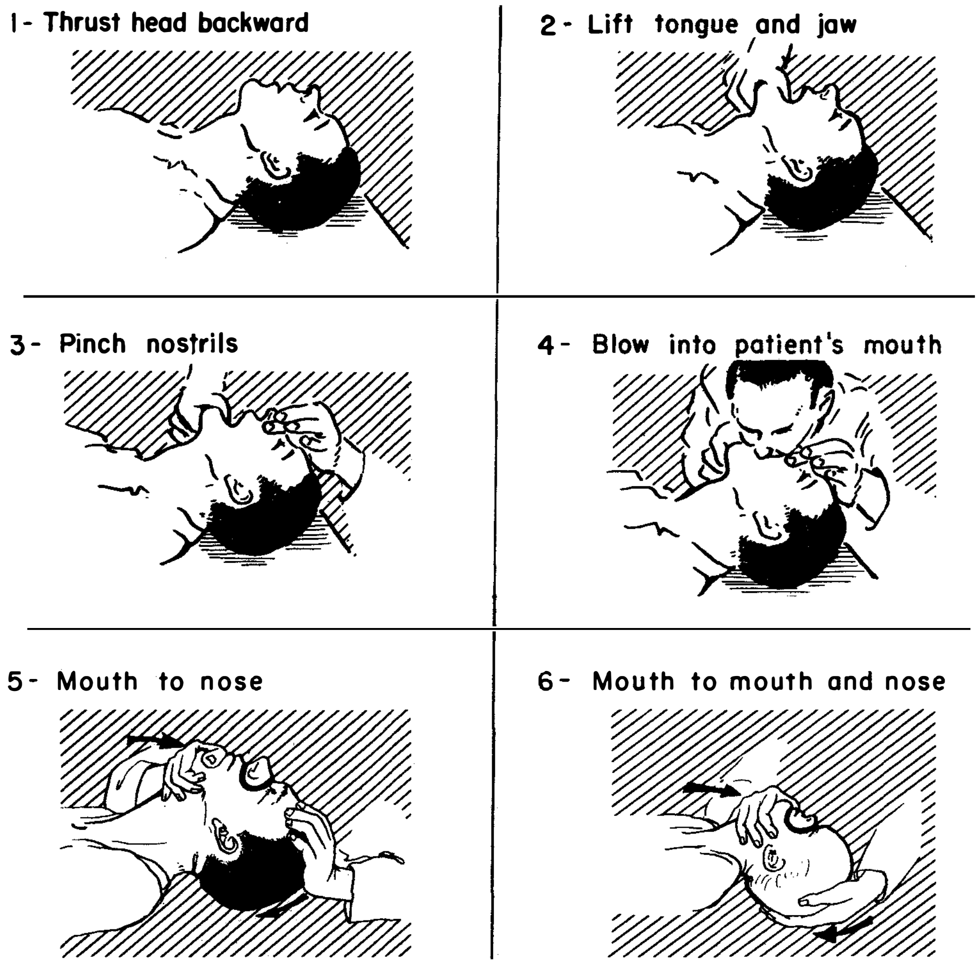

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Figure 15-4.—Mouth-to-mouth method of resuscitation.

3. Tilt his head back so his chin is pointing upward. With one hand push his jaw forward into a jutting-out position. Tilting his head and pushing his jaw forward should relieve obstruction of the airway. With the fingers of one hand, pinch patient's nostrils shut to avoid any air leakage.
4. Take a deep breath. Place your mouth over patient's mouth and breathe into him. Your first blowing effort should determine whether any obstruction exists. Watch his chest rise to make sure his air passage is clear.
5. Remove your mouth, turn your head to one side, and listen for the return rush of air that indicates air exchange. Repeat the blowing effort about 12 times per minute.
6. If you are not getting air exchange, recheck patient's head and jaw position. If you still do not get air exchange, turn the patient quickly on his side and administer several blows between his shoulder blades in an effort to dislodge foreign matter. Again clean his mouth with your fingers.

Don't worry about germs when a life is at stake. Those who do not wish to come into direct contact with the patient may hold a cloth or handkerchief over patient's mouth or nose and breathe through it. The cloth does not greatly affect the exchange of air.

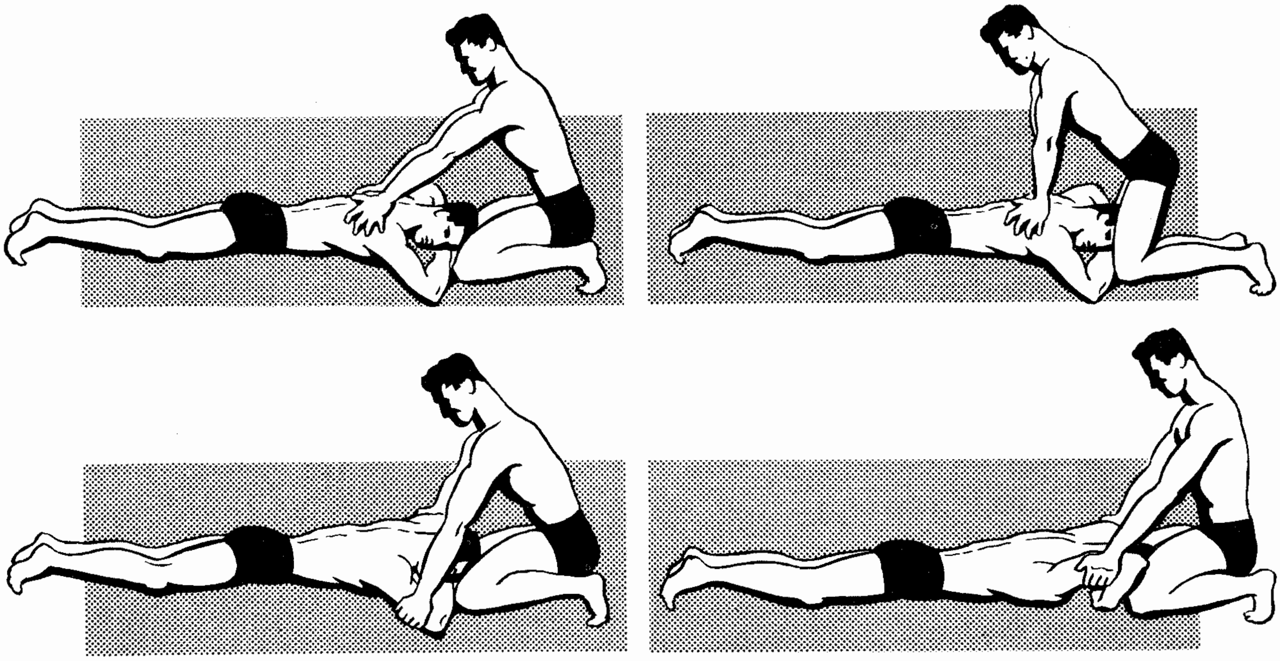

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Figure 15-5.—Back-pressure arm-lift method of resuscitation.

Medical research has established conclusively that the mouth-to-mouth respiration technique is superior to all others in reviving a person whose breathing has stopped for any reason. The method is adaptable to a patient of any age. Everyone should be familiar with it.

Back-Pressure Arm-Lift Method

The back-pressure arm-lift method of artificial respiration is illustrated in figure 15-5. This procedure requires the following steps:

1. Place patient so that he is lying face down. If he is on a sloping surface, position him so that his head is slightly lower than his feet. Bend both his elbows and place one hand on the other, as shown in figure 15-5. Rest his head on his hands, with his face turned to one side.
2. Kneel on one knee, facing patient. (You can use either knee.) Place your knee close to his head. Put your other foot near his elbow. You may find it more comfortable to kneel on both knees; if you do, have one knee on each side of the patient's head. Next, place your hands on the middle of his back, just below his shoulder blades, in such a position that your fingers are spread downward and outward, with thumb tips nearly touching.
3. With your arms held straight, rock forward slowly so that the weight of your body is gradually brought to bear on the patient. This action compresses his chest and forces air out of the lungs. Do not exert sudden pressure, and do not put your hands too high on his back or on his shoulder blades.
4. Release pressure quickly by removing your hands from the patient's back.
5. Now rock backward, and allow your hands to come to rest on patient's arms just above his elbows. As you swing backward, lift his arms upward. The arm lift pulls on the patient's chest muscles, arches his back, releases the weight on his chest, and causes his chest to expand and fill with air. Finally, lower the patient's arms. Now you have finished one full cycle.

Repeat the cycle approximately 12 times per minute (5 seconds per cycle). Follow this rhythm: Rock forward and press; rock

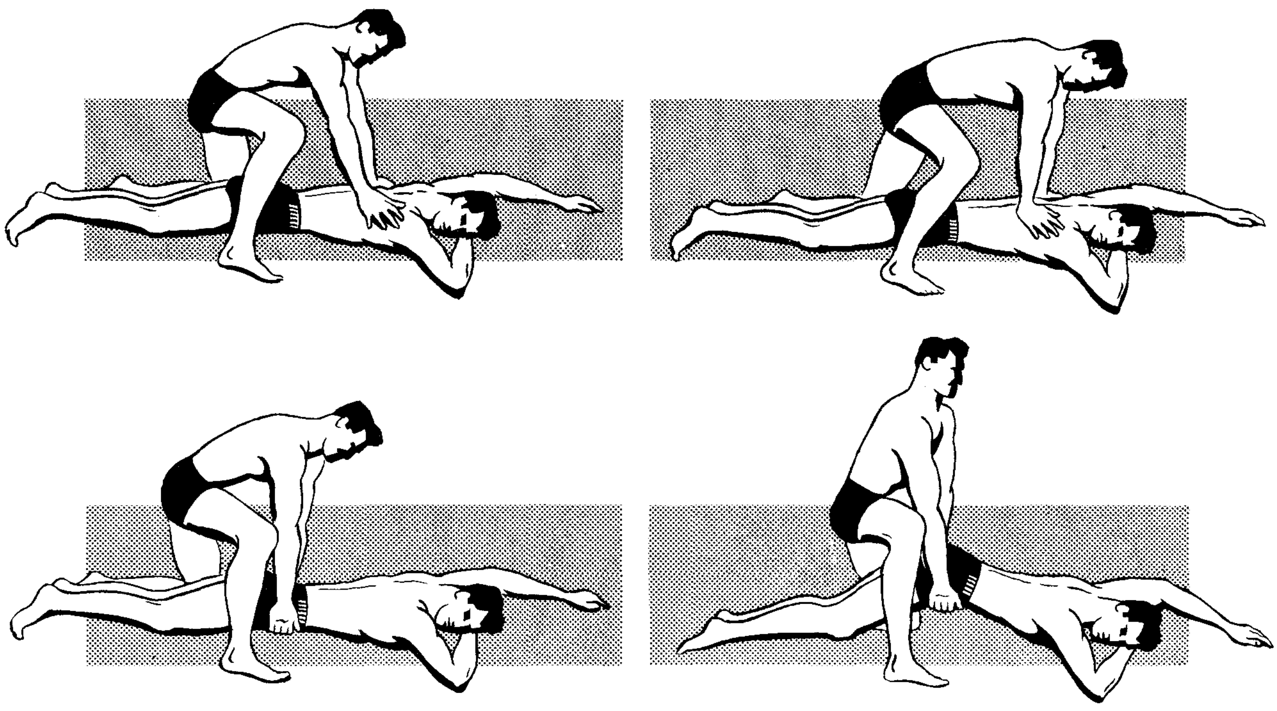

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Figure 15-6.—Back-pressure hip-lift method of resuscitation.

backward and lift. The pressing and lifting should take approximately equal periods of time. The release periods should be as short as possible.

Try to maintain a slow, easy rhythm—rocking forward on the back-pressure phase, rocking backward on the arm-lift movement. The rocking motion helps to maintain rhythm. Remember that a smooth rhythm is important in performing artificial respiration, but split-second timing is not essential.

Back-Pressure Hip-Lift Method

The back-pressure hip-lift method of resuscitation is shown in figure 15-6. It is used when necessary to give artificial respiration to a person injured in the upper part of the body—chest, neck, shoulders, or arms. The hip-lift procedure is also useful in situations where lack of space makes it difficult or impossible to use the arm-lift method. The hip-lift technique has the disadvantage of being somewhat harder on the operator.

The back-pressure hip-lift principle requires the following steps:

1. Place patient face down, with one arm bent at the elbow and the other arm extended as in figure 15-6. Rest his head on his hand or forearm, with his face turned so that his nose and mouth are free for breathing. Clear his mouth of any objects or materials that might obstruct his breathing. At the same time, bring his tongue forward so that it will not clog the air passage.
2. Kneel on either knee, and straddle the patient at the level of his hips. Place your hands on the middle of his back, just below his shoulder blades. Your fingers should be spread downward and outward, with your thumb tips nearly touching. Be careful that your hands are not too high on his back; they should be below his shoulder blades.
3. With your arms held straight, rock forward slowly so that the weight of your body is gradually brought to bear upon

the patient. Keep your elbows straight and your arms almost vertical, so that pressure is exerted almost directly downward. Do not exert sudden pressure, nor more pressure than is required to feel a firm resistance.

4. Release pressure quickly by removing your hands from the patient's back.
5. Now rock backward and let your hands come to rest on the patient's hips, well below his waist. Slip your fingers underneath his hip bones.
6. Lift the patient's hips 4 to 6 inches. Lifting them allows his abdomen to sag downward, and his diaphragm to descend, causing his chest to expand and fill with air. Lower the patient's hips. You now have finished one full cycle.

As in the arm-lift method, the cycle should be performed approximately 12 times per minute. If a relief operator is available, he can come in on one side and take over after one of the lift movements.

Treatment During Recovery

When a person is regaining his breath, the bluish or pale appearance of his skin may be succeeded by a distinct flush of color. His muscles then may begin to twitch and his fingers to scratch and clutch. Swallowing movements are sometimes the first sign of natural respiration. The first attempt to breathe may be a faint catch of breath, or a sigh. You must be careful not to exert pressure when the victim is trying to get his first breath. If he begins to breathe on his own, adjust your timing to assist him. Do not hinder his efforts to breathe; instead, synchronize your efforts with his.

Keep the patient warm. Do not give any liquids until he is fully conscious. To avoid strain on his heart, the patient should be kept lying down and not allowed to stand or sit immediately after he revives. Do not permit the patient to walk or otherwise exert himself. The slightest exertion at this point might easily cause his death from heart failure. After a temporary recovery of respiration, the patient sometimes stops breathing again. If natural breathing stops, resume artificial respiration at once.

SHOCK

Some degree of shock follows all injuries. It may be slight and almost unnoticed, lasting only a few moments, or it may be severe enough to cause death. An interruption of breathing, from whatever cause, almost always is followed by severe shock.

Symptoms

A person suffering from shock feels weak, faint, and cold. His face is usually pale and his skin is cold and clammy. Sweating is likely to be very noticeable. Remember, however, that signs of shock do not always appear at the time of injury. Indeed, in many serious cases, they may not appear until hours later.

The symptoms of a person suffering from shock are, directly or indirectly, the result of the circulation of the blood becoming disturbed. His pulse is weak and rapid. Breathing is likely to be shallow, rapid, and irregular, because poor circulation of blood affects the breathing center in the brain. It is unlikely that you will see all these symptoms of shock in any specific instance. Some of them appear only in late stages of shock when the patient's life is in serious danger. It is imperative that you know the symptoms that indicate the presence of shock, but don't ever wait for symptoms to develop before beginning the treatment for shock.

Prevention and Treatment

The most helpful deed you can perform for a person revived by artificial respiration is to begin treatment for shock. If shock has not yet developed, the treatment may actually prevent its occurrence. If it has developed, you may be able to keep it from reaching a critical stage. You must, therefore, begin treatment for shock at the earliest practicable moment.

Get medical assistance as quickly as possible. Meanwhile, place the patient in a horizontal position, with his head slightly lower than the rest of his body. If impossible to do so, it might still be feasible for you to raise his feet and legs enough to help the blood flow to his brain. Do the best you can, under the circumstances, to get the patient into this position. Never let the patient sit or stand or walk around.

Heat is important in the treatment for shock, as patient's body heat must be conserved. Keep the patient warm, but not hot. Apply only enough clothing and blankets to bring his body to normal temperature.

As a general rule, liquids should not be given as a part of first aid treatment for shock. Until recently, first aid books emphasized giving warm fluids (in particular water, tea, and coffee) as a part of the treatment. Now it is believed that administering fluids is not a necessary or even desirable part of first aid treatment. It is true that a person in shock is in need of liquids. But liquids given by mouth are not absorbed—and therefore are ineffective—except in very mild cases of shock. In moderate or deep shock, intravenous administration of fluids is necessary; but this medical procedure cannot, under any circumstances, be performed by a person not properly trained.

One final precaution concerning the use of liquids: never give alcohol to a person who is in shock or may go into shock. Alcohol increases the blood supply to the surface blood vessels, and diminishes the blood supply to the brain and other vital organs.

BURNS

Burns and scalds are caused by exposure to intense heat, such as that generated by fire, bomb flash, sunlight, hot solids, hot gases, and hot liquids. Contact with electric current also causes burns, particularly if the skin is dry. (Dry skin offers about 20 times more resistance than moist skin to the passage of electric current. When the skin is dry, therefore, local heating effects (burns) are greater, even though total damage to the body is less than when the skin is wet.)

It should be noted that burns and scalds are essentially the same type of heat injury. When injury is caused by dry heat, it is called a burn; when caused by moist heat, it is called a scald. Treatment is the same in both cases.

- Classification of burns: Burns are classified in several ways—by the extent of the burned surface, by the depth of the burn, and by the cause of the burn. Of these categories, the extent of body surface burned is the principal factor in determining seriousness of the burn, and also plays the greatest role in the casualty's chances for survival.

Shock can be expected in adults with burns of over 15 percent; in small children, with burns of over 10 percent of body surface area. In adults, burns to more than 20 percent of the body endanger life. Usually 30-percent burns are fatal if adequate medical treatment is not received.

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The depth of injury to the tissues is spoken of in degrees. First-degree burns are the mildest, producing redness, increased warmth, tenderness, and mild pain. Second-degree burns redden and blister the skin and are characterized by severe pain. Third-degree burns destroy the skin and may destroy muscle tissue and bone in severe cases. Severe pain may be absent because nerve endings have been destroyed. The color may vary from white and lifeless (scalds) to black (charred).

Always remember that the size of a burned area may be far more significant than the depth of a burn. A first-degree or second-degree burn that covers a large area of the body usually is more serious than a small third-degree burn. A first-degree sunburn, for example, can cause death if a large area of the body is burned.

In general, the causes of burns are classified as thermal (heat) or chemical, or as resulting from sunburn, electric shock, or radiation. Whatever the cause of the burn, shock always results if the burns are extensive.

Treatment of Burns and Scalds

First aid for all burns consists of the following main items: (1) relieve pain, (2) prevent or treat shock, and (3) prevent infection.

In electric shock, the burn may have to be temporarily ignored while resuscitative measures are carried out. Otherwise the treatment is the same as for heat burns.

Local treatment for chemical burns varies, depending on the causative agent. Chemical burns are discussed more fully later in this chapter.

- Ice water treatment: Clean water and ice are not always available, but when they are, ice water (as an emergency measure) provides immediate relief from pain and also seems to lessen the damaging effects of burns. For burns affecting less than 20 percent of the body, immerse the burned part in ice water or, where immersion is not practical, repeatedly apply ice-cold moist towels to the burned area. Treatment should be continued until no pain is felt when the burned area is withdrawn from the water. This treatment may last from 30 minutes to as long as 5 hours. When available, hexachlorophene should be added to the water to destroy bacteria. After the ice water treatment, the regular treatment for burns should follow (discussed later).

● Relief of pain: Simple first-degree burns that do not cover a large body area may require no more than one or two aspirin tablets to relieve discomfort. Severe burns cause extreme pain, which contributes to the severity of shock. A person who has suffered extensive burns may be given not more than 1/4 grain of morphine to relieve the pain. The injection site should be massaged for a few minutes to help circulate the morphone. (CAUTION: The casualty may have other injuries. Do not give morphine to any person who has a head injury, chest injury, or who is in deep shock, even if he is suffering from extensive burns.)

● Treatment for shock: Any person who has been seriously burned must be treated for shock immediately. Serious shock always accompanies an extensive burn, and is, in fact, the most dangerous consequence of the injury. Start the treatment for shock before making any attempt to treat the burn itself.

Relieving the casualty's pain is, of course, an important part of the treatment for shock. After easing his suffering, place him in a position so that his head is lower than his feet. Make sure that he is warm enough; do not remove his clothing immediately. Remember that exposure to cold will cause shock to become worse, but do not overheat him.

In burn cases, an exception must be made to the rule of withholding liquids from a patient. A seriously burned person has an overwhelming need for liquids; and administering liquids in such cases is an indispensable part of treatment for shock caused by burns. Give small amounts of sweetened tea, fruit juice, or sugar water, if the casualty has no internal injuries, is conscious, and is able to swallow.

● Prevention of infection: Second- and third-degree burns are, in effect, open wounds and must be covered to reduce possibility of infection. Every effort must be made to use a sterile covering, but makeshift wrappings such as clean sheets and freshly laundered towels may be used.

Ointments and other medicines must never be put on the burn wound. Using these agents may make later treatment by a physician difficult or impossible.

Do not open any blisters. Do not cough or sneeze near the casualty. If possible, keep a piece of sterile gauze over your mouth and nose while you are working near the burn victim. Contamination by micro-organisms from the mouth and nose is a frequent cause of serious (and possibly fatal) burn infections.

● Treatment: If the casualty is to receive medical attention soon, do nothing more than relieve his pain, treat for shock, and cover the burn with a sterile wrapping or clean sheet or towel. Do not attempt treatment of the burn wound itself.

If more than 3 hours may elapse before the services of a physician can be obtained, you should dress the burn. First remove the casualty's clothing from around and over the burned area, preferably by cutting it away. Be especially careful not to cause further injury. If clothing sticks to the burn wound, do not attempt to pull it loose. Merely cut around the part that sticks, and leave it in place. If any material such as wax, metal, dirt, grease, or tar adheres to the burn, do not try to remove it. Do not allow absorbent cotton, powder, adhesive tape, or other substances that might cling to the burn to come in contact with the burn. Never apply iodine or any other antiseptics on a burn.

When you have cleared away as much of the clothing as you can, dress the burn. Apply a single layer of sterile, fine-mesh petrolatum gauze over the burn wound, beginning at the outside of the burn wound and working toward the center in a circular manner. Next, place bulky fluffs of gauze over the burn, with a large padded dressing as the outer layer. Wrap gauze strips smoothly and gently around the dressing. The bandage should give light, even pressure and immobilize the injured part. Once the bandage is applied, it should be left alone. Leave it in place until the casualty receives medical care.

● Burns of the eye: Burns of the eye require special attention. If they are true heat burns, caused by exposure to steam, bomb flash, welding arc, or any other source of intense heat, treat them as follows:

1. Put a few drops of clean mineral oil or olive oil into each eye.
2. Cover each eye with a small, thick compress, and fasten the compress in place with a bandage or an eyeshield.

3. Make sure that the casualty does not rub his eyes.
4. Get medical attention for the casualty as soon as possible.

ELECTRICAL FIRES

Any fire is a potential source of disaster. In electrical fires, the following procedures should be observed.

1. Deenergize circuit for the affected equipment. Every radio transmitter has an EMERGENCY OFF switch that removes all power from equipment. In addition to local power switches on equipment, the power supply to all transmitters and receivers, converters, and teletypes can also be secured at power distribution panels.
2. Spread the alarm. Ashore, call the fire department. Aboard ship, use the phone or intercom. If available, send another person to sound the alarm in accordance with ship's fire bill.
3. Secure ventilation. Turn off blowers; close doors.
4. Report fire to the OOD by telephone or messenger.
5. Attack fire with equipment available in immediate vicinity, such as portable 15-pound CO_2 (carbon dioxide) extinguishers.

When extinguishing an electrical fire, remember that quick action is required only to deenergize the circuit. When this action has been taken, STOP! LOOK! THINK! The use of CO_2 fire extinguishers directed at the base of the flame is always best for all electrical fires. Because carbon dioxide is a dry, noncorrosive, inert gas, it will not damage electrical equipment. And, because it is a nonconductor of electricity, it can be used safely in fighting fires that otherwise would present the additional hazard of electric shock.

PORTABLE FIRE EXTINGUISHERS

Some portable 15-pound carbon dioxide fire extinguishers have a squeeze-grip style release valve that is operated by a simple hand squeeze-grip. Others have a release valve operated by a handwheel at the top. Both valves have a locking pin to prevent unintentional discharge of the carbon dioxide. To operate, observe the following steps.

1. Carry fire extinguisher in an upright position, and approach fire as closely as heat permits. (Keep extinguisher erect while using it. Because of its construction, it should not be laid on its side.)
2. Remove locking pin from valve.
3. Grasp nozzle horn by its handle. (It is insulated to protect your hand from extreme cold of discharging carbon dioxide.)
4. Open valve by turning valve wheel to left (or squeeze release lever), thus opening valve and releasing carbon dioxide. At the same time direct the flow toward the base of the fire. Move horn slowly from side to side, and follow flames upward as they recede.
5. Close valve as soon as conditions permit, and continue to open and close it as necessary. The firefighter may shut off handwheel-type valve for brief intervals without appreciable loss of carbon dioxide. But once valve seal is broken, carbon dioxide will leak away in 10 minutes or so. The squeeze-grip type likewise may be turned off while in use, but it will hold contents indefinitely without leakage. In continuous operation, the 15-pound cylinder of either type will expend its contents in about 40 seconds.
6. The discharge should not be stopped too soon. When flame is extinguished, coat entire surface engaged in fire with carbon dioxide snow in order to prevent reflash.

The firefighter must be warned that the very qualities that make carbon dioxide a desirable extinguishing agent also make it dangerous to life if the compartment should become filled with it. Certainly, when it replaces oxygen in the air to the extent that combustion cannot be sustained, breathing cannot be sustained either. Radio rooms do not have CO_2 systems for total flooding such as those installed in uninhabited spaces used for gasoline and paint stowage. Consequently, when using 15-pound portable fire extinguishers, the firefighter usually does not have to consider the possibility of harm to personnel. Because carbon dioxide is heavier than air, it does not rise, but remains in a pool close to the deck. The quantity of gas released from one—or several—of these extinguishers is insufficient to reduce below a dangerous minimum the total oxygen content of the air in a compartment.

Anyone using a carbon dioxide extinguisher should be warned that snow blisters the skin and causes painful burns if allowed to remain on the skin.

If all efforts with carbon dioxide fail to put out a fire, fresh water applied with a fog applicator may be used. Because of the fine diffusion of its particles, fog reduces but does not entirely remove danger of electric shock.

In cable fires in which the inner layers of insulation (or insulation covered by armor) support combustion, the only positive method of preventing the fire from running the length of the cable is to cut the cable after it is deenergized, and separate the two ends. This preventive action should be accomplished only with well-insulated tools, such as wooden-handled fire axes or insulated pliers.

WORKING ALOFT

To work on antennas, you must go aloft. Radarmen, Signalmen, and the deck force also may have work to do on the masts and stacks. Before going aloft, it is necessary to obtain permission from the OOD and CWO. Another requirement is to inform them when work is completed and the men are down.

When radio or radar antennas are energized by transmitters, workmen must not go aloft unless advance tests show positively that no danger exists. A casualty can occur from even a small spark drawn from a charged piece of metal or rigging. Although the spark itself may be harmless, the "surprise" may cause the man to let go his grasp involuntarily. There is also shock hazard if nearby antennas are energized, such as those on stations ashore or aboard a ship moored alongside or across a pier.

Danger also exists that radar or other rotating antennas might cause men working aloft to fall by knocking them from their perch. Motor safety switches controlling the motion of radar antennas must be tagged and locked open before anyone is allowed aloft close to such antennas.

If you work near a stack, draw and wear the recommended oxygen breathing apparatus. Among other toxic substances, stack gas contains carbon monoxide. Carbon monoxide is too unstable to build up to a high concentration in the open, but prolonged exposure to even small quantities is dangerous.

Here is what the CWO requires you to do when he receives word that men are going aloft: (1) Secure all radio transmitters and disconnect and ground the transmitting antennas. (2) Unpatch remote control units at the transmitter transfer panel, and place a "Secure, men aloft" sign on all transmitters. (3) Report accomplishment of these details to the CWO so that he can inform the OOD and men going aloft that all radio transmitters are secured.

Make entries in your radio log to show the time of securing, time of opening up to resume operating, name of the OOD granting permission to open up, and the time men came off the mast.

Under no circumstances turn on any transmitter unless informed that the men are off the mast, and then only with permission of the OOD and CWO.

Observe these safety precautions when you are going aloft:

SAFETY PRECAUTIONS WORKING ALOFT

1. You must have permission of the CWO and OOD.
2. You must have the assistance of another man, along with a ship's Boatswain's Mate qualified in rigging.
3. Wear a safety belt. To be of any benefit, the belt must be fastened securely as soon as you reach the place where you will work. Some men have complained on occasion that a belt is clumsy and interferes with movement. It is true the job may take a few minutes longer, but it is also true that a fall from the vicinity of an antenna is usually fatal.
4. Do not attempt to climb loaded with tools. Keep both hands free for climbing. Tools can be raised to you by your assistant below. Tools should be secured with preventer lines to avoid dropping them.
5. Ensure yourself of good footing and grasp at all times.
6. Hold fast.

LIQUID CLEANERS

The widespread use of solvents to clean, maintain, and recondition electrical and electronic equipment as an assist for removing oil, grease, and other contaminants requires that the supervisor properly indoctrinate all personnel in the necessary safety precautions.

HAZARDS

Any man who smokes while using a volatile flammable cleaning solvent is inviting disaster. Unfortunately, many such disasters do occur. For this reason, the Navy does not permit the use of gasoline, benzine, ether, or like substances for cleaning purposes. Only nonvolatile solvents are authorized for use in cleaning electronic apparatus.

In addition to the potential hazards of accidental fire, many cleaning solvents are capable of damaging the human respiratory system in cases of prolonged inhalation. The following list of "Dont's" and "Do's" will serve as effective reminders to maintenance personnel who must use cleaning solvents.

DON'TS

1. Don't work alone in a poorly ventilated compartment.
2. Don't breathe directly any of the vapor of a cleaning solvent for prolonged periods.
3. Don't spray cleaning solvents on electrical windings or insulation.
4. Don't apply solvents to warm or hot equipment. This practice increases the toxicity hazard.
5. Don't use a solvent in the presence of any open flame. Doing so can lead to the formation of phosgene, which is a highly poisonous gas.

DO'S

1. Do use a blower or canvas wind chute to blow air into a compartment in which a cleaning solvent is being used.
2. Do open all usable portholes, and place wind scoops in them.
3. Do place a fire extinguisher close by, ready for use.
4. Do use water compounds in lieu of other solvents where feasible.
5. Do wear rubber gloves to prevent direct contact.
6. Do use goggles when a solvent is being sprayed on permissible surfaces.
7. Do hold the nozzle close to the object being sprayed.

Inhibited methyl chloroform should be used where compounds are not feasible. Methyl chloroform is an effective cleaner and about as safe as can be expected when reasonable care is exercised in applying it. Its use requires plenty of ventilation and observance of fire precautions. Avoid direct inhalation of the vapor. Inhibited methyl chloroform is unsafe for use with a gas mask because the vapor displaces oxygen in the air.

For additional information on the safety precautions to be observed when using solvents, see articles 9600-412 through 9600-415 of the NavShips Technical Manual.

APPENDIX I
GLOSSARY OF TERMS

ACP — "Allied Communications Publication." Provides communications instructions and procedures essential to conducting combined military operation and communications in which two or more allied nations are involved.

AF — "Audio Frequency." A frequency which can be detected as a sound by the human ear. The range of audio frequency extends from approximately 20 to 20,000 Hps.

AFTS — "Audio Frequency Tone Shift." Keeping the radio carrier constant and shifting back and forth between two discrete audio frequency tones to produce the MARK/SPACE signals of a teletype channel.

AMPERE — The practical unit of electrical current.

AMPLITUDE — The maximum periodically varying quantity (such as an alternating voltage) as measured from its average or zero values.

AMPLITUDE MODULATION — The process by which the amplitude of the r-f carrier wave is varied in accordance with the electrical form of the message. In amplitude modulation the frequency of the r-f carrier remains constant.

ANTENNA — A device used to radiate or intercept radio waves.

ANTENNA LOADING — The process of adding/removing inductance or capacitance of an antenna to make its electrical length adaptable to the radiated or received signal.

ATMOSPHERE — The mixture of gases, chiefly oxygen and nitrogen that surrounds the earth.

ATTENUATION — A reduction or loss in energy. Attenuation occurs naturally during wave travel through lines, waveguides, spaces, or a medium such as water. Attenuation may be produced intentionally by inserting an attenuator in a circuit or placing an absorbing device in the path of the radiation.

AUTODIN — "Automatic Digital Network." A worldwide automatic communication system that provides automatic data service. It is a general purpose network of the defense communications system.

AUTOVON	"Automatic Voice Network." An automatic circuit switching network which provides voice interconnection between military and other installations. Navy afloat and aircraft units are provided access to autovon.
BAUD	A unit of telegraph signaling speed. The speed in bauds is the number of code elements (marks and spaces) per second.
BIDIRECTIONAL	Response in two opposite directions.
CALIBRATING	To determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter or other device or to determine the settings of a control that correspond to particular values of voltage, current, frequency or some other characteristic.
CARRIER	The unmodulated radio wave produced by a transmitter.
CIC	Meaning #1: Combat information center. Meaning #2: Content Indicator Code. Which intended meaning will be readily apparent to the reader by the contents of the subject matter.
CODRESS	Message type where the originator and all addressees are included in the encrypted text.
CONDUCTIVITY	The ability of a material to conduct electric current.
CRITICAL FREQUENCY	The maximum frequency below which a radio wave will be refracted by an ionospheric layer at vertical incidence at a given time. Higher frequencies will penetrate the layer. Also called penetration frequency.
CURRENT	A movement of electrons or charges along a conductor.
DECIBEL	A unit used to relate the ratio of two power levels. Each three decibels (db) is equivalent to a 2-to-1 power ratio.
DIFFRACTION	The apparent bending of a wave around edges of an object. It is caused by interference between wave components scattered by the boundaries of the object.
DIRECT WAVE	A radio wave that is propagated in a straight line from transmitter to receiver.
DISTORTION	An undesired change in waveforms.
DNC	Director Naval Communications.
DUCTING	A phenomenon in which radio waves are trapped in a layer or duct of warm air. The duct acts as a wave guide and may cause the wave to be received over abnormally long distances.

EHF	Extremely high frequency. (30 - 300 GHZ)
ELECTROMAGNETIC ENERGY	Energy associated with radio waves, heat waves, and other types of electromagnetic radiation.
ENCRYPTION	The process of converting intelligible information to an unintelligible form for transmission.
EXEMPT	An element of a collective call sign who is not an intended addressee of the message. Designated by the prosign XMT.
FACSIMILE (FAX)	A system of communication in which a photograph, map, or other fixed graphic material is scanned and the information converted into signals for transmission by wire or radio to a facsimile receiver at a remote point.
FADING	Variations, usually gradual, in the field strength of a radio signal that are caused by changes in the transmission path or medium.
FEEDBACK	The return of a portion of the output of a circuit to its input.
FIELD STRENGTH	The strength of an electric, magnetic, or electromagnetic field at a given point.
FREQUENCY	The number of complete cycles per unit of time for periodic phenomena such as alternating current, sound waves, or vibrating systems.
FREQUENCY DIVERSITY	Diversity reception which involves the use of two or more carrier frequencies, each having the same modulation, to take advantage of the fact that fading does not occur simultaneously on different frequencies.
FREQUENCY MODULATION	Modulation in which the instantaneous frequency of the carrier is caused to change by an amount proportional to the instantaneous amplitude of the modulating wave.
FREQUENCY OF OPTIMUM TRAFFIC	The frequency, depending upon the condition of the ionosphere, which is capable of providing the communications between two specific points for a given hour.
FSK	Frequency Shift Keying. A variation of frequency modulation. The r-f carrier frequency is shifted above and below the carrier frequency of the transmitter corresponding to the marks and spaces of a teletype signal.
FREQUENCY SPECTRUM	The entire range of frequencies from sound waves up through the various degrees of light waves.
GIGAHERTZ	Kilomegahertz. Giga is a prefix representing 10^9.

GROUNDWAVE	Refers to those types of radio transmissions that do not make use of refractions from the ionosphere. Direct waves, ground-reflected waves, surface waves, and tropospheric waves are all components of the ground wave.
GROUND REFLECTED WAVE	The component of the ground wave that reaches the receiving antenna after being reflected from the ground or the sea.
HERTZ	Term used to indicate cycles per second. Example: Hz, KHz, MHz, etc.
INCIDENT WAVE	A wave that impinges on a discontinuity or on a medium having unlike propagation characteristics. Also, a current or voltage wave that is traveling through a transmission line in a direction from source to load.
INFRARED	Electromagnetic radiation that lies in the frequency range just below that of visible red light.
IONOSPHERE	The outer region of the earth's atmosphere where ions and electrons are present in quantities sufficient to effect the propagation of radio waves. It begins about 30 miles up and extends to about 250 miles.
ISB	Independent Side Band. Independent sideband is radiation of a reduced r-f carrier on which one intelligence is used to modulate the upperside and another intelligence is used to modulate the lowerside.
ISOTROPIC ANTENNA	A hypothetical antenna that radiates or receives signals equally well in all directions.
KHZ	Kilo Hertz (1000 Hertz).
LOBE	The "tear drop" shaped radiation pattern of a directional antenna. The direction of maximum radiation coincides with the axis of the major lobe. All other lobes in the pattern are called minor lobes.
LOWEST USABLE FREQUENCY (LUF)	The lowest high frequency which is dependent upon equipment characteristics that is effective at a specified time for ionospheric propagation of radio waves between two specified points.
LSB	Lower sideband. The band of frequencies in an amplitude modulated r-f wave which extends from the r-f carrier frequency to 3 KHz below the r-f carrier frequency.
MAXIMUM USABLE FREQUENCY (MUF)	The highest operating frequency that is reflected from the ionosphere for a point-to-point path for 50% of the days in a given month.
MICROWAVE	Wavelengths in the microwave spectrum from about 30 cm to 0.3 cm.

MHz	Mega Hertz. (1,000,000 Hertz)
NAVCALS	Naval communication area local station. Coordinates control of communications under direction of NAVCAMS.
NAVCAMS	Naval communications area master station, control coordination of all naval communications within a NAVCOMMAREA.
NAVCOMMSTA	Naval communications station. An activity which operates and maintains those facilities, systems, equipments, and devices necessary to provide requisite fleet support and fixed communications services for a specific area.
NAVCOMMU	Naval Communications Unit. An activity smaller in personnel, resources a facilities than a NAVCOMMSTA and which is assigned a more limited or specialized functional mission.
NAVRADSTA	Naval Radio Station. A NAVRADSTA may be either transmitter or receiver and provides the navcommsta/navcommu with transmitting and receiving facilities.
NOISE	An undesired electric disturbance that tends to interfere with the normal reception or processing of a desired signal.
NORATS	Operational radio and telephone system. A system that provides an interface between voice radio circuits and shore telephone system. Designed to enable commands afloat or airborne to communicate directly with commands ashore.
NULL	An indication of zero or minimum value for a measured quantity.
OFF-LINE	The term used to describe the process of encrypting messages for transmission using manual procedures and having the message in an encrypted form when handled by the operator.
OHM	The unit of electric resistance. A current of 1 ampere will flow through a resistance of 1 ohm when a voltage of 1 volt is applied.
OMNIDIRECTIONAL	Radiating or receiving evenly in all directions.
ON-LINE	The term used to describe the method of automatically encrypting a message as it is transmitted through a classified crypto system.
OSCILLATOR	A circuit that generates alternating current at a frequency determined by the values of its electrical components.
PARABOLIC ANTENNA	A directional microwave antenna using some form of parabolic reflector to give improved sensitivity and directivity.

PEAK ENVELOPE POWER (PEP)	The average power supplied to an antenna by a single sideband transmitter.
PHASE	The position of a point on the wave form of an alternating or other periodic quantity with respect to the beginning of the cycle.
PHASE MODULATION	Modulation in which instantaneous phase of the carrier wave is caused to shift from its normal position by an amount proportional to the instantaneous amplitude of the modulating wave.
POWER	The rate at which electrical energy is supplied to or taken from a device, measured in watts.
PROPAGATION	The method by which electromagnetic or sound waves travel through a conducting medium.
RADIO FREQUENCY (r-f)	A frequency at which coherent electromagnetic energy is useful for communications purposes.
REFLECTOR	A system of metallic rods, screens, or surfaces used with an antenna to give it a directional effect.
REFRACT	The bending of heat, light, radar, radio, or sound waves as they pass obliquely from one medium to another in which the velocity of propagation is different.
RELATIONSHIP OF VOLTAGE, CURRENT, RESISTANCE, AND POWER	Voltage is the force that moves electrons, creating current flow. Current flow is directly proportional to the amount of applied voltage. Resistance is the opposition a circuit offers to the flow of current. In a circuit containing only resistance power is equal to the product of the current and the voltage.
RELEASING OFFICER	The commanding officer or officers designated by the commanding officer with the authority to release outgoing messages for the command.
RESISTANCE	The opposition that a device or material offers to the flow of electrical current. Resistance is measured in ohms.
RESONANCE	The condition existing in a circuit when the frequency of an applied voltage or current equals the natural or resonant frequency of the circuit.
RFCS	Radio Frequency Carrier Shift. See the definition for FSK.
RHOMBIC ANTENNA	A horizontal antenna having the shape of a diamond or rhombus. Usually fed at one apex and terminated with a resistance or impedance at the opposite apex.
SELECTIVITY	A merit figure that expresses the ability of a circuit or device to respond to an input quantity.

SHF	Super High Frequency (3-30 GHz)
SKIP DISTANCE	The shortest distance, from the transmitter, at which a given sky wave will be returned to the earth after reflection from the ionosphere.
SKIP ZONE	An area beyond the groundwave reception region, within which no radio signals are received. Beyond the skip zone sky-wave signals may be received.
SKY WAVE	A radio wave that travels upward and away from the earth. It may be returned to the earth by refraction from the ionosphere.
SPACE DIVERSITY	Radio reception involving the use of two or more antennas located several wavelengths apart. These antennas feed individual receivers whose outputs are combined.
SPACE WAVE	The component of a radio wave that travels through space from the transmitting antenna to the receiving antenna. One part of the space wave travels directly to the receiving antenna while the other part is reflected off the earth.
STANDING WAVES	A stationary wave which builds up on a transmission line when some of the energy being fed by the source is reflected back from the load. The incident and reflected energy re-enforce at fixed points and build up a standing wave.
STRATOSPHERE	A layer of the earth's atmosphere above the troposphere extending from about 7 miles to about 50 miles above the earth. The temperature is essentially constant in the stratosphere.
SUNSPOT	A dark spot observed on the sun. Such observations are usually followed by magnetic storms near the earth. These storms affect radio communications at the lower frequencies.
SURFACE WAVE	A wave that travels along the surface of the earth. The distance the surface wave travels from the transmitting antenna is governed by the power generated from the transmitter.
TROPOSPHERE	The portion of the earth's atmosphere extending upward from the surface of the earth up to about 6 miles in which temperature generally decreases with altitude, clouds form, and convection exists.
TUNING	Adjusting circuits for best performance at a desired frequency.
TWX	A commercial teletypewriter exchange.
UHF	Ultra-High Frequency. (300-3000 MHz)

UNIDIRECTIONAL	Flowing in only one direction such as d-c current. Radiating in only one direction.
USB	Upper Side Band. The band of frequencies in an amplitude modulated r-f wave which extends from the r-f carrier to 3 KHz above the r-f carrier.
VLF	Very Low Frequency. (below 30 KHz)
VOLT	The unit of voltage, potential difference, and electromagnetic force. One volt will cause a current of one ampere to flow through a resistance of one ohm.
VOLTAGE	The term used to designate a difference in electrical pressure between two points in a circuit which is capable of producing a flow of current.
WATT	The unit of electrical power. In a d-c circuit, the power (in watts) is equal to the voltage (in volts) multiplied by the current (in amperes).

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