NAVY TRAINING COURSES

RADIOMAN 3 & 2

NAVPERS 10228-B

RADIOMAN 3 & 2

Prepared by

BUREAU OF NAVAL PERSONNEL

NAVY TRAINING COURSES

NAVPERS 10228-B

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ACTIVE DUTY ADVANCEMENT REQUIREMENTS

REQUIREMENTS*	E1 to E2	E2 to E3	E3 to E4	E4 to E5	E5 to E6	E6 to E7A
SERVICE	4 mos. service—or completion of recruit training.	6 mos. as E–2 or 8 mos. total service.	6 mos. as E–3 or 14 mos. total service.	12 mos. as E–4.	12 mos. as E–5; total service at least 36 mos.	36 mos. as E–6.
SCHOOL	Recruit Training.		Class A for PR3, PRS3.		Class B for MN1.	Class B for AGCA, MNCA, MUCA.
ENLISTED PERFORMANCE EVALUATION	As used by CO when approving advancement.		Counts toward performance factor credit in advancement multiple.			
PRACTICAL FACTORS	Locally prepared check-offs.		Records of Practical Factors, NavPers 760, must be completed for all PO advancements.			
PERFORMANCE TEST			Specified ratings must complete applicable performance tests before taking examinations.			
EXAMINATIONS	Locally prepared tests.		Service-wide examinations required for all PO advancements.			
NAVY TRAINING COURSE (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.				
AUTHORIZATION	Commanding Officer		U. S. Naval Examining Center			BuPers
	TARS are advanced to fill vacancies and must be approved by district commandants or CNARESTRA.					

*Recommendation of petty officers, officers and approval by commanding officer required for all advancements.

INACTIVE DUTY ADVANCEMENT REQUIREMENTS

REQUIREMENTS*		E1 to E2	E2 to E3	E3 to E4	E4 to E5	E5 to E6	E6 to E7A
	FOR THESE DRILLS PER YEAR						
TOTAL TIME IN GRADE	24 OR 48 12 NON-DRILLING	9 mos. 9 mos. 12 mos.	9 mos. 15 mos. 24 mos.	15 mos. 21 mos. 24 mos.	18 mos. 24 mos. 36 mos.	24 mos. 36 mos. 48 mos.	36 mos. 42 mos. 48 mos.
DRILLS ATTENDED IN GRADE#	48 24 12	27 16 8	27 16 13	45 27 18	54 32 20	72 42 32	108 64 38
TOTAL TRAINING DUTY IN GRADE#	24 OR 48 12 NON-DRILLING	14 days 14 days None	14 days 14 days None	14 days 14 days 14 days	14 days 28 days 14 days	28 days 42 days 28 days	42 days 42 days 28 days
PERFORMANCE TESTS				Specific ratings must complete applicable performance tests before taking examination.			
PRACTICAL FACTORS (INCLUDING MILITARY REQUIREMENTS)		Record of Practical Factors, NavPers 1316, must be completed for all advancements.					
NAVY TRAINING COURSE (INCLUDING MILITARY REQUIREMENTS)		Completion of applicable course or courses must be entered in service record.					
EXAMINATION		Standard exams are used where available, otherwise locally prepared exams are used.					
AUTHORIZATION		District commandant or CNARESTRA					BuPers

*Recommendation of petty officers, officers and approval by commanding officer required for all advancements.

#Active duty periods may be substituted for drills and training duty.

PREFACE

This book is written for men of the U.S. Navy and Naval Reserve who are studying for advancement to the rates of Radioman 3 and Radioman 2. It includes a survey of naval communications, and contains discussions of security, international Morse code, administration, and the various communication procedures. Four chapters relate in whole or in part to communication equipment. It should be noted that, on the recommendation of the Chief of Naval Operations, chapter 10 on Teletypewriter Procedure is marked FOR OFFICIAL USE ONLY.

Those who work in communications know how fast procedures and equipment evolve. This book was up to date when published, and it will, from time to time, be revised. Between revisions 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 Navy Training Courses, *Radioman 3 and 2* was prepared by the U.S. Navy Training Publications Center for the Bureau of Naval Personnel, and was reviewed by the Office of the Chief of Naval Operations (CNO–DNC).

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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READING LIST

NAVY PUBLICATIONS

Radioman 3 and 2, NAVPERS 10228–B	3, 2
Basic Electricity, NAVPERS 10086, chapters 1 through 5, 7 through 8, 13.	3
U. S. Navy Safety Precautions, OPNAV 34P1, chapter 18.	3
ACP's 122, 124, 125, 126, 127, 149 (effective editions)	3
DNC 5 (effective edition)	3
DNC 26, chapter 1	3
NWIP 16–1	3
Basic Electronics, NAVPERS 10087, chapters 1 through 9, 11, 12, 13.	2
DNC 26	2
NWP 16	2
Electronics Technician 2, vol. 1, NAVPERS 10190–A, chapters 1 through 8.	2
Handbook of Test Methods and Practices, NAVSHIPS 91828–A, articles 3–1 through 3–6.	2

USAFI

United States Armed Forces Institute (USAFI) courses for additional reading and study are available through your Information and Education Officer*. A partial list of the courses applicable to the Radioman rating follows. Course numbers beginning with M designate self-study courses; course numbers beginning with C designate correspondence courses. Texts are the same for both.

Number	Title
MA 781 or CA 781	Fundamentals of Electricity
MA 885 or CA 885	Fundamentals of Radio
MA 887 or CA 887	Intermediate Radio
MB 331 or CB 331	Typewriting I

*Members of the United States Armed Forces Reserve components, when on active duty, are eligible to enroll for USAFI courses, services, and materials, if the orders calling them to active duty specify a period of 120 days or more, or if they have been on active duty for a period of 120 days or more, regardless of the time specified in the active duty orders.

CREDITS

Information concerning teletypewriter equipment appears in this book through the courtesy of the American Telephone and Telegraph Company. Certain passages in chapter 9, as well as figures 9–11, 9–14, 9–15, and 9–18 through 9–21, were taken from the following publications:

How to Operate the No. 15 Page Teletypewriter.

How to Operate the No. 19 Page Automatic Teletypewriter.

How to Operate the No. 28 Keyboard Sending and Page Receiving Teletypewriter on Private Line Service. Manual TTY–28–1.

RADIOMAN 3 & 2

CHAPTER 1

INTRODUCTION—WHY BE A RADIOMAN?

The fleet needs good men in all ratings, for a modern naval force is only as good as the men who man the ships. Even with the most modern equipment, a naval force would be almost powerless without good men to operate and maintain that equipment.

The Navy needs intelligent, devoted men: the Navy needs GOOD RADIOMEN. Effective communications are vital to the success of a modern navy. A battle could be lost because of a communication failure, or by the mistakes of poorly trained communication personnel.

Radiomen, in effect, are part of the operating forces, whether stationed aboard ship or at a shore station that transmits vital information to the fleet. Wherever you are stationed as a Radioman, you won't be loafing! It's a tough job, often requiring long hours of work. But it is rewarding—not in extra pay, but in the realization of a job well done, a vital job well done.

What Does a Radioman Do?

The Radioman is primarily an operator, but he does have responsibilities as a technician. Look at the qualifications in appendix II! They show you that, aside from knowing how to operate it, you have to know what makes your equipment work.

Radiomen are used in all important segments of the Naval Establishment—from large communication centers to small stations, from attack carriers to the smallest patrol craft. They keep vital information flowing.

Ashore, most Radiomen are found in communication centers. Here, they are concerned with getting messages to and receiving them from ships of the fleet, and also monitoring other circuits. Radiomen also operate teletypewriters, fascimile equipment, radio direction finders, and electronic countermeasures equipment.

Afloat, the Radioman is a "jack of all trades" in the communication business. His assignments include a little bit of everything, such as manning radiotelephone circuits, copying fleet broadcasts, operating teletypewriter equipment, or operating electronic countermeasures equipment.

Along with operating these equipments, the Radioman must be prepared to keep them in operation and perform maintenance when necessary.

Now you know in a general way what a Radioman does. But you might ask, "What must I do to become a Radioman?" It takes a WILLINGNESS TO LEARN and to WORK. Together, these qualities can take you a long way in the Navy.

ADVANCEMENT

Rating Structure

First, let's review the rating structure. The enlisted rating structure is a systematic alignment of groups (rates and ratings) and is the Navy's primary tool for classifying enlisted personnel. Jobs which require about the same skills, knowledge, and training are classified under one rating, such as Radioman. Remember that RADIOMAN is the rating and RM3, RM2, RM1, and RMC are rates or pay grades within the rating. Advancements within that rating require more complex skills, broader knowledge, and the ability to assume more responsibility.

Some ratings, such as FT, have emergency service ratings. Others also have exclusive emergency service ratings.

An emergency service rating covers just part of the qualifications of the parent rating. Most members of the Naval Reserve hold an emergency service rating. In wartime, Regular Navy personnel would shift to emergency service ratings.

An exclusive emergency service rating is used only under conditions of full mobilization. It is designed to fit recruits, who have specialized skills, into the Navy with a minimum of technical training. These ratings do not exist in peacetime.

All ratings are gathered in 12 different groups. Ratings within the group are occupationally related. Radioman, for instance, is in group V along with Communications Technician, Yeoman, Personnel Man, and others.

Advancement Quals

To find out what you have to know to be eligible for advancement, consult the *Manual of Qualifications for Advancement in Rating* (NavPers 18068, Revised). Your training officer has a copy. This publication lists the minimum qualifications required of enlisted personnel for advancement. The "Quals" have two main divisions, MILITARY and PROFESSIONAL. Each is further divided into PRACTICAL FACTORS and EXAMINATION SUBJECTS, and, in some ratings, the professional division also has PERFORMANCE TESTS. Practical factors can be described as AN ABILITY TO and the exam subjects as A KNOWLEDGE OF.

Military requirements are those general qualifications which apply to all enlisted personnel, such as watch standing, first aid, and military conduct. Before being advanced, you must show that you are proficient in each of the qualifications specified for the next pay grade. You also may be required to demonstrate your proficiency in the quals for all the lower pay grades. Be sure you learn well!

Professional qualifications for Radioman are listed in appendix II. Study them. Be sure that you know what is expected of you. But remember that these are the MINIMUM quals.

Now, how do you go about getting advanced? First, there are certain basic requirements that must be met, such as length of service in pay grade and total service, sea duty time, and minimum quarterly marks. These requirements vary from time to time; so check with your leading PO or with your division officer to make sure that you meet these requirements.

Next, you must satisfactorily complete the Navy training course for Radioman, and demonstrate your ability in the practical factors.

You must then be recommended by your commanding officer. Among other things, you must have demonstrated leadership ability and personal integrity. His recommendation makes you eligible to take the service-wide competitive examination. If you pass the examination with a high enough score, your commanding officer will be given authority to advance you in rating.

Remember, though, that you can pass and still not be advanced. The reason is that it sometimes is necessary to establish quotas, and only those making the highest scores will be advanced. It therefore behooves you to learn as much as you can in order to be certain of attaining one of the "highest" scores. That's where this book comes in.

This textbook provides a base on which to build your knowledge of the Radioman rating. It will teach you radiotelegraph, radiotelephone, and the teletypewriting procedures. It introduces you to representative communication equipment. But refer to *Basic Electronics* (NavPers 10087) and *Basic Electricity* (NavPers 10086). Make sure that you understand the required portions of each. Then you are ready to tackle *Radioman 3 and 2.*

Correspondence Courses

Your ship may require that you take the correspondence course for *Radioman 3 and 2,* or may have its own local program. Regardless of which system is used, the course will be based on this book, so start studying it.

Carry it around with you. Study it when you have a spare moment or two. Read it and reread it, because you'll never learn what's in the book by reading it just once. But don't try to absorb too much at one time.

After reading a page or two, see if you can restate the high points in your own words. Don't make the mistake of memorizing the text. Instead, a summary in your own words will be your ticket to understanding. Put the major points in writing—in other words, take notes on what you have learned. It'll help to fix the ideas firmly in your mind.

Work steadily. You are much better off studying a little bit often than studying a lot occasionally. Steady progress is the keynote to success.

Test your progress by answering the questions at the end of each chapter. If you can't answer one, go back over the material. If it still puzzles you, ask your leading petty officer for help. He'll be glad to square you away.

Follow this same plan for a correspondence course. You won't get too much out of the course if you just hunt through the book trying to answer each question as you come to it. Read and study the text, then answer the questions. After you have answered as many as you can, then look all of them up in the text.

Even if a correspondence course isn't required on your ship or station, or in your unit, it's a good idea to enroll in one. Aside from the general benefit of knowing your rating better, it'll give you practice for the service-wide exam.

To enable you to get the most out of this book, an index is provided. Important items with their page numbers are listed alphabetically for your convenience. A table of contents in the front of the book lists the chapter headings. Also in the front of the book you will find a preface. It gives you some additional information on this text. By all means read it.

Another important item. This book doesn't have all the answers. It's only the beginning. Following the preface you will find a reading list which is based on *Training Courses for General Service Ratings,* NavPers 10052–D. You should become familiar with all of these publications. They make up a study guide to help you learn as much as possible about your rating.

LOOKING AHEAD

Let's look beyond Radioman Third and Second Class. Let's assume that you have studied hard, worked hard, passed with flying colors, and are going on to bigger and better things.

As you advance from Radioman Second Class to First Class, you will be expected to assume more responsibility in the communication division. You will be required to help train and supervise other Radiomen. You will be expected to be able to work on more complicated mechanisms and to assume a greater administrative burden.

To advance to Chief Radioman you must be ready to organize a communication office either at a shore station or aboard ship. You will be asked to assign personnel to various jobs. And you must have the ability to plan, organize, and supervise the training program for Radiomen.

Opportunities Offered

The Navy encourages ambitious men and provides many opportunities for self-improvement and advancement. How well you do depends to a large degree on you. If you conscientiously apply yourself, you'll get those promotions. And if you have talent to spare, the door is wide open. From Chief Radioman, you can advance to warrant officer (Electronics Technician). But for this billet, you must exert yourself, studying your allied ratings closely. As a warrant officer you may have to supervise RD's, SO's, and ET's, besides RM's.

Another possibility for the ambitious Radioman is the Limited Duty Officer program. To become eligible you have to be a First Class PO and have at least 10 years' naval service. If selected, you will be commissioned an ensign with limited duty in electronics. Don't wait until you have 9½ years' service before you start your preparations. Dig in now! See your division officer and your I and E officer to get some help in planning a sound educational program. Advanced planning is necessary to success.

Good luck and smooth sailing!

CHAPTER 2

NAVAL COMMUNICATIONS

A naval force stands out to sea as a fast striking unit that steams for thousands of miles, prepared to offer battle wherever the enemy may be found. Such a force may consist of scores of ships of many specialized types. When in disposition to meet an atomic or thermonuclear attack, it may be spread over an area the size of the state of Connecticut.

No matter how deep into hostile waters a force may penetrate, it is never 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 which 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

In performing your duties you do your part to fulfill the mission of naval communications. This mission is to provide trustworthy, fast and secure communications adequate to meet the Navy's needs, both in peace and war. Communciations has two major aims: first, to serve command; second, to aid administration. COMMAND controls and directs naval forces. ADMINISTRATION provides the men, material, and supplies. Communications serves command when it carries battle orders from a fleet commander to his subordinates, forwards docking information from harbor control to an entering vessel, or delivers a storm warning from SOPA to all ships in the area. It aids administration when its circuits are used to hurry the movement of supplies to an advanced base, to furnish ship alteration data to an overseas repair facility, or to arrange transportation for a draft of men.

Naval communications is further pledged to assist in such disasters as floods, hurricanes, and earthquakes when normal communication facilities are out in the disaster area.

POLICY OF NAVAL COMMUNICATIONS

The policy of naval communications is to—

1. Carry out its mission.
2. Promote the safety of life at sea and in the air, and maintain facilities for communication with the United States merchant marine, aircraft over the sea, and with domestic and foreign communication stations.
3. Encourage development of commercial and amateur communication activities, and increase their value to national security.
4. Work with the other services and with Government agencies to coordinate military communications; improve Government communications; avoid unnecessary duplication of facilities; help in standardizing communication methods, procedures, and material; and assist in making national communication policy.

SOME BASIC COMMUNICATION PRINCIPLES

Through the years naval communications has always been guided by certain basic principles. Foremost among these are RELIABILITY, SECURITY, and SPEED. Reliability of communications is always first. A message must say exactly what the originator meant it to say; it must be sent by the best means of communication available; and it must be complete and accurate in every way when finally placed in the hands of the addressee.

Present operating procedures provide both good security and reasonable 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, and security is more important than speed. During a critical moment in combat, however, very urgent messages may be sent in plain language rather than be delayed for encryption and decryption. Here security is sacrificed for speed.

Another fundamental principle of naval communications is PREPAREDNESS. Peacetime methods and procedures must be so organized that very little time and effort would be wasted in shifting to a full wartime status. It is also necessary that the means for prompt transmission of warnings and of operational information be instantly available. For these reasons the Navy keeps its training level high, and maintains emergency and standby communication facilities.

TELECOMMUNICATIONS

The word TELECOMMUNICATIONS refers to communication over a distance. There are several forms of telecommunication, of which at least five—radiotelegraph, teletypewriter, radioteletypewriter, radiotelephone, and facsimile—concern the Radioman as operator. In your message-handling duties afloat and ashore, however, you will also work with traffic sent by other methods. Know what they are.

I. ELECTRICAL TELECOMMUNICATIONS
   A. Radiotelegraph
   B. Teletypewriter

C. Radioteletypewriter
D. Radiotelephone
E. Television
F. Facsimile
G. Underwater cable

II. VISUAL TELECOMMUNICATIONS
A. Flaghoist
B. Flashing light
C. Semaphore

ELECTRICAL TELECOMMUNICATIONS

Radiotelegraph

Radiotelegraph (often called CW for "continuous wave") is a system for transmitting messages by a radio wave which an operator separates into the dits and dahs of the Morse code by opening and closing a hand key. Radiotelegraph was in use by the Navy as early as 1903, and even today, in spite of the development of faster and more convenient methods of electronic communications, is one of the most reliable and trustworthy systems possessed by the Navy.

According to a NATO staff communicator:

> No technical advances have eliminated the need for the manual radio operator. To date, we have no automatic method that can in size, weight, frequency economy, and simplicity compare with CW telegraphy; we have no system which will discriminate against accidental or intentional interference to the extent possible with a trained operator. There is no electronic substitute for an operator's brain . . . Under marginal conditions the additional flexibility, simplicity, and reliability of a CW circuit may mean the difference between having and not having communications.

Teletypewriter and Radioteletypewriter

The mental and manual actions performed by an operator in converting letters to Morse code (and vice versa) are replaced in teletypewriter and radioteletypewriter 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 is transmitted. At receiving stations the signals are fed into receiving machines, which type the message automatically.

Teletypewriter signals may be sent either by landline or by radio. Landline teletypewriter communication is used both by the military services and by commercial communication companies, such as Western Union. Radioteletypewriter (RATT) is primarily intended to furnish high-speed automatic communication over ocean areas.

Today the primary shipboard use of RATT is for receiving fleet broadcast schedules, for which it is very well suited. Radioteletypewriter can clear traffic at a rate up to 100 WPM, as compared to the 18- to 25-WPM speed of the CW fleet broadcasts. Since the shipboard operator is freed from manual copying, and hundreds of vessels may be receiving a single broadcast, the total saving in trained manpower is considerable.

Radiotelephone

Radiotelephone (sometimes called voice radio) is one of the most useful military communication methods.

Because of its directness, convenience, and ease of operation, radiotelephone is used by ships and aircraft for short-range tactical communication. Its direct transmission of voice makes it possible for a conning officer to have in his hands a means of personal communication with the OTC and with other ships. There is little delay while a message is prepared for transmission, and acknowledgments can be returned instantly. Radiotelephone equipment is usually operated on frequencies that are high enough to have line-of-sight characteristics—that is, the waves will not follow the curvature of the earth. This limits the usual range of radiotelephone from 20 to 25 miles, thus giving a certain degree of security. Radiotelephone procedure can be learned fairly easily by persons with no other training in communications.

With these advantages of radiotelephone go some disadvantages. Transmissions may be unreadable because of static, enemy interference, and a high local noise level caused by shouts, gunfire, and bomb or shell bursts. Wave propagation characteristics of radiotelephone frequencies are sometimes 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 take care what they say.

Television

Military television is still in the experimental stage. There is little such equipment in the fleet today, but television promises to be useful for purposes requiring rapid and continuous transmission of pictorial data from a distance. It seems especially suitable for—

1. Remote steering of guided missiles.
2. Reception of reconnaissance data from aircraft.
3. Remote inspection of underwater salvage operations.
4. Simultaneous briefing of many commanding officers or aviators of a task force when the tactical situation is too urgent to permit duplication of weather data, charts, or other pictorial information.

Facsimile

Facsimile (FAX) resembles television in that it is a process for transmission of pictures. It is unlike TV in that (1) facsimile gives the receiving station a permanent record of the transmission while television does not; and (2) facsimile requires several minutes to transmit a picture twice the size of this page, while television sends a continuous stream of 30 pictures per second.

FAX is very useful for transmitting such matter as photographs and weather charts. The image to be sent is scanned by a photoelectric cell, and variations in the cell output due to the character of the picture are used to modulate a radio wave. At the receiver the signal operates a recorder which reproduces the picture.

Cable

Cable uses heavily insulated wires for an underwater link between sending and receiving stations. The Navy does not own or operate cables; so cablegrams must be handled by private firms. Cable is used as seldom as possible for official messages, for tolls are high and the Naval Communication System can usually furnish transoceanic radio facilities.

VISUAL TELECOMMUNICATIONS

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

The most important 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 primary means for transmitting brief tactical and informational signals to surface units. Signals are repeated by addressees, thus providing a sure check on the accuracy of reception. Texts of messages which may be sent are limited to those found in signal books.

Flashing Light

Directional flashing light is a visual telegraphic system in which an operator opens and closes the shutter of a searchlight to form the dits and dahs of the Morse code. The light may be pointed and trained to be seen only from the viewpoint of the receiver.

Nondirectional flashing light is sent out from a lamp secured on a yardarm. Dits and dahs are made by switching the lamp on and off. Since the light is visible in every direction away from the ship, this method is well suited for messages which are for several addressees.

In wartime, flashing light communication that must be carried on after dark is usually conducted by means of infrared beams, which are not visible unless viewed through a special receiver.

Semaphore

Semaphore is a communication means by which an operator signals with two hand flags, moving his arms through various positions to represent letters, numerals, and other special signs. It is especially suitable for long administrative messages because of its speed. It is not readable much farther than 2 miles, even on a clear day.

STRUCTURE OF NAVAL COMMUNICATIONS

There are three elements of naval communications:

1. Office of Director, Naval Communications;
2. The Naval Communication System;
3. Communication organizations of the operating forces.

Office of Director, Naval Communications

The office of Director, Naval Communications (a part of the CNO organization), is the headquarters of naval communications. This office controls radio and visual communications, landline systems, registered publications, and the Navy postal service. The Director of Naval Communications (DNC) is responsible for the work of the office.

Naval Communication System

The Naval Communication System is the physical organization that carries out the orders and instructions of the office of DNC. It includes all shore-based communication activities and the landlines and radio circuits that bind them into a worldwide network. Its purpose is to support the forces afloat. The System consists of the following elements:

1. Shore communication stations: the NAVCOMMSTAS and NAVCOMMFACS, which are all designated as primary or major communication centers; the minor communication centers; and the tributary stations. Except for tributaries, most of these stations are equipped to issue registered publications.
2. Registered publication issuing offices not a part of a NAVCOMMSTA or NAVCOMMFAC.
3. Fleet post offices in San Francisco and New York.
4. Naval Communication Units.
5. The Naval Security Group.

NAVCOMMSTAS AND NAVCOMMFACS. The major elements of the Naval Communication System are its naval communication stations (called naval communication facilities when located on foreign soil), of which the Navy has about 20 in strategic locations over the world.

Five NAVCOMMSTAS and one NAVCOMMFAC are designated as PRIMARY COMMUNICATION CENTERS. They furnish complete radio coverage of the major portions of the earth's ocean areas.

They are—

NAVCOMMSTA Washington, D. C.;
NAVCOMMSTA San Francisco;
NAVCOMMSTA Pearl Harbor;
NAVCOMMSTA Guam;
NAVCOMMSTA Balboa, Canal Zone;
NAVCOMMFAC Port Lyautey, French Morocco.

Each primary center maintains a primary FLEET BROADCAST over which messages are sent to ships in some particular area. Vessels in the Mediterranean, for example, receive traffic from NAVCOMMFAC Port Lyautey, French Morocco. NAVCOMMSTAS Guam and

Pearl Harbor divide the Pacific areas between them. All the major oceans of the world are covered in a similar manner.

Each primary center also sends out a GENERAL BROADCAST of hydrographic information, weather forecasts, time signals, news, and the like. Facilities are also provided for ship-shore communication.

Primary communication centers are linked by radio and landline circuits to each other and to the MAJOR COMMUNICATION CENTERS throughout the world. These are also NAVCOMMSTAS and NAVCOMMFACS, and each maintains these facilities: circuits as necessary for local needs; secondary fleet and general broadcasts covering more limited areas than those of the primary centers; and ship-shore radio circuits.

MINOR COMMUNICATION CENTERS serve areas where the traffic volume is not heavy enough to justify a primary or major center. Most are located at such activities as naval air stations and supply and ammunition depots. They handle local communications and relay messages between tributary stations and the major and minor communication centers.

Each primary, major, and minor communication center maintains a TAPE RELAY STATION whose function is to forward messages in tape form by means of the automatic or semiautomatic tape relay equipment which we will meet later in this manual.

TRIBUTARIES are small stations serving some particular command. They differ from minor communication centers primarily in that they handle less traffic and perform no relay functions. Tributaries are links into the worldwide arterial network of the Naval Communication System. They send out and receive messages as necessary to serve local command.

RPIOS AS SEPARATE ACTIVITIES. Most registered publications issuing offices (RPIOS) are located at NAVCOMMSTAS and NAVCOMMFACS, but it is not always easy for a ship to draw from these activities. On direction of CNO, accordingly, independent RPIOS may be established at places where there is a large amount of shipping, but no NAVCOMMSTA or NAVCOMMFAC.

FLEET POST OFFICES. The FPOS are located in San Francisco and New York. They serve in peacetime to furnish dispatching instructions to the civilian post offices. Mail bound for naval units overseas is sorted, pouched, and labeled by the civilian postal service. It is then shipped by the most direct available transportation. In time of war the fleet post offices take over the actual handling of Navy mail.

NAVAL COMMUNICATION UNIT. Although most of the work of the Naval Communication System is done through NAVCOMMSTAS, NAVCOMMFACS, and smaller stations, important functions are performed by Naval Communication Units (NAVCOMMUS). These are activities set up by CNO to carry out limited support and/or intelligence duties. There are about 13 NAVCOMMUS at present.

A NAVCOMMU is much smaller than a NAVCOMMSTA or NAVCOMMFAC, and performs fewer functions. NAVCOMMUS are designated by number and geographical location, as NAVCOMMU NR 8, Bremerhaven, Germany.

NAVAL SECURITY GROUP. NAVSECGRU performs special communication intelligence missions as directed by CNO.

Communication Organizations of the Operating Forces

The communication organizations of the operating forces provide communication services needed to control and employ fleet units. These services include sending and receiving orders, instructions, reports, and various other forms of intelligence. Communication facilities are provided for rapid ship-shore and air-surface communication as well as for communication among individual units. Each ship is thus assured of receiving traffic necessary to the successful performance of her mission.

JOINT COMMUNICATIONS

The need for close cooperation by communicators of the three services was shown during the early stages of World War II, when Army and Navy facilities were sometimes duplicated in one location, and differences in procedures made truly efficient communications almost impossible.

Navy, Army, and Air Force communications are now coördinated by the Joint Communications-Electronics Committee (JCEC) which is made up of high-ranking communicators from each of the services. The Navy's member is DNC. As a result of the committee's efforts, unnecessary duplication of facilities is avoided. No matter which service builds or operates a particular facility, communication channels may be lent to the others on a full- or part-time basis, as required. For example, under joint practices, the Naval Communication System handles traffic for the Army, Air Force, and Coast Guard when it can do so better than the regular networks of those services.

Communication procedure is now uniform throughout the Department of Defense, which has made interservice message handling much easier. Joint procedure is set forth in Joint Army-Navy-Air Force Publications (JANAP's), and in Allied Communication Publications (ACP's). These publications, by the way, are familiar sights around every communication office. You will use them almost daily.

SHIPBOARD ORGANIZATION

A Radioman assigned duties as traffic router or messenger must know the departments aboard his ship and the nature of the work performed by each. Figure 2–1 shows standard shipboard organization, which serves as

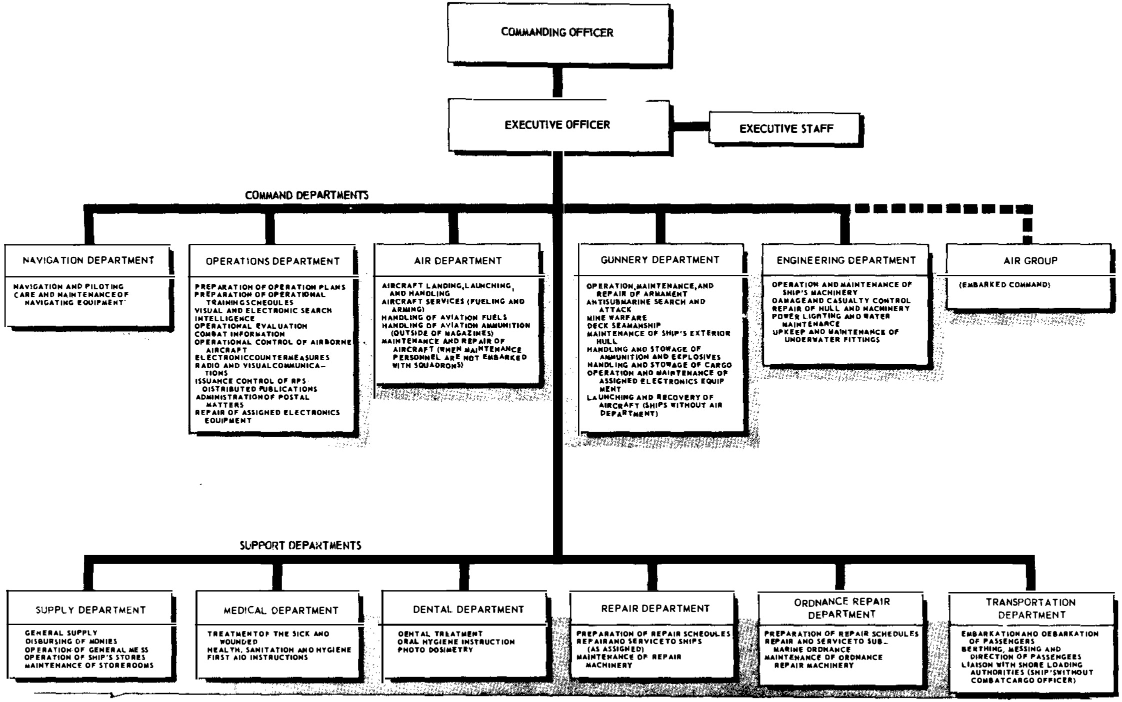


Figure 2–1.—Standard shipboard organization.

a guide for type commanders in preparing the organizations of vessels under their command. Shipboard organization varies slightly among types. In addition to figure 2–1, study the organization book for your particular vessel. If necessary, make exploratory visits to other spaces.

COMMUNICATION ORGANIZATION

Commissioned Billets

The communication organization—shown in figure 2–2—is a branch of the operations department. It is headed by the communication officer, who is responsible for all communications sent and received by radiotelegraph, radiotelephone, radioteletypewriter, facsimile, visual means, mail, and courier. He is not concerned with the ship's internal communications.

The communication officer is also responsible for (1) the care and maintenance of communication equipment; (2) preparation of communication reports; (3) operation of the ship's post office; (4) procurement, custody, correction, distribution, and reports on publications issued to the ship through the registered publications system; (5) supervision and training of the cryptoboard; and (6) cleanliness and upkeep of assigned spaces.

On large vessels the communication organization is divided into two divisions—the OR (radio) division headed by the radio officer, and the OS (visual) division, headed by the signal officer. In addition, the communication organization is assigned a custodian of registered publications, communication watch officers, cryptographers, and a cryptosecurity officer.

The radio officer is responsible for the work of the OR division, and for operation and maintenance of assigned equipment. It is his duty to assure reliable, secure, and rapid handling of radio communications. His responsibilities for the internal handling, routing and filing of messages are usually delegated to communication watch

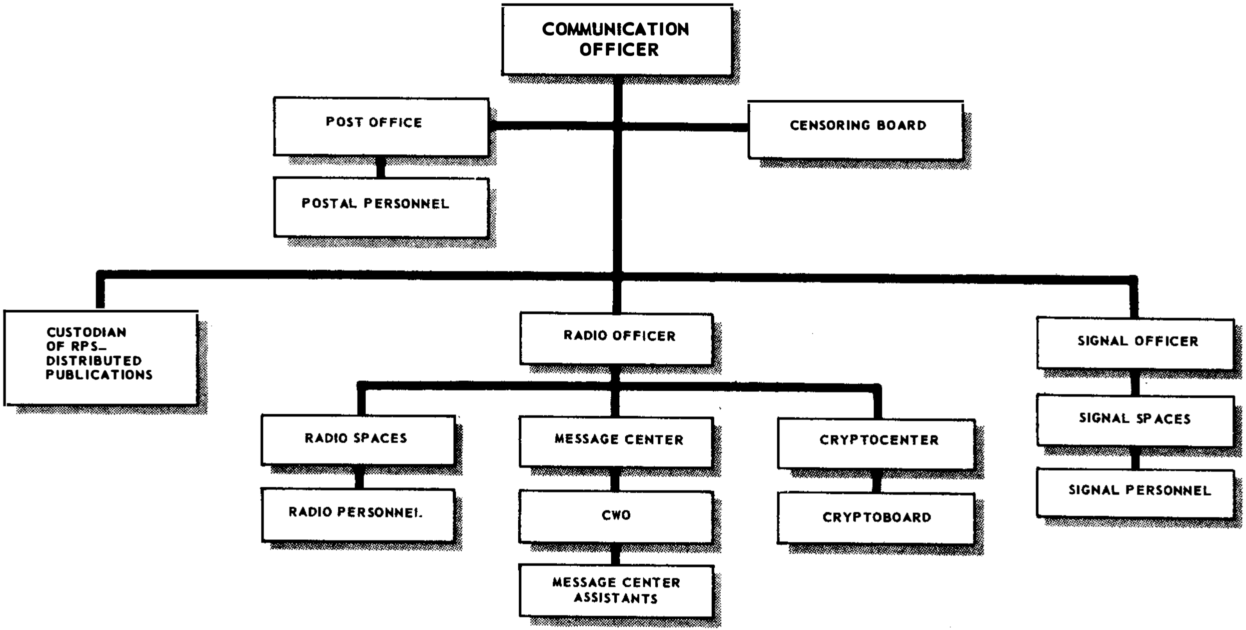


Figure 2–2.—The communication organization.

officers. The radio officer is the communication officer's principal assistant.

The signal officer, heading the OS division, is charged with operation of the ship's visual signaling facilities. His responsibilities in handling visual messages parallel those of the radio officer for radio messages.

The custodian, sometimes called the registered publications officer or RPS officer, is responsible to the commanding officer for keeping a complete, up-to-date, and corrected allowance of registered and nonregistered publications issued by the Registered Publications Section of CNO. He handles the drawing, stowage, correction, destruction, reports on, and issuance of these publications aboard his ship.

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

Cryptographers—collectively called the cryptoboard—assist the CWO with encryption and decryption of messages when the traffic load is so heavy he cannot handle it by himself. Members of the cryptoboard are designated in writing by the commanding officer. All commissioned communicators aboard are members, as well as available officers from other departments.

The cryptosecurity officer is assigned full time only on the largest vessels. He makes certain that effective cryptographic publications are available to those who must have them, and to them only; that cipher machines are in good operating condition; and that members of the cryptoboard are thoroughly trained in their duties. On most ships the custodian, a CWO, or some other communicator is given these responsibilities as collateral duties.

SHIPBOARD COMMUNICATION SPACES

Most large warships have communication spaces located fore, aft, and amidships (fig. 2–3). Besides scattering the ship's antennas, thereby helping to get rid of interference, this arrangement minimizes the danger of loss of communications by heavy damage to one portion of the ship. Equipment is so distributed that any one space can carry on at least partial communications.

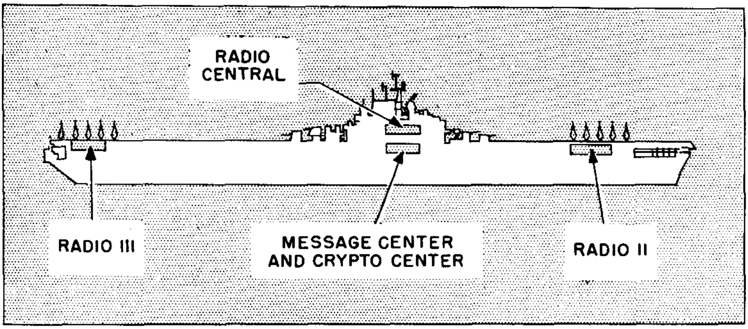


Figure 2–3.—Location of communication spaces, CVA.

The most important communication spaces aboard are amidships, where under normal operating conditions most radio traffic is handled. Here are located radio I (also called radio central and main radio), the message center, and the cryptocenter.

Radio I

Radio I is the duty station of most of the ship's Radiomen. It typically contains message files, radioteletypewriter and possibly facsimile gear, and operating positions for Radiomen—desks equipped with receivers, headphones, typewriters, and telegraph keys.

Message Center

Convenient to radio I is the message center, where outgoing traffic is prepared for transmission and incoming traffic prepared for local delivery. It is an office rather than an operating space, and contains desks for the CWO and other personnel of the watch, unclassified message files, baskets for messages awaiting processing, file boards, message logs, and the like.

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. If the message is classified, it is passed to the cryptocenter, encrypted, then given to radio central or the signal bridge for transmission. Incoming messages—after being received from radio central or the signal bridge—are logged, decrypted if necessary, written up, routed, and delivered by messenger.

Cryptocenter

Adjoining the message center is the cryptocenter, where outgoing messages are enciphered and incoming messages deciphered. Here are found cipher equipment and cryptographic publications (called cryptoaids), safes for the stowage of classified messages, and desks and typewriters as necessary. Files kept in the cryptocenter include a file for classified general messages and one for edited plain language copies of encrypted messages. Use of the cryptocenter is governed by tight security restrictions. Admittance is limited to designated cryptographers, and an entry list is posted on the door. There is only one entrance, which connects into the message center. The door ordinarily is locked, and traffic is passed in and out through a window or slot in the bulkhead.

Radios II and III

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

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

Supplementary radio spaces are scattered throughout large combatant ships. Many of these are small spaces which supplement the three main stations. Other small emergency spaces contain gasoline engine-driven generators for use in case of casualty to the ship's main power supply.

Remote Control Stations

Remote control stations are operating positions for handling radiotelephone transmissions. Stations are located on the navigation bridge, in secondary conn, CIC, all radio spaces, and in other places where direct radiotelephone communication is necessary. 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. For instance, a tactical maneuvering net 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.

SMALL SHIP COMMUNICATION ORGANIZATION

Preceding sections have outlined the communication organization aboard a large ship, where the specific duties of each officer are more clearly defined and standardized. Communication organizations of smaller ships (DD or DE size, for example) carry on much the same work, but their personnel allowances are smaller and each individual must accept more varied duties and a heavier workload.

Communications on a DD or DE is still one of the functions of the operations department, but radio and visual signaling personnel are combined into one division, the OC division. The communication officer may not have any commissioned assistant, or perhaps just one, and must himself do work that on a larger ship would fall to the radio officer, signal officer, custodian, or CWO's. On a destroyer the communication officer is an active assistant to the operations officer. He has deck as well as communication duties, and spends many hours a day on the bridge. If this duty is heavy he may have little time to devote to the routine of communications, and must depend on his first assistant or leading Chief to carry the load.

There is only one individual on a DD CWO watch. He selects the messages to be broken, and decrypts, processes, routes, and files them himself—or with the aid of an enlisted assistant.

A DD has only three radio spaces: radio central, located on the O–I deck of the forward deck house; the cryptocenter, adjoining; and the emergency radio room, abaft midships.

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. 2–4).

The Radioman may have for one or more of his stations the message center, radio central, cryptocenter, radio II or III, an emergency communication space, or the bridge (as a radiotelephone operator).

THE NAVCOMMSTA

Let us take the NAVCOMMSTA for an example of the operation of a naval shore station. Such establishments have many billets for Radiomen, and you might well be assigned to one on your next tour of shore duty.

NAVCOMMSTAS provide communication support facilities for fleets, naval district or river commands, the commanders of naval bases, stations, or shipyards, and Marine Corps supporting establishment commanders. There is no standard organization for NAVCOMMSTAS; the size and scope of their operations vary considerably, and no two are exactly alike. All, however, handle thousands of messages daily, and their personnel must specialize to a far greater extent than aboard ship.

A NAVCOMMSTA may have a personnel allowance ranging from 100 to several hundred officers, men, and civilians, depending upon its functions and the scope of its operations. In addition to communication and electronics personnel, there are also personnel for administration, supply, transportation, and other supporting services.

The commanding officer of a NAVCOMMSTA is usually a captain or commander. He establishes policies and procedures for its operations, and initiates and enforces local directives for its upkeep and security. In addition to his station command, the commanding officer of a NAVCOMMSTA normally is the staff communica-

1st. SECTION

WATCH, QUARTER AND STATION BILL

O-R DIVISION

Billet No.	NAME	Rate All.	Rate Act.	Clean. Sta.	Battle Stations Cond. I	Cond. I[illegible]	Cond. II	Cond. III	Cond. A or Z	Cond. B or Y	Fire & Rescue	Fire	Abandon Ship Boat	Abandon Ship Provide	Collision	Sea Detail	Spec. Det.	Landing Force	Gas Mask
110	A.J. Roth	RMC	RMC	←	IN	CHARGE		→			↑	↑	6			IN CHARGE			
111	D. Wilson	RM1	RM2	RAD I	SUP.	SUP.	SUP.	SUP.					2			SUP			
112	D. Cooke	RM2	RM2	RAD II	RAD II	RAD II	RAD II	RAD II					5			RAD II			
113	J. Hurley	RM2	RM3	VHF rm	RAD I	RAD I	RAD I	RAD I					6			RAD I			
114	C. Mann	TE2	TE3	RAD I	RAD I	RAD I	RAD I	RAD I					6			RAD I			
115	R. Nash	TE3	SN	RAD I	RAD I	RAD I	RAD I	RAD I					4			RAD I			
116	W. Norris	RM3	RM3	RAD III	RAD III	RAD III	RAD III	RAD III					4			RAD III			
117	C. Keefer	RM3	SN	RAD I	RAD I	RAD I	RAD I	RAD I					1			Bridge-JX			
118	M. Adams	RM3	SN	RAD II	RAD II	RAD II	RAD II	RAD II			STANDBY	STANDBY	4			RAD II			
119	R. Wagner	RM3	SN	RAD III	RAD III	RAD III	RAD III	Bridge					2			Bridge			
1151	G.G. Davis	SN	SN	COMM CENTER	JX-RAD I	JX-RAD I	JX RAD I	RAD I					5			RAD I-JX			
1152	R.M. Carter	SN	SA	CRYPTO CENTER	HEADINGS	HEADINGS	HEADINGS	RAD I					5			RAD I			
1153	P. Heely	SA	SA	RAD I	MESSENGER		MESSENGER						6			Messenger			
1154		SA		RAD II	MESSENGER		MESSENGER	→					6			Messenger			
											↓	↓							

Figure 2-4.—Watch, quarter, and station bill.

tion officer for the commandant or force commander of the naval district or area in which the NAVCOMMSTA is located. He is responsible to the commandant or force commander for coordinating naval communications within his district or area.

Communication Department

The communication department is by far the largest component of a NAVCOMMSTA. It is headed by the communication officer, who has direct supervision over the personnel and work of the department. He serves as manager of the local communication program and determines its budgetary requirements. Some of his other duties are—

1. Formulating communication plans and directives.
2. Establishing an internal routing and filing system.
3. Providing for physical security of messages, and for maintaining monitoring facilities.
4. Supervising operation of the publications library by the appointed RPS custodian of the command.
5. Supervising the training of communication personnel and cryptoboard members.
6. Supervising postal activities.
7. Operating and maintaining electronic and visual communication gear.

Within the communication department are four divisions: radio, traffic, material, and facilities (fig. 2–5).

The RADIO DIVISION operates the radio stations of the NAVCOMMSTA. There are generally two such stations, a receiving branch and a transmitting branch. Each station is headed by a radio station officer.

The TRAFFIC DIVISION processes incoming and outgoing messages (including facsimile), enforces security, and maintains custody of RPS-distributed matter issued for station use. A traffic and circuit officer is division head. He is assisted by communication watch officers, cryptographers, and a custodian, whose duties are similar to

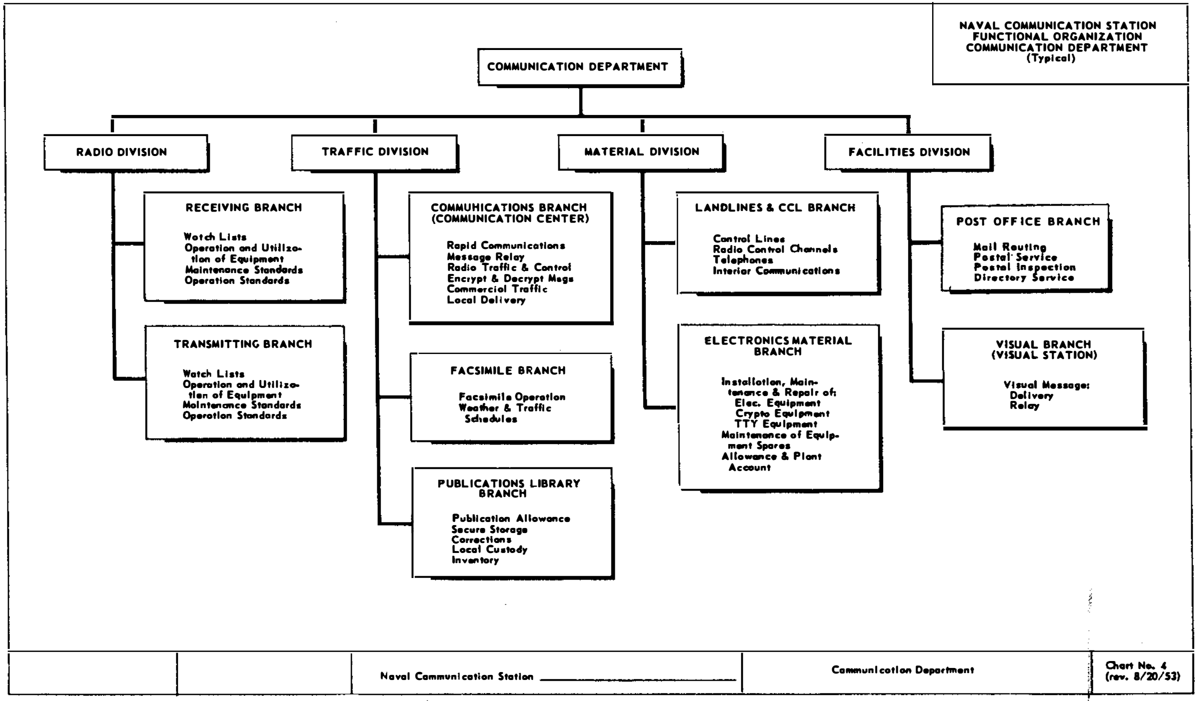


Figure 2–5.—Communication department of a NAVCOMMSTA.

those of their shipboard counterparts. The following officers may also be attached to his division: a relay center officer, to head the tape relay center; a communication security officer, responsible for monitoring and policing electrical circuits and developing communication security measures; and a facsimile officer, to plan and administer operations of facsimile facilities.

The MATERIAL DIVISION is responsible for the physical functioning of wire circuits and for repair of electronic equipment. In charge are a landline officer and an electronics material officer.

The FACILITIES DIVISION is divided into two major branches: Navy post office branch and visual branch. (Inclusion of this division is dependent upon whether the NAVCOMMSTA is located where these facilities are required.) The postal officer is charged with bulk handling and distribution of mail and for operating local postal facilities. The visual station is operated by a signal officer, who is in charge of receiving, transmitting, and relaying visual traffic to and from vessels in port or anchorage. His duties parallel those of the shipboard signal officer.

NAVCOMMSTA Spaces

Figure 2–6 shows the physical layout of a NAVCOMMSTA. The diagram is schematic, for in practice buildings and spaces vary so widely in arrangement that generalization is difficult. The elements shown will usually be present, but at some stations are scattered over many acres. Transmitting and receiving stations (stations (T) and (R), respectively) are often miles away from the rest of the activity.

The NAVCOMMSTA CONTROL CENTER is a space which in outward appearance and in function is comparable to a large telephone exchange. It is the landline entry point and the central meeting location of the station's intercommunication facilities. Control center personnel connect radio and landline circuits to appropriate equipment in the relay station, conference room,

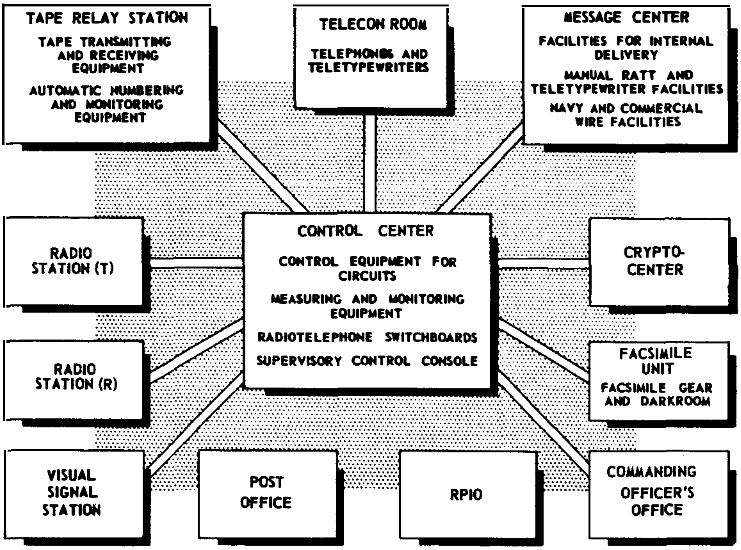


Figure 2–6.—Physical arrangement of a NAVCOMMSTA.

message center, cryptocenter, and facsimile unit. They maintain connections to the radio stations, and monitor circuits and make adjustments to keep signals at maximum quality.

The NAVCOMMSTA's message center and cryptocenter carry on much the same work as their shipboard equivalents, but the traffic load requires what amounts to an assembly line procedure, with different personnel processing messages through each step. Commercial circuits terminate in the message center.

The TAPE RELAY STATION contains banks of sending and receiving tape gear. Lines are connected through the control center to link the station to local and trunk landlines. The greatest proportion of traffic is for relay. Incoming messages are received in tape form. Relay station personnel examine tapes to determine whether the message is for relay or for local delivery. If for relay, the tape is fed into the proper machine and the message sent on its way. If for local delivery, a classified message is sent into the cryptocenter via the control center, where it is broken and relayed to the message center. If the message is plain language it is sent directly through the control center to the message center.

The TELECONFERENCE (TELECON) ROOM offers facilities for long-distance personal conferences among officers in high command positions. Communication may be by radiotelephone or radioteletypewriter. If the conference deals with classified matter, conferring officers are assisted by teletypewriter operators and cryptographers, and the exchanges are encrypted and sent by teletypewriter.

The FACSIMILE UNIT handles broadcast and point-to-point facsimile transmissions. A photographic darkroom is attached. The unit is primarily a sending and receiving agency; facsimile traffic is processed in the message center.

QUIZ

1. Name the three foremost principles of naval communications.
2. What is the mission of naval communications?
3. List four basic principles of naval communications.
4. What is the meaning of the term "telecommunications"?
5. What forms of electrical telecommunication concern the Radioman as operator?
6. What general type of material may be sent by FAX?
7. Name three means of visual communication.
8. List the three major elements in the structure of naval communications.
9. What does DNC stand for?
10. What is a JANAP? An ACP?
11. What is the difference between a NAVCOMMSTA and a NAVCOMMFAC?
12. The most important communication spaces aboard ship are amidships. Name them.
13. Who may go into the cryptocenter?
14. The shipboard communication organization is a part of the __________ department. On large ships communications is divided into the __________ and __________ divisions. These are, respectively, headed by the __________ and __________ officers.
15. Name the four divisions of a NAVCOMMSTA communication department.

CHAPTER 3

SECURITY

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

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

THE CLASSIFICATIONS

Security is a term which describes the methods used by the Government to safeguard material from unauthorized disclosure. Such information is afforded a greater degree of protection than other material and is given a special designation: CLASSIFIED MATTER. This term includes all publications, documents, cipher keys and aids, code books, letters, and messages in the three security classifications: Top Secret, Secret, and Confidential. Following are examples and definitions of each.

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.

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 effectiveness of a program or policy of vital importance to the national defense.
3. Compromising important military or defense plans, or scientific or technological developments important to national defense.
4. Revealing important intelligence operations.

Confidential and Confidential—Modified Handling Authorized

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. Personnel security investigations and other investigations, such as courts of inquiry, which require protection against unauthorized disclosure.

2. Operational and battle reports which contain information of value to the enemy.
3. Intelligence reports.
4. Military radio frequency and call sign allocations which are either of special significance or are changed frequently for security reasons.
5. Devices and material relating to communication security.
6. Information which reveals strength of our land, air, or naval forces in the United States and overseas areas, identity of composition of units, or detailed information relating to their equipment.
7. Documents and manuals containing technical information used for training, maintenance, and inspection of classified munitions of war.
8. Operational and tactical doctrine.
9. Research, development, production, and procurement of munitions of war.
10. Mobilization plans.
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 paragraphs 11 and 12 above is classified Confidential only if its unauthorized disclosure could be prejudicial to the defense interests of the Nation. If such information does not relate strictly to defense, it must be safeguarded by means other than the Confidential classification.

The Confidential classification has a subdivision: Confidential—Modified Handling Authorized (CONFMOD). CONFMOD may be authorized for matter which the originator believes will be sufficiently protected by somewhat less strict stowage and transmission safeguards than are necessary for Confidential.

Material that may be classified CONFMOD includes, but is not limited to, the following:

1. Training, field, and technical manuals and related materials.
2. Photographs, negatives, photostats, diagrams, and the like.
3. Defense procurement plans, including procurement contracts and related matters.
4. Communication materials, publications, and messages.
5. Charts and maps.
6. Information received from or furnished to foreign nations under international exchange of information agreements and policies.

CLEARANCES

No one may have access to classified matter without proper CLEARANCE. If your duties require you to use classified publications and documents (and they are virtually sure to), the commanding officer is authorized to grant you clearance after ascertaining that you are trustworthy, discreet, and of unquestionable loyalty. Clearance to handle CONFMOD and Confidential information may be based on an unblemished service record and the good opinion of your officers. Clearance to handle Secret material can be granted only after an additional check of BUPERS records and an investigation by the Office of Naval Intelligence. Notation of a man's clearance is made in his service jacket.

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 rank, duties, or clearance.

If it is known—or even suspected—that classified material has been lost, or passed into the hands of some unauthorized person, the matter 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 has learned. Never fail to report a compromise that comes to your attention.

TYPES OF SECURITY

Provisions for safeguarding classified matter are based on law and executive order. Those of interest to you may be grouped into three broad categories:

1. COMMUNICATION SECURITY prevents the enemy from obtaining information from United States or allied communications.
2. PHYSICAL SECURITY keeps classified matter solely in the possession of properly authorized individuals who are entitled to make official use of it.
3. PERSONAL CENSORSHIP prevents betrayal of official secrets through private conversations, correspondence, and so on.

COMMUNICATION SECURITY

Communication security is subdivided into—

1. Cryptographic security, which is designed to thwart enemy efforts to obtain intelligence through cryptanalysis and the study of traffic trends; and
2. Transmission security, which aims to protect transmissions from unauthorized interception, traffic analysis, and imitative deception.

CRYPTOGRAPHIC SECURITY

Cryptography is the science of cloaking information in codes and ciphers. A CODE is a system whereby words, phrases, numbers, or syllables are replaced by numbers, letters, or code words. The code word for the Normandy

Landings, Operation OVERLORD, is an example of a code used to prevent betrayal of intentions, dates, or geographical locations, had a document associated with the invasion fallen into enemy hands.

A CIPHER is a system in which individual letters of a message are replaced, letter for letter, by other letters rather than by complete words, phrases, or numbers. Cipher texts are usually transmitted in 5-letter groups.

The enemy is constantly and painstakingly studying our codes and ciphers in an attempt to discover the keys to our many cryptographic systems. This technique is known as cryptanalysis. The best defense against this type of enemy intelligence is cryptosecurity—the careful use of technically sound cryptosystems.

The cryptoboard, under the direction of the communication officer, is responsible for the proper encryption and decryption of messages. Reliable petty officers may be appointed to this board, along with officers assigned communication duties. Members of the board, known as cryptographers, must be proficient in the use of all codes and ciphers held by the command.

An especially grave compromise results from the loss of a cryptographic publication or the transmission of a faulty encryption. Since it must be assumed that the enemy has received enough information to recover the key to the system, such a cipher must be discontinued and immediately replaced, for subsequent transmissions in the same system might be little better than plain language. The work and expense of superseding a cipher system, though great, are insignificant compared to the consequences of compromise.

TRANSMISSION SECURITY

A communication may be sent by a variety of means:

1. Messenger;
2. Registered mail (guard mail, United States postal system, or diplomatic pouch);
3. Approved wire circuits;

4. Ordinary mail;
5. Nonapproved wire circuits;
6. Visual (flaghoist, semaphore, etc.);
7. Sound (whistle, siren, etc.);
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), which is responsible for the safe transmittal of highly classified matter to military addressees and certain civilian agencies throughout the world. ARFCOS courier transfer stations are located in certain designated areas, and every item of classified material sent via ARFCOS is in the physical custody and control of a commissioned officer courier from the time of entry into the system until the addressee or his authorized representative receipts for it. ARFCOS is not used to transmit classified material which may go by registered United States mail.

Guard mail is another type of messenger service used to transmit 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 delivery of 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

In addition to transmitting unclassified material, the United States postal system is used to transmit classified material except for Top Secret matter and cryptographic aids and devices. Classified matter must be sent by REGISTERED rather than ordinary mail, and transmittal must be entirely within the continental limits of the United States or Canada. The great bulk of the Navy's

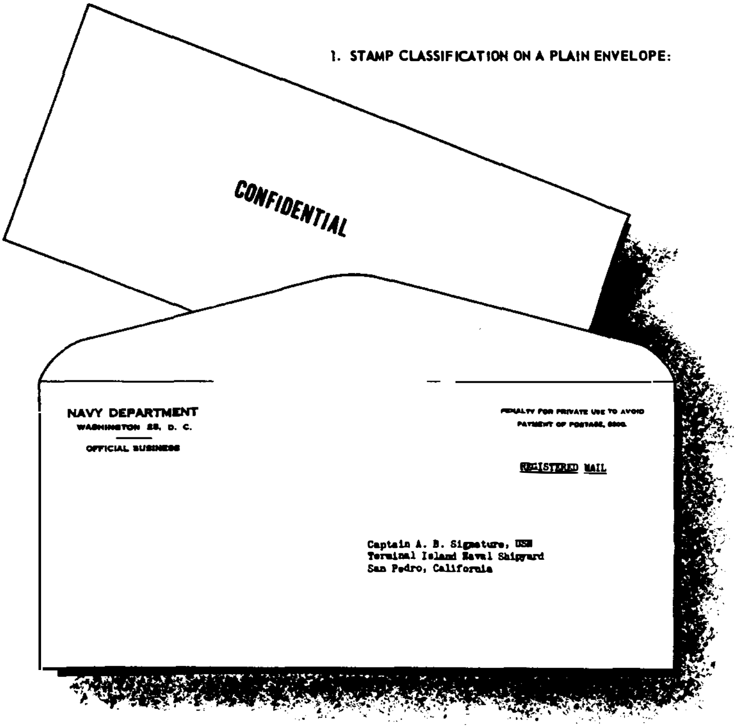


Figure 3–1.—How mailable classified matter is prepared.

administrative traffic is sent by mail, thus reserving radio circuits for operational traffic insofar as possible.

Mailable classified matter is double-wrapped, as shown in figure 3–1. 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, since they are less susceptible to interception.

There are two types of wire systems: APPROVED and NONAPPROVED.

An approved circuit is one designated by appropriate command as suitable for transmission in the clear of messages classified no higher than Secret. Approved circuits usually lie entirely on military property.

A nonapproved circuit is one which does not lie entirely within military property, has a radio link, or for some other reason is not considered safe enough for transmission of traffic in the clear. It is forbidden to send classified messages in the clear over a nonapproved wire.

Telephone circuits are normally considered nonapproved and are not used to discuss classified data unless specifically designated as approved. Approved telephone circuits are equipped with security devices to minimize the possibility of tapping.

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

Underwater cables are also 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 possibility of divulging the ship's position. They are more secure than radio because reception is limited to units in the immediate vicinity of the sender.

Visual communication methods are ranked in order of security according to the distance from which the 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.

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

Transmission of plain language messages is kept to a minimum within the vicinity of the beach. 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 used 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 are less secure. Their use is largely 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 through cryptanalysis, the enemy may be able to fix the location of operating forces through direction finding. Through deceptive techniques he may be able to confuse and hamper our communications and, by traffic analysis, forecast the intentions of our forces.

Despite its shortcomings, radio is still the primary means of communication. It is fast, reliable, and often the only method of maintaining contact between distant and highly mobile units. A satisfactory degree of security can be obtained only by its proper and intelligent use.

RADIO SILENCE. An effective defensive measure against enemy intelligence is radio silence. It is apparent that the enemy cannot gain intelligence from radio transmissions if none are sent. Radio silence is placed in effect when it is reasonable to assume that the enemy is ignorant of the location or impending movements of a ship or force.

Control of electromagnetic radiation (CONELRAD) is for suppression of radio and radar emissions in order to reduce the likelihood of enemy interception. In peacetime, CONELRAD is imposed only if required for operational purposes or training.

ENEMY DECEPTION. There are many deceptive techniques the enemy might use to obstruct our radio communications. He may, for example—

1. Remove 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 with the heading of another, with the group count corrected, and introduce it on a different net.
3. Originate and transmit counterfeit plain language messages.
4. Call a unit in the hope of taking bearings on the answer.
5. Partly obliterate a false message in order to conceal lack of knowledge of authenticators or call signs.

AUTHENTICATION. The best defense against imitative deception by the enemy is proper authentication. An authenticator is a letter, numeral, or groups of letters or numerals inserted in a message to prove its authenticity. By its correct use, the operator can distinguish between genuine and fraudulent stations or transmissions. Authentication is mandatory when—

1. Making initial radio contact.
2. Transmitting operating instructions which affect the communication situation. Example: Closing down a station or watch.
3. Transmitting (except by broadcast method) to a station under radio silence. (Broadcast method: ship addressed does not answer, thus avoiding disclosure of position.)
4. Calling a unit afloat for the first time and requiring that unit to break the CONELRAD condition of silence in order to answer.

Good judgment sometimes dictates that an operator accept a message of high priority rather than argue over authentication, even though doubt exists as to its genuineness. Such a message should be delivered promptly to the addressee with the operator's notation that it was not properly authenticated. The decision as to its authenticity is made by the addressee.

Whenever an authentication system is promulgated, accompanying instructions specify how and when it is to be used. Procedures will vary slightly with the form of authentication and the means of communication employed.

Other effective defenses against imitative deception are—

1. Thorough training in operating procedures, as described in subsequent chapters.
2. Alert operators who recognize irregularity 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.

Operators who maintain a high degree of circuit discipline also lessen the chances of enemy deception. Circuit discipline can be obtained 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 common causes of the violations which endanger radio transmission security.

TRAFFIC ANALYSIS. In addition to hampering our communications through imitative deception, the enemy may gain valuable information from traffic analysis. This is the technique of obtaining intelligence from a study of communication traffic without recourse to cryptanalysis. It includes statistical study of message headings, receipts, acknowledgments, relays, traffic peaks, and tabulation of the volume and type of traffic.

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 WHISKEY, and a fourth to a unit off OSCAR. The enemy's traffic records show that messages are rarely transmitted to these four addressees simultaneously. They also show that previous transmissions of this type were followed by arrival of a convoy at point ROMEO. The enemy may logically conclude that a convoy from BRAVO to ROMEO is being planned, and that these transmissions are probably arranging for an escort.

The following are some measures intended to render traffic analysis by the enemy more difficult:

1. Minimum use of radio when alternate means of communication are available.
2. Rotation of frequencies.
3. Minimum number of service messages.
4. Use of the broadcast method wherever possible.
5. Control of the timing and volume of test transmissions to avoid revealing information about future operations.
6. Concealment of originator and addressee(s) in the text of an encrypted message.

7. Avoidance of plain language transmissions.
8. Encryption of unit call signs and address groups.
9. Keeping external routing instructions to a minimum.

RADIOTELEPHONE. Security violations on voice circuits are as serious as those occurring on radiotelegraph circuits. Although radiotelephone transmissions are usually limited to the line of sight, on occasion they have been readably intercepted at distances up to 2500 miles. Radiotelephone transmissions are actually less secure than radiotelegraph transmissions on the same frequency, because anyone can understand them even without a knowledge of the Morse code.

Circuit discipline is just as important on the radiotelephone as on radiotelegraphy. Radiotelephone is used for tactical or operational purposes on most frequency bands by all forces and types; so strict adherence to correct operating procedure is mandatory. Poor circuit discipline slows communication, causes confusion, and may give information to the enemy.

In addition, practice in proper euphony and pronunciation are requisite to a properly manned radiotelephone circuit. Radiotelephone procedure is described in a later chapter.

The following practices are specifically forbidden:

1. Violation of radio silence.
2. Unofficial conversation between operators.
3. Transmitting in a directed net without permission.
4. Excessive tuning and testing.
5. Transmission of an operator's name or personal sign.
6. Unauthorized use of plain language.
7. Use of unauthorized prowords.
8. Linkage or compromise of classified call signs and address groups by plain language disclosures or associated with unclassified call signs.

The following are to be avoided:

1. Use of excessive power.
2. Needless loss of time in tuning, changing frequency, or adjusting equipment.
3. Transmission beyond the capabilities of receiving operators.

PHYSICAL SECURITY

Stowage

All classified matter must be stowed in a manner which will guarantee its protection. The degree of protection necessary depends on the classification, quantity, and scope of the material.

The safety of physical stowage facilities is measured by NUMERICAL VALUES. The more secure the facilities the higher the numerical values assigned.

The GRAPH, figure 3–2, shows the numerical values required for quantity and type of documents of each classification. The TABLE, figure 3–3, is a guide for evaluating stowage facilities. These two must be used together.

For example, a ship stows plain language translations of encrypted messages in a heavy steel safe in the cryptocenter. Visitors are not allowed in any of the communication spaces, and only cryptographers may enter the cryptocenter itself or remove anything from the safe. The cryptographer on watch acts as a guard in attendance at the container. We can, from the table, assign a numerical value to these facilities, as follows:

	VALUE
Sheltered aboard a commissioned ship	15
Stowed in heavy steel safe	30
Military guard in attendance at container	30
Aboard ship, in an area where only ship's company has access	25
System in effect for control of personnel access to container when closed, and to contents when open	5
TOTAL	105

From the graph, figure 3–2, you can see that stowage facilities with a numerical value of 105 are secure enough for everything but the two most sensitive classes of Top Secret.

Consult chapter 6 of the *United States Navy Security Manual for Classified Matter* for further information on stowage of classified matter.

Handling Precautions

At the close of each working day you must make certain that all classified material you have used has been locked up. Notes regarding classified matter must not be left on memorandum pads or under 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 are to be placed in burn bags with other classified material to be destroyed according to a schedule promulgated by the communication officer or custodian. The top of each bag is folded over twice, securely stapled, and then numbered. The bags are counted just before the burn trip and immediately after arrival at the burn area. The number of burn trips per week or month depends on the amount of classified matter handled by your ship or station.

It is the duty of every burn detail to know exactly what is to be burned and to doublecheck every item. If no incinerator is available, the material to be burned may be placed in a perforated drum or container with a cover of wire netting. This will prevent wind or draft carrying away fragments. The material must be watched until completely consumed, and ashes must be broken up and scattered so that no scraps escape destruction. When burn material is carried in a bag which is not to be burned, the bag should be turned inside out to make certain every piece of paper has been removed.

Vaults, safes, or lockers used for storage of classified matter must always be kept locked when not under the supervision of authorized personnel. Cryptographic

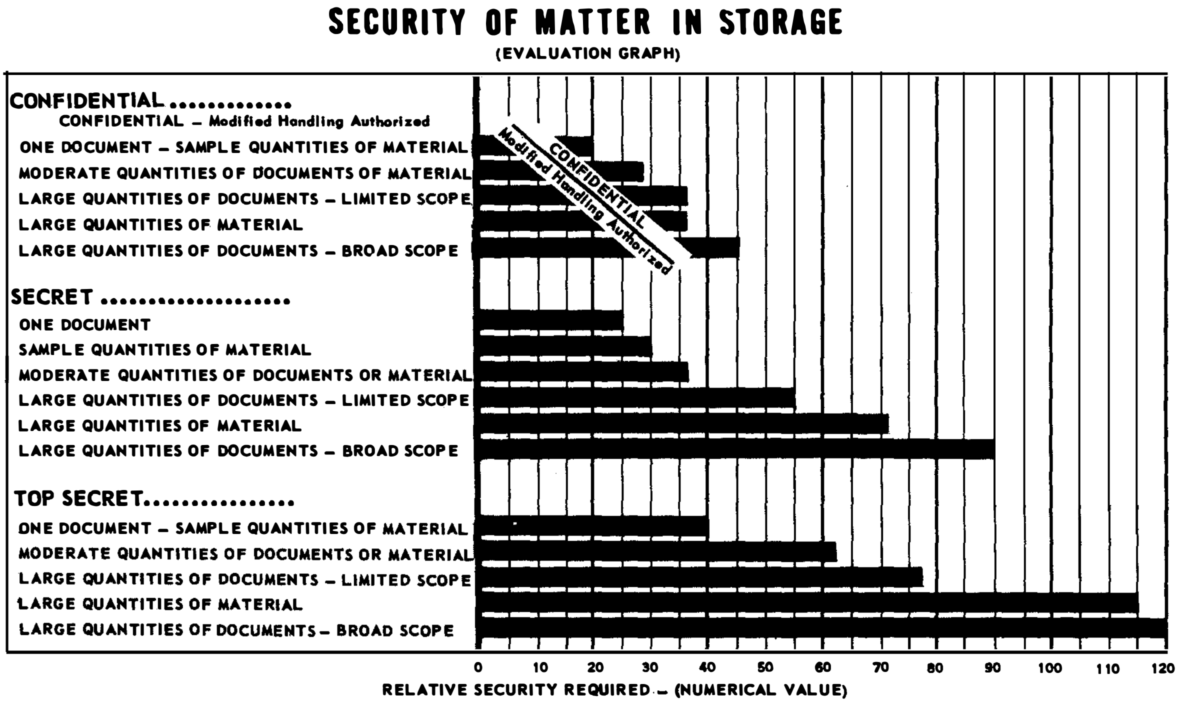


Figure 3–2.—Numerical values required for quantity and type of documents of each classification.

TABLE OF NUMERICAL EQUIVALENTS (SIMPLIFIED)

1. SHELTER	
a. None	0
Light structure, such as a quonset hut, which can be locked and barred	10
Heavy structure, such as masonry building	15
Commissioned ship	15
2. STOWAGE CONTAINER	
a. None	0
Any portable container	0
Wooden container, any type lock	2
Metal container, key lock	5
Metal container, combination lock	15
Light-weight steel safe	20
Light vault	20
Heavy steel safe	30
Bank vault	40
3. GUARDING	
a. Unguarded	0
Military guard in general area	15
Military guard checks container every hour	20
Military guard checks container every 30 minutes	25
Military guard in attendance at container	30
b. No supporting guard force	0
Military supporting guard force	20
Aboard ship, in areas where only ship's company has access, or visitors are under constant escort	25
4. PROTECTIVE ALARM SYSTEM	
a. No alarm on container	0
System to detect opening of container	15
System to detect tampering with or opening of container	20
System to detect approach to, tampering with, or opening of container	30
b. No general area alarm	0
System to detect entry into general area	25
5. CONTROL OF PERSONNEL ACCESS TO CONTAINER WHEN CLOSED, AND TO CONTENTS WHEN OPEN	
a. System necessary but not in effect	−20
System not required	0
System in effect	5

Figure 3–3.

aids and related classified matter must never be left unguarded by the user. In case of a fire or other emergency, it is your personal responsibility to safeguard all classified matter in your possession.

On board ship, ciphers and codes are not subjected to the same risks as on land. However, if a ship is in danger of sinking or is severely disabled, steps are taken in accordance with the ship's destruction bill to prevent classified matter from falling into enemy hands. This bill details the method and the order of destruction of classified matter. Each man in the communication division is assigned (by billet rather than by name) to carry out part of the bill. It is vital that action be prompt and effective.

PERSONAL CENSORSHIP

The Radioman, in the course of his duties, may find himself in possession of highly classified information—the existence of which is oftentimes shared only by himself, the communication officer, and the commanding officer. It is his duty to be alert against a slip of the tongue which might reveal this information to someone not authorized to know. The *Security Manual* states that "indiscreet conversation and personal letters constitute the greatest menaces to security." The only safe policy to follow while on duty, then, is: Say nothing about classified matter to anyone not authorized to know. Off duty, say nothing about your work to anyone, including family and friends. Information innocently imparted to unauthorized persons may be repeated by someone ignorant of its importance until it becomes common knowledge.

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

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

1. Location, identity, or movement of ships or aircraft.
2. The forces, weapons, military installations, or plans of the United States or her allies.
3. Casualties to personnel or material by enemy action.
4. The employment of any naval or military unit of the United States or her allies.
5. Criticisms of equipment or morale of the United States or her allies.

Personal censorship also extends to telephone conversations. As we have seen, 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 the enemy. They sometimes reveal secrets which the enemy is laboriously attempting to extract through cryptanalysis. Even in peacetime, lost and stolen diaries can cause serious damage to the prestige of the Nation.

The security precautions mentioned here do not guarantee protection, nor do they attempt to meet every conceivable situation. However, the man who adopts a commonsense outlook in addition to knowledge of the few basic regulations can solve most security problems.

ADDITIONAL SECURITY INFORMATION

The effective editions of the following publications contain additional information on security. Those marked with an asterisk are classified.

The United States Navy Security Manual for Classified Matter, OPNAV INST 5510.1A

United States Navy Regulations, 1948, chapter 15
RPS 4*
ACP 122*
The Naval Communications Bulletin, published quarterly by DNC (with classified supplement*)
Navy directives in the 2200–2260 series (communication security) and in the 5500–5599 series (administrative security)

For information on local security rules, study the security regulations of your ship or station.

QUIZ

1. Name, from highest to lowest, the three degrees of protection for classified matter. Which one has a subdivision?
2. Who may grant you a security clearance?
3. What is the purpose of communication security? Of physical security? Of personal censorship?
4. Name two subdivisions of communication security and define each.
5. If it is known, or even suspected, that classified matter has been lost or passed into the hands of some unauthorized person, the matter is said to be__________.
6. What should you do if you find a message which you believe violates some principle of good communications?
7. Define ARFCOS.
8. What is an approved circuit?
9. What is the most secure of ALL the means of communication? The least secure?
10. What is the most secure VISUAL communication system? The least secure?
11. When is radio silence placed in effect?
12. What is the best defense against imitative deception by the enemy?
13. What is the highest classification that may go through the United States mails?
14. What should you do if you accept a message that is not properly authenticated?
15. Some classified documents are stowed inside a heavy steel safe in a locked brick building in a downtown area. The building has a burglar alarm that will detect entry into the general area, and after working hours a military guard checks the safe every 30 minutes. What is the numerical value of these facilities? Is this stowage safe enough for stowage of large quantities of Secret documents of broad scope?

CHAPTER 4

INTRODUCTION TO RADIO EQUIPMENT

This chapter will present, in elementary form, the first principles of radio equipment. The coverage, though self-contained, does not pretend to be comprehensive. Rather, it is meant to be studied in conjunction with your assignments in the Navy Training Courses, *Basic Electricity,* NavPers 10086, and *Basic Electronics,* NavPers 10087. You will find the RM assignments in the front of this manual, following the preface.

Let us begin with a review of electrical units, then proceed to the radio wave, and from there into transmitters, receivers, facsimile, and motors and generators.

ELECTRICAL UNITS

An electrical current is often compared to the flow of water through a main. To gage the rate of flow we must have a measure of quantity (pints, quarts, gallons, barrels, etc.) and a measure of time (seconds, minutes, hours, etc.).

In an electrical circuit the current that flows is composed of electrons, which are tiny charged particles that form one of the constituent parts of atoms. The electron is far too small to serve as a measure of quantity, and a larger unit, the COULOMB—6.3 billion billion electrons—is used instead. The measure of time is the second. A flow of 1 coulomb per second is equal to 1 AMPERE, a term that is at the same time a measure of quantity and time, just as the term KNOT is a measure of both distance and time.

Voltage and Resistance

Assume that a water main is fed from a standpipe some miles away. Water flows because the water level in the standpipe is higher than the outlet of the main, and the difference in their levels causes a pressure to be exerted on water in the main.

The movement of electricity is comparable. If there is a difference in the relative electrical level (charge) between two terminals of the conductor, electrons move from the point of relative surplus (negative terminal) to the point of relative shortage (positive terminal) and a current flows. This difference in electrical level is termed DIFFERENCE IN POTENTIAL, and may also be thought of as pressure. It is measured in VOLTS. An electrical conductor offers resistance to the flow of current just as the inside surface of the main offers resistance to the flow of water. Electrical resistance is measured in OHMS. To force 1 ampere through a resistance of 1 ohm requires a pressure of 1 volt.

Power

Power, the TIME RATE of doing work, is the product of voltage and amperage. The electrical unit of power, the WATT, is the product of 1 volt and 1 ampere.

THE RADIO WAVE

It is believed that the radio wave travels through a series of crests and troughs similar to an ocean wave, or better, the round, outward-moving waves created by a stone thrown into a pond. The movement of radio waves is somewhat like the movement of water waves away from a point of disturbance.

A brief study of figure 4–1 will aid in understanding four important aspects of the radio wave: AMPLITUDE, WAVELENGTH, CYCLE, and FREQUENCY. The amplitude of a wave is the distance from average water level to the peak (or trough) of the wave, and is the measure of the energy level of the wave—just as it is of the radio wave, which, if we could see it, would closely resemble figure 4–1. A wavelength is the distance from one crest to the next. (It is just as accurate to measure from trough to trough, or from any point to the next corresponding point.) A cycle is a complete sequence of variation of movement of the wave from a trough, through a crest, into another trough. The number of cycles which occur in a given unit of time is said to be the frequency of a wave.

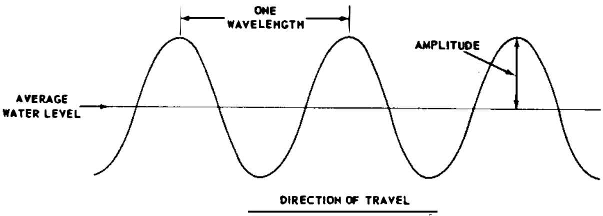


Figure 4–1.—Movement of a water wave from a point of disturbance.

Now, consider the ocean wave. With long, rolling ground swells, the wave may have a length of a half mile or more. If the cycles occur twice per minute, the ocean wave has a frequency of 2 cycles per minute. The length of a radio wave may vary from several miles down to a fraction of an inch. Its frequency may be a few thousand cycles per second or many million cycles per second.

In practice, radio wavelength is measured in meters. (A meter is 39.37 inches.) Frequency is counted in thousands and millions of cycles using two prefixes from the metric system, KILO and MEGA. Two expressions in everyday use by communication personnel are KILOCYCLES (thousands of cycles per second) and MEGACYCLES (millions of cycles per second). The Navy abbreviates these words as KCS and MCS.

A frequency of 15,000 cycles per second is expressed as 15 KCS; 500,000 cycles as 500 KCS. When the number of kilocycles reaches 1000, megacycles are used instead to make the reckoning easier. Thus 82,000 KCS is expressed as 82 MCS.

It is common practice to group frequencies into bands. The so-called commercial broadcast band, extending from 535 KCS to 1605 KCS, is a familiar one. Frequency band designations and their corresponding abbreviations are shown in the table below.

Designation of radio waves according to frequency	Authorized abbreviations	Frequency
Very low	VLF	Below 30 KCS
Low	LF	30 to 300 KCS
Medium	MF	300 to 3000 KCS
High	HF	3 to 30 MCS
Very high	VHF	30 to 300 MCS
Ultra-high	UHF	300 to 3000 MCS
Super-high	SHF	3000 to 30,000 MCS
Extremely high	EHF	30,000 to 300,000 MCS

Frequency directly affects the behavior of radio waves. At low frequencies waves bend to follow the curvature of the earth and so travel farther: provided the power is there to push them. Thus shore stations with huge power and antenna installations are best equipped to give long-range radio communication at low frequencies.

After a certain high frequency is attained, the waves do not bend around the earth. Instead, they penetrate the earth's atmosphere and go into space. Most radiotelephone transmissions are at these high frequencies, and in general cannot be heard past the point where the earth curves away at the horizon. Remember, however, that this is because of the properties of the frequencies used for radiotelephone communication, and is not necessarily a characteristic of radiotelephone itself. Radiotelephone transmissions sent out on the lower frequencies will travel far beyond the horizon.

Think once more of a stone tossed into a pond. Circular waves glide outward from the splash, one within another, until their energy is used up. A transmitting station corresponds to the point of disturbance made by the stone. In the center is an antenna with alternating

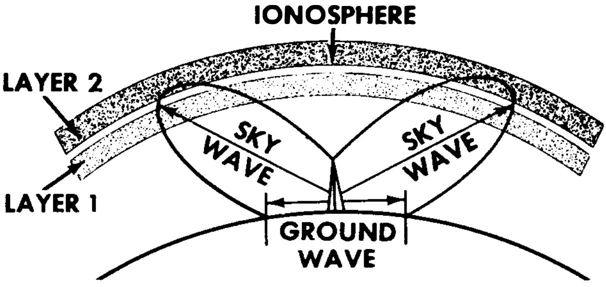


Figure 4–2.—Formation of ground and sky waves.

current producing radio waves in the space around it. Unlike the waves on the pond, however, radio waves move in all directions, going up into the sky as well as along the surface of the earth. Those moving along the surface of the earth are GROUND WAVES; those going into the atmosphere, SKY WAVES. Figure 4–2 illustrates the formation of GROUND and SKY waves.

Ground waves moving over the surface of the earth rapidly weaken until they are no longer of useful strength. The sky wave, when it leaves the antenna, continues to rise until it literally "bumps into" the sky. Some of the wave is absorbed on collision, but much of its energy is bent and returned to earth again (fig. 4–3).

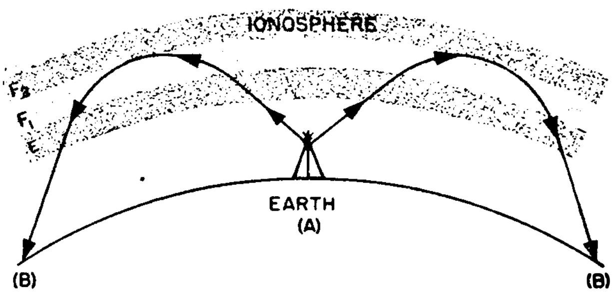


Figure 4–3.—Refraction of the sky wave by the ionosphere.

These bent waves are very useful in communications, for they continue to bounce between earth and sky, increasing their range until all the energy is spent.

The reflecting of radio waves by the "sky" is accomplished by charged layers of particles called IONS. The intense rays of the sun striking the upper atmosphere on their way to the earth produce these ions, which form in layers to become the ionosphere. This mass of particles, located from 30 to 350 miles above the earth's surface, constantly shifts and changes as the effects of the sun's rays vary from daylight to dark and from winter to summer.

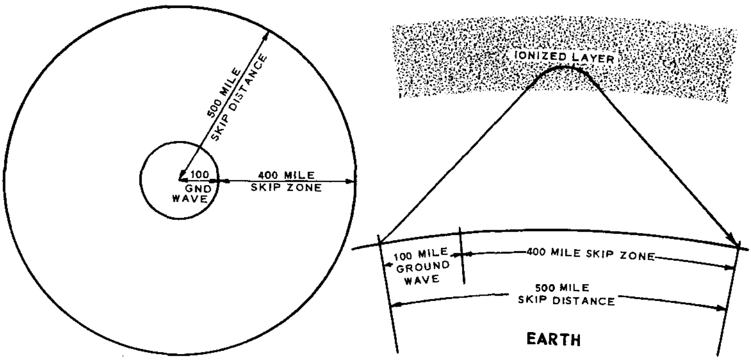


Figure 4–4.—Skip zone and skip distance.

A change in the ionosphere affects radio transmission and reception, since it causes more of the radio wave to be absorbed at one time, or bends it to a different degree at another time.

Wherever the bent sky wave returns to earth, it can be picked up by a radio receiver. Suppose the ground wave from your antenna travels 100 miles and the first sky wave returns to earth 500 miles from your ship. There is a strip 400 miles wide around you in which your signal cannot be detected (fig. 4–4). This is called the SKIP ZONE. It begins at the end of the useful ground wave and extends to the first returning sky wave. The 500-mile distance between transmitter and point at which the sky wave first returns to earth is called SKIP DISTANCE.

UHF Propagation

Most radiotelephone communication takes place in the UHF band, which includes the frequencies between 300 and 3000 MCS. The low end of this band is used for communication and portions of the high end are used for radar. Several advantages are gained by using frequencies in the UHF band. Because the ionosphere is not dense enough to reflect a sky wave of UHF radiation, most transmissions are limited to the line of sight or the direct wave.

However, UHF transmissions are not always limited to line of sight. Sometimes the lower atmosphere is composed of horizontal layers in which the temperature and moisture content vary in a manner that is not usual. If variation is great enough, DUCTS may be formed. These ducts may channel radio and radar waves far beyond the horizon.

Line-of-sight reception is very satisfactory and is relatively free from static and fading. Another advantage is the secrecy of transmissions due to the small area normally covered. The usual range of transmissions is somewhat extended because of refraction; it is actually about 15 percent beyond the visible horizon.

TRANSMITTERS

The largest transmitter in use by the Navy (and the largest in the world) is the installation at Jim Creek, Washington State, with a million-watt signal that blankets most of the earth; the smallest is the handie-talkie with an .027-watt output that can be heard through a radius of a few miles. Most ships are equipped with transmitters rated at between 100 and 500 watts. It is difficult to generalize on the maximum range of shipboard equipment, for the distance varies both daily and seasonally and is affected by atmospheric disturbances and geographical location. It may be said, however, that a ship is rarely out of radio communication because of equipment limitations.

The general plan for all transmitters can be seen in figure 4–5.

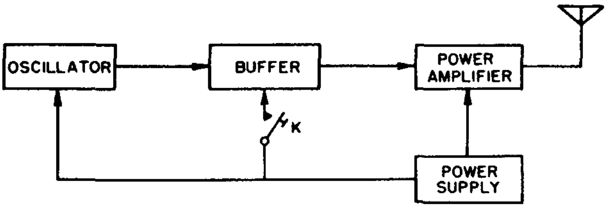


Figure 4–5.—Stages of a typical transmitter.

Every transmitter has an OSCILLATOR, which generates the basic signal. The oscillator may be of the self-excited type, which originates the signal in electron tubes and associated circuits, or it may be of the crystal type, which employs in conjunction with an electron tube a piece of quartz cut to vibrate at a certain frequency when electrically energized. In either case voltage and current delivered by the oscillator are very feeble, and both must be amplified many times to be radiated any distance.

The buffer stage is a voltage amplifier which increases the amplitude of the oscillator signal to a level that will drive the power amplifier. Voltage delivered by the buffer varies with the type of transmitter, but it may be hundreds or thousands of volts. Current in most equipments is still only a fraction of an ampere.

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 in a moment.

The final stage of a transmitter is the power amplifier. Power is the product of current times voltage, and here a large amount of RF current is made available to the load. This energy is passed into the antenna to be radiated.

Harmonics and Frequency Multiplication

The term HARMONICS is sometimes loosely used to designate unwanted radiations caused by imperfections in the transmitting equipment, but this is not entirely accurate. True harmonics are always exact multiples of the basic or FUNDAMENTAL frequency generated by the oscillator, and are created in the vacuum tubes and their associated circuits. Even harmonics are two, four, six, eight, etc., times the fundamental; odd harmonics are three, five, seven, nine, etc., times the fundamental. If an oscillator has a fundamental frequency of 2500 KCS, 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 for high frequencies; and, if a crystal is used to control a high-frequency oscillator, it must be ground so thin that it might crack while vibrating. To overcome these difficulties, oscillators are built to generate a relatively low fundamental frequency. Higher frequencies are developed by having the buffer stage tuned to higher harmonics. This is called FREQUENCY MULTIPLICATION and is illustrated in the block diagram.

In the block diagram, the oscillator is tuned to the fundamental, 2500 KCS. The next stage, the doubler, is tuned to the second harmonic, 5000 KCS. In the doubler stage, the 5000 KCS also has harmonics; and as far as the next stage, the tripler, is concerned, 5000 KCS can be considered as a new fundamental. Therefore the tripler stage can be tuned to the third harmonic of 5000 KCS, or 15,000 KCS. Thus the output of the tripler stage is six times the frequency of the oscillator.

OSCILLATOR		DOUBLER		TRIPLER
Oscillating at fundamental frequency 2500 KCS.	→	Tuned to 2d harmonic of 2500, or 5000 KCS.	→	Tuned to 3d harmonic of 5000 KCS, or 15,000 KCS.

Modulation

We have, to this point, discussed only continuous wave transmitters. If the radio wave is to be made to carry voice or other sounds—that is, if it is to be MODULATED—the CW transmitter must be combined with an audio amplifier.

In figure 4–6 the output of a speech amplifier is fed into a modulator stage, causing the output of the power amplifier to vary in accordance with the voice signal. The radio-frequency (RF) and audio-frequency (AF) voltages are combined in the power amplifier to form a wave

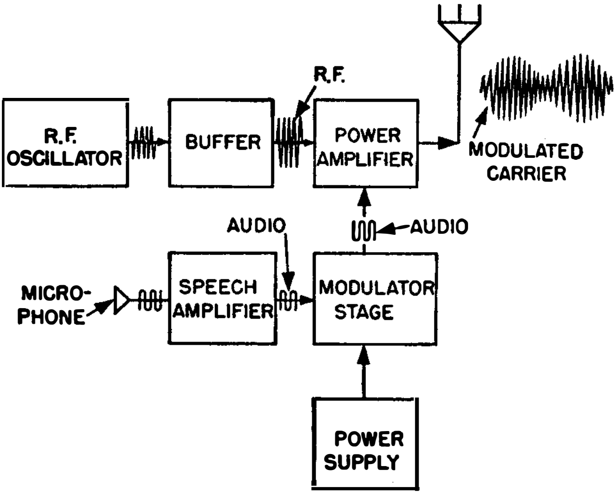


Figure 4–6.—Block diagram of a modulated transmitter.

that contains characteristics of both. Notice in figure 4–6 that the amplitude of the carrier wave varies in direct proportion to the amplitude of the audio component. The part of the resultant wave that comes from the transmitter section is the RF component; the part from the speech amplifier is the AF component.

If the modulation voltage is sent into the power amplifier stage, such a transmitter is said to be using HIGH-LEVEL MODULATION, if the modulation is accomplished at an earlier stage, as in figure 4–7, the transmitter is said to be using LOW-LEVEL MODULATION. High-level modulation is more efficient, but low-level modulation requires less power. Navy transmitters employ high-level modulation except when weight is an important consideration, as it is in aircraft and portable equipment.

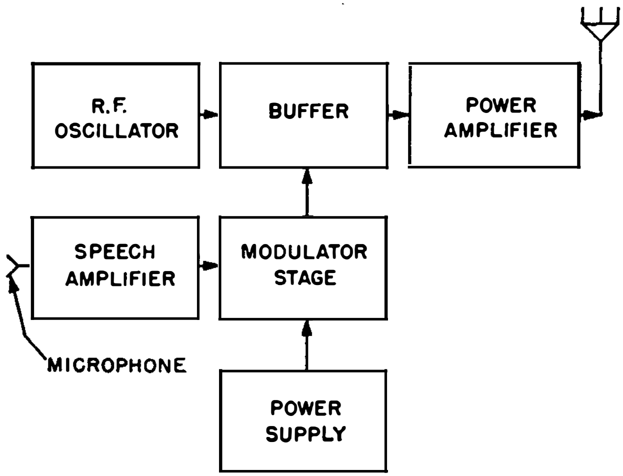


Figure 4–7.—Block diagram of a low-level modulated transmitter.

MODULATED CW. Some transmitters combine the characteristics of CW and modulated CW transmission.

Figure 4–8 is a block diagram of a modulated CW code transmitter. An audio-frequency oscillator, generating a note of constant frequency, is inserted in place of a speech amplifier. The RF section of the transmitter produces a constant wave. When the key in the audio- oscillator is closed, the AF signal is sent into the power amplifier, modulating the carrier wave. The received sound is at the frequency of the audio oscillator.

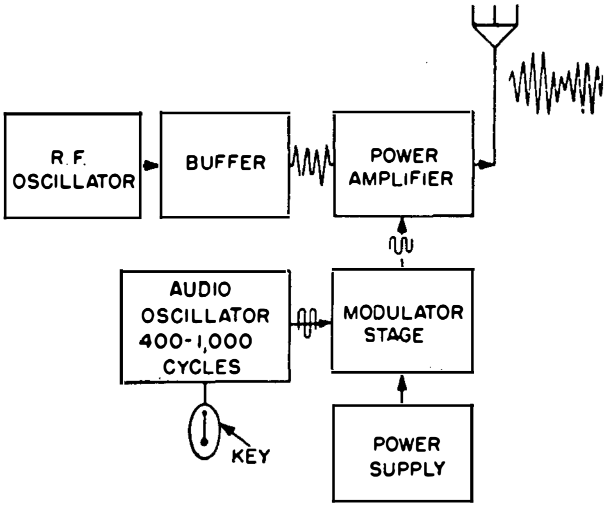


Figure 4–8.—Block diagram of a modulated CW code transmitter.

FREQUENCY MODULATION.—It is possible to modulate a signal by varying the frequency (rather than the amplitude) of the carrier wave in accordance with the audio frequencies of voice or music.

The primary advantages of frequency modulation are improved fidelity and increased freedom from static. Owing to these qualities it is of considerable use in commercial broadcasting, but its shortcomings—frequency extravagence, short range on available frequencies, and others—have severely limited its military communication applications. The Navy has, however, found FM satisfactory for other purposes, among them altimeters and some radars.

Radio energy generated by the transmitter is radiated by the antenna.

Any wire carrying alternating current will radiate some energy. Perhaps you have noticed the interference in an automobile radio when near power lines. A power line is, of course, a poor antenna because it was designed to carry rather than to radiate energy.

One basic antenna is the dipole (sometimes called a Hertz, or half-wave antenna), a wire with a length equal to half a wavelength. It must be remembered that a transmitter is merely a high-voltage generator of alternating current. If a feeder line from a transmitter is connected to the center of a dipole, the antenna will act as though an AC generator were set between two quarter-wave antennas, as in figure 4–9. During one-half of the generator's alternation, electrons in the antenna will flow from right to left (fig. 4–9B). On the next half alternation, electrons flow in the opposite direction (fig. 4–9C).

The voltage in the transmitting antenna establishes an electric field in the space about the wire, and the current establishes a magnetic field. One cannot exist without

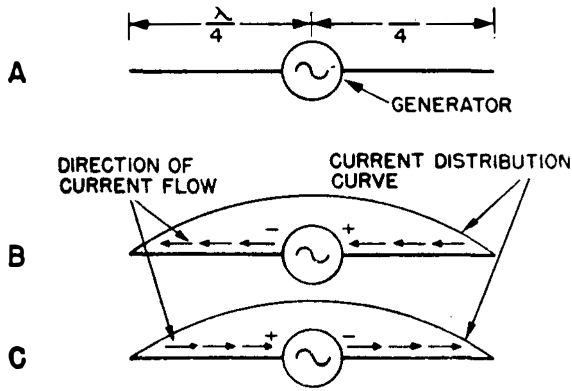


Figure 4–9.—Instantaneous direction and distribution of current in an antenna.

the other. The two together make up an ELECTROMAGNETIC wave, which is what engineers call a radio wave.

If the feeder line to the antenna were cut, stopping the flow of energy to the antenna, the electromagnetic field would collapse back to the parent wire. An alternating current is flowing into the wire and, as it changes direction, there is an infinitely small interval when no current flows. The field at once begins to collapse; but, even though the energy is moving at the speed of light, the outermost part of the field cannot return to the wire before the next half alternation has thrown up a new field of opposite polarity. Thus the returning field is pushed away from the antenna and becomes a free wave of electromagnetic energy radiating through space.

A vertical dipole, suspended in space away from the influence of the earth, would be surrounded by a magnetic field the shape of a doughnut, as in figure 4–10, parts A and B. No radiation takes place at the ends of the dipole (line *OA*). Radiation progressively increases through

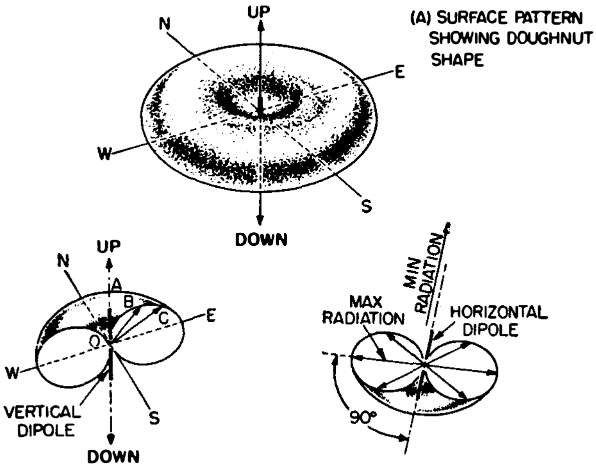


Figure 4–10.—Electromagnetic field surrounding a dipole.

lines *OB* and *OC*, until the maximum is radiated on a plane parallel to the surface of the earth.

The field radiated by a horizontal dipole is in the shape of a doughnut standing on edge (fig. 4–10). The greatest field strength is now in a vertical plane, but still at right angles to the dipole.

Standing Waves

If an antenna is energized by an alternating current of a frequency equal to the antenna's resonant frequency, the current and voltage values will vary along the length of the wire, and will always be 90° out of phase. In a dipole, current will be at minimum in the center and at maximum at the ends. These points are called NODES. Figure 4–11 shows the location of node points along a full-wave antenna. Current and voltage nodes appear every half wavelength, but are separated from each other by one-quarter wavelength.

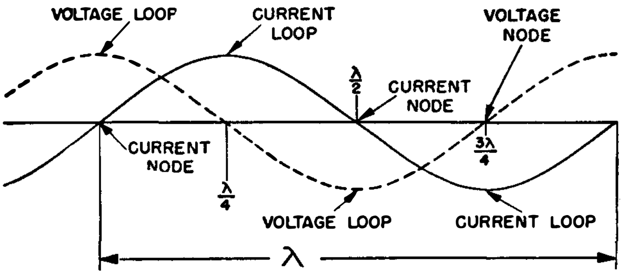


Figure 4–11.—Standing waves along full-wave antenna.

The wave of energy sent out by the transmitter travels to the ends of the antenna, from where it is reflected back along the length of the wire. The time required for this process depends upon the length of the antenna, and hence upon the frequency. If the dipole is resonant to the frequency generated by the transmitter, the returning wave strikes the fresh oncoming wave and the current and voltage in the two waves reinforce each other.

This condition continues as long as the antenna is energized, and 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 is really the case. Only in the presence of standing waves is the antenna radiating at maximum.

Actual and Electrical Antenna Length

The dipole has been defined as an antenna with a length equal to half a wavelength. Assume that a station wishes to transmit on a frequency of 3 MCS. There is a formula for finding the wavelength for a given frequency, and from that the proper antenna length:

$$\frac{300 \times 10^6}{\text{Frequency in cycles per second}} = \text{Wavelength (in meters)}.$$

The numerator 300×10^6 is a constant, the speed of radio waves in meters per second. Substituting, we find:

$$\frac{300 \times 10^6 \text{ (velocity in meters per second)}}{3 \times 10^6 \text{ (frequency in cycles per second)}} = 100 \text{ meters (wavelength)}.$$

The dipole to be used for that frequency will be:

$$\frac{100}{2} = 50 \text{ meters, or about 164 feet.}$$

This formula holds true only for an ideal antenna, completely free from the influence of the earth. Since no antenna really is free from the earth's influence, the physical length of an antenna should be about 5 percent shorter than the electrical length given by the formula. A half-wave antenna for a 100-meter station will be 50 meters minus 5 percent, or 47.5 meters long.

The physical length of a half-wave antenna for frequencies above 30 MCS can be calculated from the frequency by the following equation:

$$\text{Length (feet)} = \frac{492 \times 0.95}{\text{Frequency in megacycles}}.$$

The number 492 is a constant. The correction factor 0.95 is 100 percent minus the 5 percent loss due to the effect of the earth.

It is, of course, impractical to lengthen or shorten an antenna physically every time the transmitter is tuned to a new frequency. The length may, however, be changed electrically, a process known as TUNING the antenna.

Because of cost and construction difficulties, half-wave antennas are seldom used for transmitters operating at frequencies below 1000 KCS. A dipole for 550 KCS, for example, would have to be about 851 feet long. At the lower frequencies the MARCONI antenna, another basic type, affords a solution to the problem of undue length.

Marconi Antenna

The principle of the Marconi antenna (also known as the quarter-wave or grounded antenna) is illustrated in figure 4–12. The transmitter is connected between the bottom of the antenna and the earth. Although the antenna is only a quarter-wavelength, the earth itself acts as another quarter-wave antenna. By the aid of this IMAGE wave in the earth, half-wave operation is obtained from an antenna half the size of a dipole.

The relationship of current and voltage in a quarter-wave antenna is similar to that in a dipole. Voltage is greatest at the top of the antenna and least at the bottom. Current is greatest at the bottom and least at the top.

The Marconi antenna is used a great deal with portable transmitters. On an airplane, a quarter-wave mast or a trailing wire is the antenna, and the fuselage produces the image. Similar installations are made on ships. A quarter-wave mast or horizontal wire is the antenna, and the superstructure and hull provide the image.

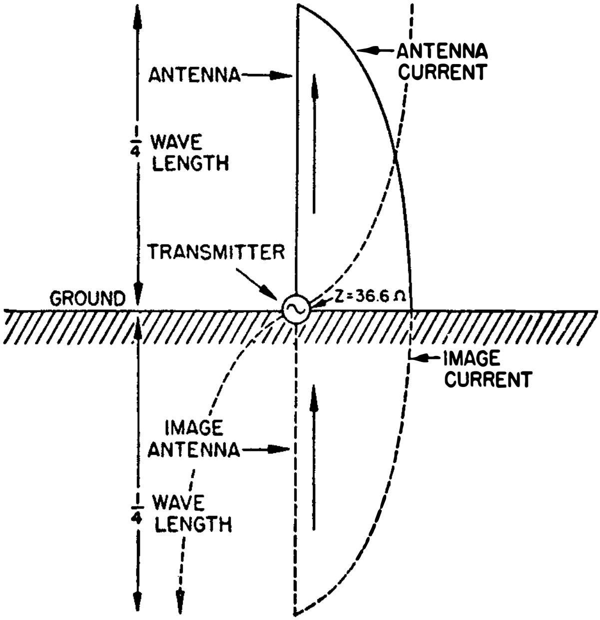


Figure 4–12.—Quarter-wave Marconi antenna, showing image current.

Your Job and Antennas

You may never be called upon to rig an antenna, or even change an installation you are using but, with mastery of the foregoing information, you should have little trouble, should the occasion arise.

In rigging emergency antennas, have your antennas already cut to proper length, with necessary insulators and turnbuckles secured to each end. Keep them coiled and stowed so as to be readily accessible. With these preparations made beforehand, a jury rig can be set up with minimum delay.

Remember, the antenna's job is to radiate, in the form of electromagnetic waves, the energy delivered by the transmission lines from the transmitter. To do this, the antenna must be correctly built and correctly installed. But more important, as far as you are concerned, the transmitter must be correctly tuned and coupled to the antenna. That is your job.

RECEIVERS

The five functions of a radio receiver are to—

1. Pick up signals.
2. Select the desired station and reject all others.
3. Amplify the signal from that station.
4. Demodulate, or detect, the carrier wave.
5. Reproduce the audio signal.

Signals are picked up by the receiver's antenna. Radio waves, striking the wire, set up a tiny electromotive force (EMF), or voltage, which is induced into the tuning circuits of the receiver. The induced voltage is of exactly the same frequency, and contains essentially the identical variations that were present when the carrier wave left the transmitter's antenna.

Field Strength

The amount of EMF induced in an antenna depends upon the length of the antenna and the strength of the carrier wave at that point. The carrier wave, strongest when it leaves the transmitting antenna, is attenuated (weakened) as it travels until its energy level, called FIELD STRENGTH, is too weak to be perceptible.

Field strength is expressed as the number of microvolts that would be induced in an antenna 1 meter long. (A microvolt is a millionth of a volt.) For example, the signal from one transmitter induces an EMF of 100 microvolts in an antenna 1 meter long. A second transmitter, which may be nearer or operating at higher power, induces 1000 microvolts in the same antenna. Thus, by comparison, the field strength of the second transmitter is ten times that of the first.

The amount of EMF induced in an antenna depends on the length of the antenna as well as upon the field strength of the signal. If the field strength of a certain signal is 100 microvolts per meter, an antenna 3 meters (but less than one-quarter wavelength) long will have an induced EMF of 300 microvolts.

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 from 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.

Some types of receivers are more selective than others. A radiotelephone receiver tunes more sharply than a commercial broadcast receiver, and a CW communication receiver is more selective still. You can compare the three tuning curves from figure 4–13.

Sideband frequencies are always produced when a carrier frequency is modulated. It is these sideband frequencies which contain the intelligence transmitted. Among the sidebands will be frequencies which are the sum or difference of the radio frequency and the modulating frequency. For example, if a carrier frequency of 1000 KCS is modulated by an audio signal of 1 KC, there will be resultant sideband frequencies of 1001 and 999 KCS.

Carrier waves from commercial broadcast stations contain sideband frequencies which extend 5 KCS on either side of the resonant frequency. If a station is transmitting on 1140 KCS, 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 4–13 is OPTIMUM—"at its best." The top is broad and flat and the sides are steep. Actually most AM broadcast re-

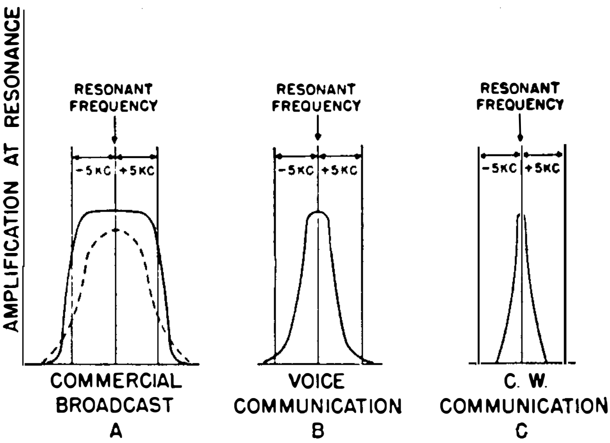


Figure 4–13.—Band widths of three types of receivers.

ceivers 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 KCS on either side of the resonant frequency. The voice may sound unnatural, like a voice on the telephone, but it can be understood.

CW sets tune so sharply that unless an operator is careful he can turn his dial through the signal without even hearing it.

TRF and Superheterodyne Receivers

There are many receiver circuits, but the majority of Navy receivers belong to two classes, the TUNED RADIO FREQUENCY (TRF) and the SUPERHETERODYNE. Both perform the same basic function which is, in the simplest terms, to convert the EMF induced in the antenna into a form you can hear.

The tuned radio-frequency receiver is the simpler of the two. It consists of three major parts (fig. 4–14). The first part, the RF amplifier, has two purposes: to select

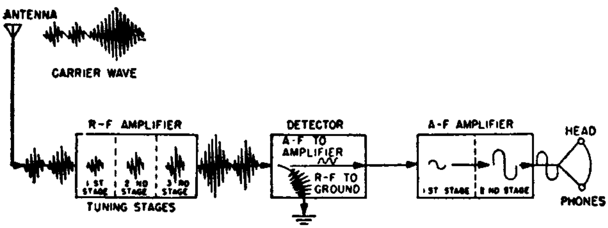


Figure 4–14.—Block diagram of the TRF receiver.

the proper signal and to amplify it through various stages. Following the RF amplifier is the detector, in which the audio-frequency component is separated from the radio-frequency portion of the signal. The RF portion is bypassed to ground, and the AF wave is passed on to the third part—the AF amplifier—where further amplification takes place. The final step is completed when the audio signal is sent into the headphones (or loudspeaker) to emerge as sound.

The superheterodyne contains all the major units of the TRF, with three additional units—mixer, local oscillator, and intermediate-frequency (IF) amplifiers—inserted between the RF amplifier and detector. (Refer to fig. 4–15.) Operation of the RF amplifier, second detector, and AF amplifier is the same as in the TRF receiver, but the added components (local oscillator, and IF amplifiers) change the operation of the circuit as a whole.

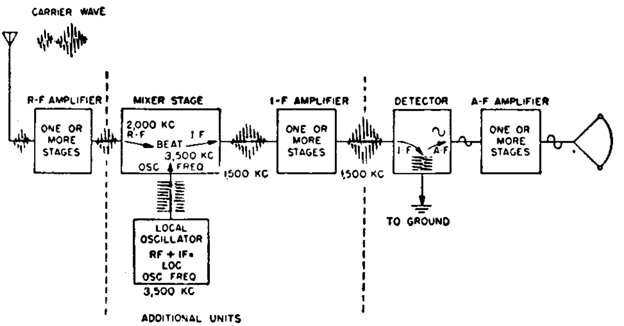


Figure 4–15.—Block diagram of the superheterodyne receiver.

The carrier wave from the RF amplifier is fed into the mixer stage. In figure 4–15 the received carrier wave frequency is 2000 KCS. A second and higher frequency—3500 KCS in the example—is produced in the local oscillator. The frequency of the local oscillator is controlled by the tuning dial on the receiver. As the receiver is tuned to a new frequency, the frequency generated by the local oscillator changes also, but always remains a certain number of kilocycles higher than signal frequency. In figure 4–15 the local oscillator signal is 1500 KCS higher than the carrier. This signal is sent into the mixer stage to be beaten against the carrier signal—that is, HETERODYNED.

The mixing or heterodyning of these two frequencies produces an INTERMEDIATE-FREQUENCY SIGNAL of 1500

KCS which contains all the modulation characteristics of the original signal. The intermediate frequency is equal to the difference between the station frequency and the local oscillator frequency. The intermediate frequency is then amplified in one or more stages called intermediate-frequency amplifiers and fed to a detector for recovery of the audio signal.

The IF stage has an advantage over an RF stage in that it is designed to give optimum response over a single frequency—the IF frequency.

Tuning

Most receivers have some form of tuning aid to assist the operator in locating a desired station. This commonly takes the form of a dialing or switching arrangement (intermediate frequency band-pass control) that permits preliminary tuning to be broad and final tuning to be sharp, or of a band-spreading device that permits wide movement of the dial, and gives the effect of spreading the channel over a greater area of the dial. Many receivers have tuning eyes or meters that indicate to the operator when the incoming signal is tuned to maximum.

An additional aid to quick and accurate tuning is a calibration chart for each receiver. This is merely a record of dial settings for particular frequencies. On shifting frequencies, an operator can consult the chart to see whether the settings are entered. If not, he makes the shift and logs the settings.

Volume and RF Gain Controls

The VOLUME (or AF GAIN) control on a communication receiver is used to raise or lower the sound to a desired level. This identical device is found on home radios and is familiar to everyone.

The RF gain control is related to the volume control in that it can be used to raise or lower the output sound level, but it is primarily a sensitivity control. An operator receiving a very weak signal would turn the RF gain control all the way up. If the signal is too strong, he lowers the control to avoid overloading some of the tubes of the set, thus preventing distortion.

AVC and DAVC

The automatic volume control (AVC)—sometimes called the automatic sensitivity control (ASC) or automatic gain control (AGC)—serves to keep the output volume at a constant level. This saves you the bother of repeatedly readjusting the volume control as a station fades and reappears in strength.

The AVC reduces the amplification of certain stages in a receiver as the amplitude of a received signal increases. It affects weak as well as strong signals. When a receiver is tuned, the AVC is usually cut off to afford maximum amplification for weak signals. After tuning, the AVC is turned on, provided the signal is not too weak.

In some receivers a special type of AVC, called a delayed automatic volume control (DAVC), is used. DAVC-equipped receivers do not reduce amplification of a signal until a certain level is exceeded. In this way very weak signals are not further weakened.

Noise Suppressors and Output Limiters

The high sensitivity of communication receivers causes them to pick up local noise and natural static. Interference is bothersome at best, and at worst causes fragmentary reception. There are a number of devices designed to minimize the effects of interference.

The noise suppressor works in much the same way as the tone control on a home receiver. When this control is tuned for bass reception, much of the noise is filtered off and is not permitted to reach the earphones. But the noise suppressor also reduces the volume, so that on weak signals it may be necessary to throw the switch that cuts the suppressor out of the circuit.

The output limiter prevents sudden crashes of static from injuring the operator's eardrums. There are several types, but all work as a safety valve. When the output volume of sound reaches a certain level, the limiter is activated and prevents the sound from rising any higher.

Some receivers have silencer circuits which keep the set quiet when no signal is coming in. This is a convenience when standing by for a message, and also saves you the discomfort of spending a slack watch listening to static.

Most output limiters and silencers have OFF-ON switches and an output level adjustment. The specific name for these controls depends on the make of the set.

Suppose we tune a receiver. Remember that, in practice, sets vary in the kind and number of controls they have. It is necessary to read the instruction book and examine the equipment before you attempt to tune any particular receiver. For purposes of illustration assume the following controls:

Control marked	*Function*
GAIN	For RF gain control.
SELECTIVITY	Intermediate-frequency band-pass control for regulation of broadness of tuning.
SILENCER	For noise suppression.
OUTPUT LEVEL	For variable audio level control.
TUNING	For selection of station and control of dial pointer.
POWER	To energize and deenergize set.

Before turning on the set it is advisable to check installation instructions to be sure that external wiring, power supply, antenna output, and grounding connections are properly made.

The following procedure is for CW reception.

1. Preliminary control settings:
   a. GAIN, SILENCER, and OUTPUT LEVEL at 0.
   b. SELECTIVITY in the BROAD position.
   c. NOISE LIMITER at ON position.
2. Tuning:
   a. Turn TUNING knob to desired frequency.
   b. Throw POWER switch to ON position.
   c. Rotate OUTPUT LEVEL knob to FULL position.
   d. Turn up GAIN control until signal is heard.
   e. Turn down OUTPUT LEVEL knob until signal begins to decrease. Leave it at that position.
   f. Readjust TUNING knob for exact frequency.
   g. Turn SELECTIVITY control to SHARP.
   h. Turn up OUTPUT LEVEL control until background noise is heard, then turn up SILENCER control until noise disappears.

EQUIPMENT DESIGNATING SYSTEMS

AN Nomenclature

On the front of each item of electronic equipment is a nameplate carrying a group of letters and numbers which identifies the gear. This group is assigned in accordance with the AN nomenclature (naming) system, and one is given to all new electronic equipment procured by the Navy, Army, or Air Force.

The first two letters are AN. This is the system indicator. It does not mean that all three services use the equipment, but only that the type number was assigned under the AN system.

AN is followed by a slant sign and three identifying letters. Letters to the right of the slant sign are very important, for they give a brief description of the equipment:

FIRST LETTER—Where installed; whether meant for use in aircraft, ground vehicle, etc.

SECOND LETTER—Type of equipment: radio, radar, underwater sound, and so on.

THIRD LETTER—Purpose of the equipment: communication, direction finding, gun directing, etc.

For an example take the equipment designation AN/SRT–4. AN is the system indicator. A glance at figure 4–16 gives us the meaning of the descriptive letters. (See below and on page 86.)

S—Water surface craft.

R—Radio.

T—Transmitting.

The AN/SRT–4 is a radio transmitting set for surface craft. The figure 4 is the model number.

Navy Model Letter System

The AN nomenclature system came into use in 1946, but you will still find a considerable amount of equipment marked and identified by the old Navy model letter system.

EQUIPMENT INDICATOR LETTERS, AN NOMENCLATURE SYSTEM

Installation	Type of equipment	Purpose
A—Airborne (installed and operated in aircraft).	A—Invisible light, heat radiation.	A—Auxiliary assemblies (not complete operating sets).
B—Underwatermobile, submarine.	B—Pigeon.	B—Bombing.
C—Air transportable (inactivated).	C—Carrier (wire).	C—Communications (receiving and transmitting).
D—Pilotless carrier.	F—Photographic.	D—Direction finder.
F—Ground, fixed.	G—Telegraph or teletypewriter (wire).	G—Gun directing.
G—Ground, general ground use (includes two or more ground installations).	I—Interphone and public address.	H—Recording (photographic, meteorological, and sound).
	K—Telemetering.	
	M—Meteorological.	
	N—Sound in air.	
	P—Radar.	
	Q—Underwater sound.	

EQUIPMENT INDICATOR LETTERS, AN NOMENCLATURE SYSTEM—Continued

Installation	Type of equipment	Purpose
K—Amphibious.	R—Radio.	J—Countermeasures (receiving and transmitting).
M—Ground, mobile (installed as operating unit in a vehicle which has no function other than transporting the equipment).	S—Special types, magnetic, etc., or combinations of types.	L—Searchlight control.
P—Ground, pack or portable (horse or man).	T—Telephone (wire).	M—Maintenance and test assemblies (including tools).
S—Water surface craft.	V—Visual and visible light.	N—Navigational aids (including altimeters, beacons, compasses, instrument landing, and depth sounding).
T—Ground, transportable.	X—Facsimile or television.	P—Reproducing (photographic and sound).
V—Ground, vehicular (installed in vehicle designed for functions other than carrying electronic equipment—such as tanks).		Q—Special, or combination of types.
U—General utility (includes two or more general installation classes, airborne, shipboard, and ground).		R—Receiving or listening.
W—Underwater, fixed.		S—Detecting and/or range and bearing.
		T—Transmitting.
		W—Remote control.
		X—Identification and recognition.

Figure 4–16.

The first letter indicates the basic purpose of the equipment. Some first letters of interest to you are:

E—Emergency power.

P—Automatic transmitting and receiving.

R—Radio receiving.

T—Radio transmitting (includes combination transmitting and receiving).

U—Remote control.

X—Naval experimental.

In the list above you can see that "R" means "radio receiving." RA was the first receiver designated under the system, RB the second, and so on. When the alphabet was exhausted, 3-letter designators were used. RAA followed RZ, then RAB followed RAA. RAZ was followed by RBA, and so on.

Numbers following model letters indicate a modification of equipment or the award of a new contract. Lower case letters are assigned to indicate a change in equipment after delivery by the manufacturer.

REPRESENTATIVE TRANSMITTERS

LF, MF, and HF Bands

AN/URT–2, –3, –4. This series of transmitting equipments is of late design and engineering in mechanical as well as electrical features. Eventually it will replace many other types of transmitters of earlier design. It is versatile in that the major circuit elements are made up into separate units, thus providing a sort of "building-block" system from which many types of equipment can be assembled. At present there are three standard types in the series, known as the AN/URT–2, –3, and –4.

The AN/URT–2 consists of the minimum number of basic units, and has a power output of 100 watts. The AN/URT–3 is the same, with the addition of a 500-watt booster amplifier and its associated power supply, thus providing optional output power of 100 or 500 watts. The

AN/URT–4 consists of two of the AN/URT–2 equipments plus the booster amplifier, thus providing two entirely independent transmitting channels of 100 watts output, with the 500-watt booster amplifier available for use with either channel when desired.

All equipments cover the frequency range 0.3 to 26 MCS. Since the frequency-generating unit is designed to produce all frequencies in this range, no doublers or other frequency-multiplier stages are required in the transmitter. The frequency-generating unit, intermediate-amplifier stages, and the final amplifier all function at the desired operating frequency. Up to ten pretuned channels may be selected by a telephone-type dial.

The equipment may be used for CW, radiotelephone, teletypewriter, and FAX transmissions.

TAJ. The model TAJ series radio transmitter is a standard shipboard transmitting equipment rated at 500 watts output and operating in the frequency range from 175 to 600 KCS. It is suitable for CW or MCW use, but is rarely used for other than CW. Because of its frequency range and power output, the antenna required is heavy and is always as long as practicable. In most instances a horizontal antenna is strung from mast to mast in order to have available sufficient length.

TBL. The model TBL series radio transmitter (fig. 4–17) is a versatile low-power equipment, and is extensively used on smaller vessels. It operates in two frequency ranges and has a rated output of 200 watts on CW and 100 watts on MCW. The low side covers the range from 175 to 600 KCS (same as the TAJ), and the high side from 2 to 18 MCS. This means that the TBL can be used to cover two frequency ranges and so save space. Both sides of this transmitter cannot be keyed at once, but to shift from one frequency range to the other is only a matter of throwing a switch.

The relatively low-power output lessens somewhat the requirements for large antennas, space for which is not available on smaller vessels.

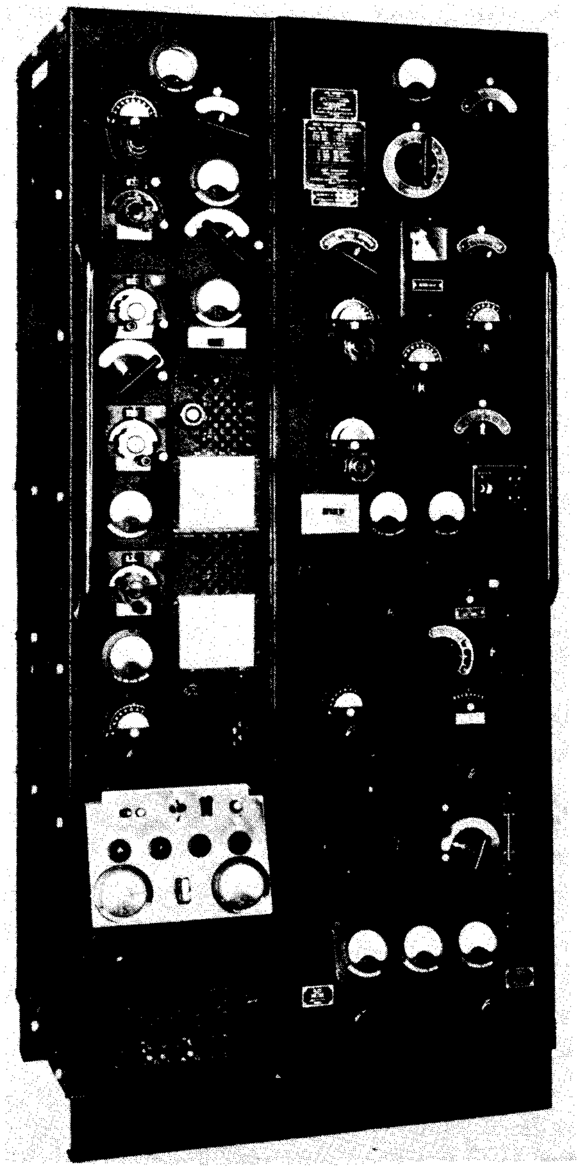


Figure 4–17.—TBL transmitter.

This equipment requires a separate speech amplifier when used for transmission of voice.

TDE. The model TDE series transmitter is another versatile low-power gear with a dual-frequency range of operation. Its rated output is 100 watts CW and 35 watts MCW, with the dual-frequency range covering 300 KCS to 18 MCS.

Unlike the TBL, the TDE requires no external units for use on voice transmissions. This equipment was designed for, and is extensively used on, the smaller ships where space is a major consideration.

The main disadvantage of the TDE is that it is not as ruggedly constructed as the TBL/TAJ types, and is therefore more subject to failure.

TCK. The model TCK series transmitter is of 400 watts CW output and 100 watts MCW output. Its frequency range is from 2 to 18.1 MCS. The TCK was designed primarily for shore station use, and is rarely found aboard ship because of difficulty of tuning to a single-end antenna. No external units are required for voice operation. There is a built-in crystal-controlled calibrator in the oscillator section which is used for the oscillator frequency adjustment, thereby eliminating the need for an external frequency meter.

TBK AND TBM. The model TBK series transmitter (fig. 4–18) is one of the most commonly seen HF transmitters in use by the Navy. It was originally designed in 1934 and, with modifications, has seen continuous service. Rated output is 500 watts for CW only in a frequency range of 2 to 18.1 MCS. It is rugged, stable, and easy to tune.

The TBK incorporates a low-power facility in the frequency range of 2 to 9.05 MCS. When in the LOW position, the LOW-HIGH power switch on the front of the equipment cuts the final amplifier from the circuit and the output is reduced to 75 watts. This is used for close-in work where high power is not desired.

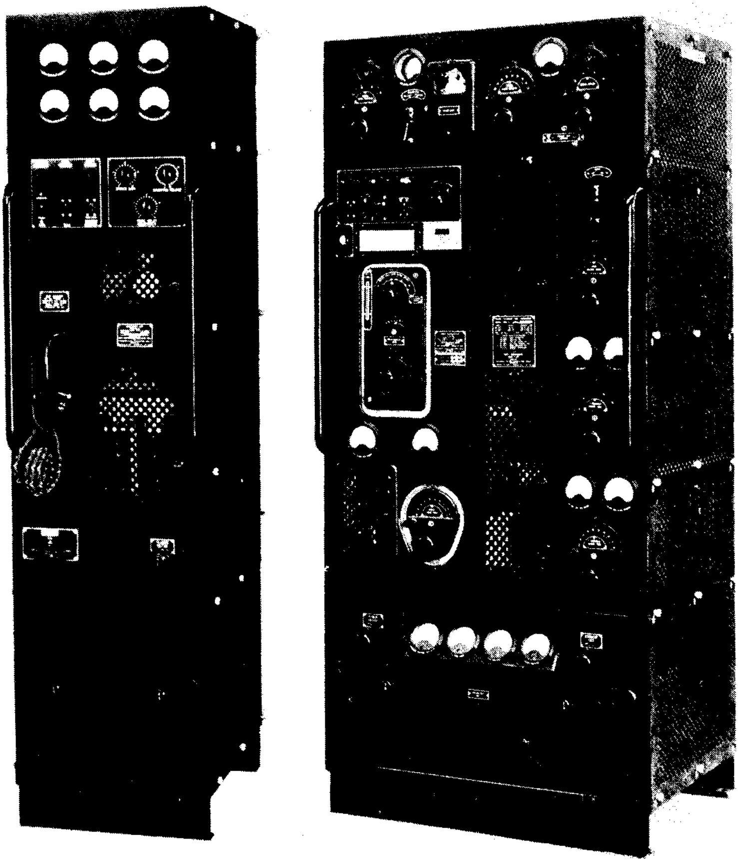


Figure 4–18.—TBK/TBM-type transmitter with modulator unit.

The model TBM series transmitter is almost identical with the TBK except that it has incorporated a modulator unit which permits MCW and voice operation also, with an output of 350 watts.

TCS TRANSMITTER-RECEIVER. The model TCS series transmitter-receiver set is a small shipboard equipment with a rated output of 25 and 15 watts, respectively, for CW and MCW. Small ships carry these sets primarily for close-range voice communication. This gear was designed as secondary communication equipment. Frequency range is from 1.5 to 12 MCS. The frequency-determining section may be either crystal-controlled or a continuously variable oscillator, whichever is more desirable. Transmitter and receiver use the same antenna, which is switched from receiver to transmitter by a relay when the transmitter is keyed. The over-all TCS system was designed for a short antenna (low power), and best results are obtained with a vertical 20-foot whip.

UHF Transmitters

UHF equipments are prevalent in the Navy. They operate in the 225 to 400 MCS frequency range, and their primary purposes are for tactical surface-to-surface, surface-to-air, and air-to-operations.

Although VHF communications (now obsolete in the Navy) were subject to skip distances under certain atmospheric conditions, UHF communications are not. In fact, signal reception in the UHF band is critical, and antenna locations are important. Aboard ship the UHF antennas are installed as high as possible to reduce interference.

Power output requirements are relatively low, and most UHF gear is designed for MCW and voice types of emission. Voice is most commonly used.

TED. The TED is a single-channel, low-power UHF radiotelephone transmitter for use primarily in ship-to-ship, ship-to-aircraft, and harbor communications. Its frequency range is from 225 to 400 MCS. It may be installed in surface ships, submarines, or shore stations.

The TED and other models TED–1 and TED–2, operate in conjunction with the standard Navy shipboard remote control system, and are associated with the AN/URR–13 receiver. The TED, TED–1, and TED–2 are virtually identical except for the remote-control unit for land operation, supplied with the TED only.

AN/GRC–27 TRANSMITTER-RECEIVER. The AN/GRC–27 is designed for ground radio installation, but at present is being installed aboard ship as primary UHF equipment.

There are 1750 crystal-controlled channels available for use in its frequency range of 225 to 400 MCS, of which any 10 are preset for instantaneous use. It takes 7 seconds to shift automatically from one channel to another. This equipment provides MCW and voice signals with a 100-watt output. Remote control shifting is provided.

AN/ARC–27 TRANSMITTER-RECEIVER. The AN/ARC–27 is designed primarily for installation in aircraft, but it is also placed in aircraft rescue boats. It has 18 preset crystal-controlled channels, and is normally used with a remote-control unit. This equipment is for a voice signal with 10 watts output.

REPRESENTATIVE RECEIVERS

VLF, LF, MF, and HF Receivers

RAK/RAL. The RAK/RAL series are both TRF sets and are usually installed together, as a unit, in such places as the emergency radio room. Total frequency coverage is 15 KCS to 23 MCS, with the RAK covering 15 to 600 KCS and the RAL 300 KCS to 23 MCS. A remote-control unit permits an operator to monitor both sets at the same time or either set separately.

CW, MCW, and voice transmissions may be received, but these sets are not recommended for voice because of high selectivity. The narrow bandwidth which provides the selectivity will not pass all of a wide intelligence envelope and distortion results.

The narrow bandwidth of the RAK/RAL receivers also limits search capabilities. Once a signal is found, however, discrimination and signal strength are excellent.

RBA, RBB, AND RBC. Total frequency coverage of these receivers is from 15 KCS to 27 MCS: the RBA covers from 15 to 600 KCS, the RB from 0.5 to 4 MCS, and the RBC from 4 to 27 MCS.

The RBA is a TRF receiver, while the RBB and RBC are "superhets." The RBA is provided with an audio BROAD-SHARP switch for varying the bandwidth of the audio stages to reduce interference from static and overriding signals. The RA may be used for CW, MCW, and voice signals; however, like the RAK/RAL, it is not recommended for voice because of high selectivity.

The RBB and RBC are identical in every respect possible, employing as many common components and subassemblies as compatible with difference in frequency coverage. These equipments recover CW, MCW, and voice signals with high sensitivity and good selectivity.

RBS. The RBS receiver is an HF set. Its frequency range is from 2 to 20 MCS, and it may be used for CW, MCW, and voice. The RBS has high sensitivity and good selectivity. The case is designed with a shock-resistant watertight bulkhead mounting for installation in almost any available space.

UHF Receivers

AN/URR–13. The AN/URR–13 is a compact superheterodyne receiver designed to provide reception in the UHF range. Its frequency coverage is from 225 to 400 MCS. It is used in conjunction with the TED transmitter.

The set consists of a panel, frame, and chassis assembly housed in a cabinet equipped with shock mounts for shipboard installation.

RDZ. The RDZ receiver is a superheterodyne receiver designed to receive either voice or MCW transmissions in the frequency range from 200 to 400 MCS. An autotune mechanism in this receiver makes it possible to select any one of ten preset crystal-controlled channels. The receiver is shown in figure 4–19. The RDZ receiver and its companion transmitter, the TDZ, may be controlled with channel selector units installed at several

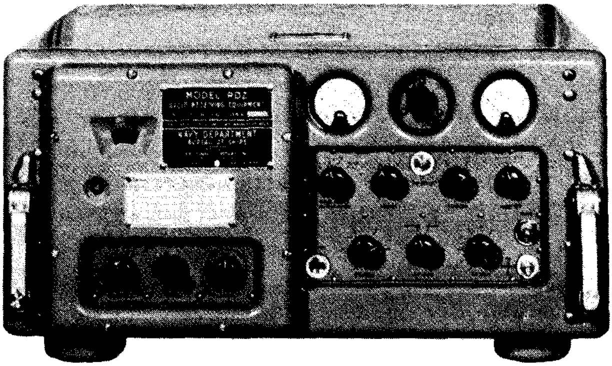


Figure 4–19.—RDZ receiver.

positions remote from the equipment. These selector units make it easy to change the frequency of receiver and transmitter in a matter of seconds for some remote position. Connections to and from the receiver are filtered to limit possible interference from nearby electrical apparatus.

EMERGENCY AND PORTABLE EQUIPMENT

Aboard ship, portable radio equipment is usually for emergency purposes. It is used when the ship's fixed radio equipment is destroyed, or normal and auxiliary power supply is out. Portable equipment is small, comparatively light in weight, and uses batteries or a hand-driven generator for power.

Location of these units aboard ship is of considerable importance. To minimize the effects of casualty, they are placed in various sections of the ship.

Types of portable equipment provided for a ship vary. Normally, the equipment is selected to cover important frequencies required. One type will cover the distress frequency, another the high-frequency range, still another UHF, and so on.

The types and models of portable equipment are constantly changing. In our discussion here, only representative types are covered, to give you a general knowledge of this means of radio communication.

One type of portable transmitter commonly found aboard Navy ships is designed to operate on 500 KCS, the distress frequency. It has a 5-watt output and can be used in lifeboats or liferafts. Because of an automatic transmitting feature, this equipment can easily be operated by inexperienced personnel. The equipment consists of a transmitter, storage battery, vibrator power pack, and antenna. These components are housed in a buoyant, watertight carrying case. Instructions for operation are found on a plastic plate attached to the front panel. This unit is intended to be kept in a convenient place aboard ship, where it will be available for immediate removal to a lifeboat, liferaft, or other point of operation.

This equipment may be operated automatically, or by a key mounted on the front panel. When operated automatically, the equipment transmits either an SOS or SSS signal, followed by 12-second dashes, to permit direction-finding by rescue vessels. The available power allows operating periods of 3 minutes at half-hour intervals for 20 hours, or approximately 1½ hours of continuous operation.

Another type of portable radio equipment is designed for transmitting and receiving in the medium- to high-frequency bands. This is ship-to-shore gear, capable of 9-watt CW output or 3-watt voice output. The frequency range is 2000 to 4525 KCS and 2000 to 5800 KCS on the receiver sections, and 2000 to 5000 KCS on the transmitter.

The range on this equipment varies with the emission. With CW, the gear is capable of approximately 30 miles; with voice, 15 miles. Major units are supplied with canvas-pack carrying cases. All the units of this equipment are watertight and submergence-proof.

The antenna assembly consists of two antennas: a small whip antenna and a large single-wire L-type. The type to be used depends upon the space and time available when the equipment is needed.

The accessory box contains batteries for the receiver supply. At least 80 hours of service, based on intermittent use of 4 hours per day, should be obtained from a fresh set.

FACSIMILE

Facsimile (FAX) is a method for transmitting pictorial and graphic information by wire or radio and reproducing it in original form at the receiving station. There are two forms of FAX. One is used to transmit photographs, the image being reproduced on photographic film or paper; the other is employed for such matter as weather charts and blueprints that lack the detail of a photograph and can be received on a special electrographic paper.

Facsimile is a relatively late addition to military communications, although commercial firms have used it for a number of years to provide pictorial service to newspapers. The process should not be considered as a replacement for radiotelegraph, radiotelephone, teletypewriter, or other widely used communication media. Rather, it supplements the older methods because many forms of graphic intelligence, which cannot be converted easily into verbal form, are necessarily used in military operations. Examples are charts, reconnaissance photographs and sketches, maneuvering board plots, circuit diagrams for equipment modifications, and harbor and area shipping control plots.

A disadvantage of the process is the difficulty of applying security to the transmission. FAX traffic is for this reason usually limited to unclassified material.

The most useful application of facsimile, that of transmitting fully plotted weather charts, has been under development since the close of World War II. The Joint National Facsimile Network, sponsored by the Weather Bureau and the coordinated planning committees of the military services, is devoted exclusively to this work. This network covers the entire continental United States, linking by landline about 100 USAF, Navy, Weather Bureau, and commercial stations. Fifty-nine are Navy stations. Participants intercept weather charts from a joint analysis center by plugging recording equipment into their "drops" on the landline. The Air Force maintains operational control over the network, but it will eventually be transferred to the Weather Bureau.

The network does not meet the Navy's need for weather data on areas outside the continental United States. Most current FAX traffic is prepared in the Navy's weather centrals, which have facilities for correlating weather observations from all over the world and formulating usable charts. Completed charts are distributed by radio and wire line to hundreds of ships and stations and to the other services. This in most instances represents a round-the-clock service, for weather forecasts as little as 6 hours old are out of date and require revision.

Use of facsimile for distribution of weather charts has eliminated need for skilled weather analysts and duplicate plotting aboard each ship and station where weather information is required. Significant economies, as well as a more uniform, accurate, and rapid weather service have been effected.

The Navy has a number of facsimile equipments in use. All operate in much the same way. The picture to be sent is wrapped around a cylinder on the transmitting machine (fig. 4–20). It is necessary that the picture lie perfectly flat, for variations in the surface plane cause faulty transmission of the intelligence. The cylinder rotates at a constant speed and at the same time moves longitudinally along a shaft. The picture is illuminated by a beam of light focused through a condensing lens. As the beam passes over each portion of the picture, it is reflected into a photoelectric tube, and variations in intensity of reflected light due to the character of the

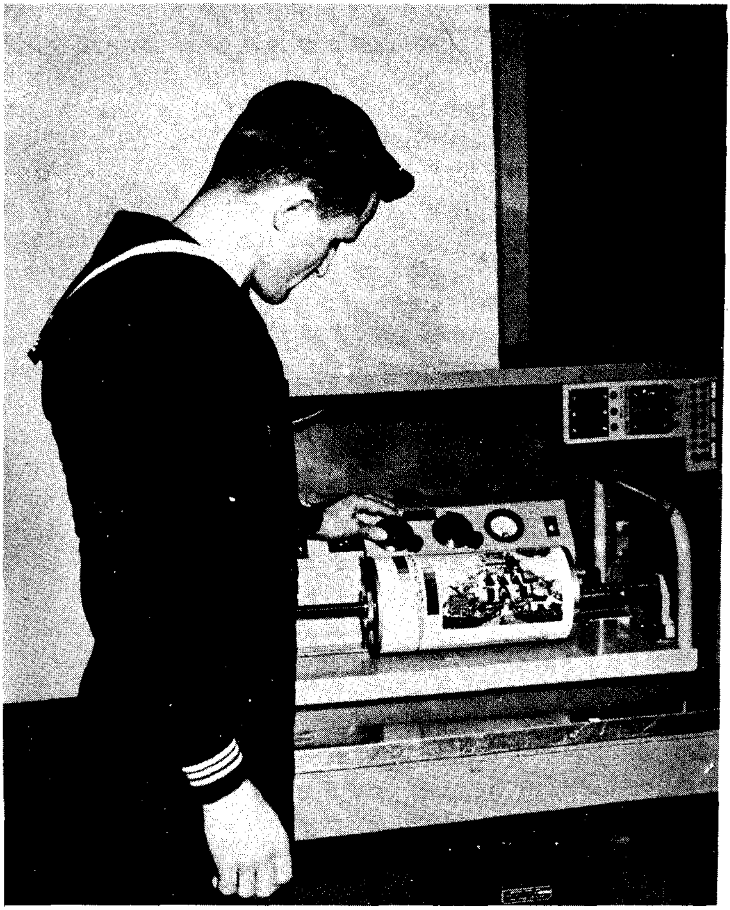


Figure 4–20.—FAX transceiver.

picture creates voltage variations in the tube output circuit. These voltage variations constitute the picture signal and may be sent directly over a landline or used to modulate the radio-frequency carrier of a transmitter.

The photoelectric tube has been called the electric eye, but it does not have the capacity of the eye or camera lens to view many images simultaneously. It can only measure the light value of any single area toward which it is directed. It is not possible to show the picture to the tube for an instant and expect it to analyze the intelligence for transmission. Rather, it is necessary to divide the picture into small areas containing monotone values of detail, which the photoelectric tube is capable of analyzing correctly. Thus facsimile uses a scanning principle, and allows the photoelectric tube to view a spiraling area one one-hundredth inch wide. As the drum rotates and moves longitudinally, consecutive areas are viewed by the tube until the entire picture has been analyzed for transmission.

At the receiver the signal is demodulated and the voltage variations used to operate a recorder in synchronization with the transmitter. If the transmission is to be recorded on photographic film or paper, the signal reaching the receiver is amplified until it is strong enough to operate a neon recorder lamp. The lamp scans sensitized paper or film on the drum, reception taking place in a darkroom. The paper or film is exposed in varying degrees corresponding to the image viewed by the photoelectric tube in the transmitter. In the case of film, photographic development yields a negative which may be used for making prints.

Where it is desirable to operate without a darkroom or chemicals, the nonphotographic process is preferable. One type of FAX receiver employs a device called a bar, hammer, or helix, which produces a picture by pressing down on carbon paper with pressures varying according to the transmitted picture. A second and more common type records on a specially prepared paper by what is literally a burning process (fig. 2–21). A stylus is connected to the output of the recorder amplifier in such a way that a high voltage is developed at the stylus point as signals are received. The electrified stylus burns a white surface coating on the paper, which has a black undercoating that is conducting. One type of this paper

Figure 4–21.—FAX receiver employing high-voltage recording stylus.

may be used for making copies by the gelatin-ink transfer (hectograph) process.

One of the greatest problems in the development of facsimile, and still a difficulty of operation and maintenance, is that of synchronizing transmitting and receiving drums. As the scanning begins, both drums must be revolving at exactly the same speed. This is accomplished by a sealed, temperature-compensated tuned fork which vibrates at 1800 cycles per second. A frequency variation of as little as one-tenth cycle will, in 20 minutes, cause an inch of skew in the received copy.

The 1800 CPS frequency is fed into the synchronous motor amplifier circuit. Each amplified pulse causes the rotor of the motor to advance one tooth or pole. If the rotor has 60 teeth, it will make a complete revolution for every 60 pulses received. Eighteen hundred pulses per second will drive the motor at one-sixtieth of 1800 or 30 revolutions per second.

The 1800 CPS tone is also transmitted. At the receiver it is used to energize the tuned fork that drives the receiving drum. Before starting traffic, the sending operator transmits a few minutes of "sync pulses," which operate a clutch mechanism which initially phases the receiving to the transmitting drum.

Drum speeds can be changed by altering the gear ratios. A faster speed is practical for short distances but, in long-range transmission, image distortion increases rapidly with increases in drum speed.

A difficulty encountered in any transmission circuit, especially over long distances, is interference. In CW, voice, or RATT, bursts of noise obliterate a portion of the signal and repeats may be required. In facsimile, bursts of interference cause a 1/100-inch line through a portion of the picture, but leave it readable. A number of systems for minimizing fading and interference are in use; at present the Navy is concentrating on frequency-shift keying for facsimile transmissions.

MOTOR GENERATOR UNITS

A motor generator unit is sometimes used to meet the power requirements of a particular radio installation. A motor generator unit is simply a generator for which the prime mover is a motor. The two armatures are commonly mounted on the same shaft and housed in the same frame. (Before proceeding with this section acquaint yourself with the sections on motors, generators, and test equipment in *Basic Electricity,* NAVPERS 10086. Before operating or adjusting a unit, examine and familiarize yourself with the installation and the information in the instruction book.)

You will most likely find a simple START-STOP switch used to energize and deenergize a unit. Pushing the START button will energize the unit and pushing the STOP button will deenergize it.

Three operational adjustments are occasionally necessary. They are performed on the speed governor, the motor field, and the generator field, and on most equipments are screwdriver adjustments, made when output voltage is not within required specifications.

To illustrate adjustment procedure we can take a typical case in which a DC motor drives an AC generator. If the voltage is outside specified limits the speed or frequency should be checked first. This can be done by attaching a tachometer to the shaft, or by connecting a frequency meter to the output terminals. The speed governor is then adjusted a small amount at a time to bring the speed or frequency within specified limits. A tachometer is a device similar in construction to an automobile speedometer, but it is graduated to indicate revolutions per minute.

The motor field adjustment is made at the factory and should not need to be changed. However, if the occasion arises where this is necessary, the speed governor is disconnected and the motor field adjusted until the speed specified by the instruction book is obtained. Then the speed governor is connected and adjusted as described above. If the speed is within specified limits and output voltage is still not correct, it may be further corrected by adjusting the generator field while operating the unit under the load and input conditions prescribed in the instruction book for such adjustment.

QUIZ

1. What is the unit of measurement of difference in potential? Of electrical resistance? Of power?
2. Define amplitude, wavelength, cycle, and frequency.
3. What is the meaning of the metric prefixes KILO and MEGA?
4. Radio waves moving along the surface of the earth are called ______ waves; those going into the atmosphere are called ______ waves.
5. Why does a change in the ionosphere affect radio transmission and reception?
6. Every transmitter has an _________, which generates the basic signal.
7. What is the third harmonic of 4200 KCS?
8. What is the relationship of the length of a dipole to the wavelength?
9. Name the five functions of a receiver.
10. What is meant by the sensitivity of a receiver? The selectivity?
11. What is the purpose of the automatic volume control on a receiver?
12. Name two equipment designating systems.
13. What is facsimile?
14. The three operational adjustments occasionally necessary on motor generators are performed on the ______, the ______ and the ______.
15. How can you check the speed or frequency of a motor generator?
16. What is the most useful application of facsimile?
17. Why is portable and emergency radio equipment placed in various parts of the ship?

CHAPTER 5

INTERNATIONAL MORSE CODE

The international Morse code is a telegraphic alphabet, with letters and numbers represented by sound patterns. Mastery of the code is one of the most important of the Radioman's skills.

If you are a service school graduate, you have been taught the Morse code, and much of this chapter may be of little interest to you. If you are striking for Radioman from the deck force, and this is your first acquaintance with the code, you have many, many hours of hard work ahead. Do not be discouraged on this account. Many fine Radiomen have learned the code for themselves. Most ham operators are self-taught. You can learn it too if you will stay with it.

The international Morse code is a dit and dah system. (By the way, the code is pronounced by saying "dit" and "dah," NOT "dot and "dash." So forget about dots and dashes and think only in terms of dits and dahs.) The groups of dits and dahs which represent each letter must be made as one unit, with a clear break between each dit and each dah, and a much more distinct break between the letters. A dit is one-third the length of a dah.

You must never try to count the dits and dahs. Don't let yourself get in the habit of doing so. It's a temptation at first, but you won't be able to count fast enough when the code speed picks up. Learn SOUND PATTERNS instead. To understand what this means, rap out the pattern beginning "Shave and a haircut." You recognize this from its characteristic rhythm, not from the fact it has a certain number of beats in it. You must learn the code the same way. There are 36 Morse sound patterns representing the letters and numbers, plus a few others representing prosigns and punctuation marks. With study and drill you will learn to recognize each as fast as you now recognize "Shave and a haircut." The accent always falls on dahs, and you should pronounce each rhythmical combination with that in mind.

Go through the alphabet several times getting the sound feel of the dit and dah combinations.

MORSE ALPHABET

In the pronunciation guide for sounds of letters given below, sounds are written as phonetically as possible. In the middle of a group, the short sound "dit" actually takes on the sound "di." The phonetic alphabet is included in parentheses after the letters. Get in the habit of referring to the letters phonetically.

Letter	*Pronunciation*
A (ALFA)	di-DAH
B (BRAVO)	DAH-di-di-dit
C (CHARLIE)	DAH-di-DAH-dit
D (DELTA)	Dah-di-dit
E (ECHO)	dit
F (FOXTROT)	di-di-DAH-dit
G (GOLF)	DAH-DAH-dit
H (HOTEL)	di-di-di-dit
I (INDIA)	di-dit
J (JULIETT)	di-DAH-DAH-DAH
K (KILO)	DAH-di-DAH
L (LIMA)	di-DAH-di-dit
M (MIKE)	DAH-DAH
N (NOVEMBER)	DAH-dit
O (OSCAR)	DAH-DAH-DAH
P (PAPA)	di-DAH-DAH-dit
Q (QUEBEC)	DAH-DAH-di-DAH
R (ROMEO)	di-DAH-dit

Letter	*Pronunciation*
S (SIERRA)	di-di-dit
T (TANGO)	DAH
U (UNIFORM)	di-di-DAH
V (VICTOR)	di-di-di-DAH
W (WHISKEY)	di-DAH-DAH
X (XRAY)	DAH-di-di-DAH
Y (YANKEE)	DAH-di-DAH-DAH
Z (ZULU)	DAH-DAH-di-dit

Number	*Pronunciation*
1	di-DAH-DAH-DAH-DAH
2	di-di-DAH-DAH-DAH
3	di-di-di-DAH-DAH
4	di-di-di-di-DAH
5	di-di-di-di-dit
6	DAH-di-di-di-dit
7	DAH-DAH-di-di-dit
8	DAH-DAH-DAH-di-dit
9	DAH-DAH-DAH-DAH-dit
Ø	DAH-DAH-DAH-DAH-DAH

Punctuation mark	*Pronunciation*
Dash	DAH-di-di-di-di-DAH
Parenthesis	DAH-di-DAH-DAH-di-DAH
Period or decimal point	di-DAH-di-DAH-di-DAH
Slant	DAH-di-di-DAH-dit
Apostrophe	di-DAH-DAH-DAH-DAH-dit
Colon	DAH-DAH-DAH-di-di-dit
Comma	DAH-DAH-di-di-DAH-DAH
Question mark	di-di-DAH-DAH-di-dit

HINTS ON STUDYING CODE

If you have any trouble learning the code, the following method may be helpful. Go through the three groupings of short, medium, and long sounds with their accompanying practice words. Make up words of your own if you wish to give yourself further practice. Speak the practice words in code. Say "TEE: DAH dit dit," "MINE: DAH-DAH di-dit DAH-dit dit."

If you can speak words in code rapidly and distinctly, you will have an easier time when you learn to receive code on the receiver. The sounds are very similar.

Short sounds		*Practice words*
E	dit	TEE ATE EAT TEA MEAT MEET
T	DAH	MINE TIME MAINE TEAM
A	di-DAH	AIM NITE TAME TEA MATE
I	di-dit	TAME NAME MITE MIAMI
M	DAH-DAH	MAMA MEAN MAN MAT EMIT
N	DAH-dit	MINT MANE TAN ITEM TINT

Medium length sounds		*Practice words*
D	DAH-di-dit	MUST SAME MAMA SUIT AUTO
G	DAH-DAH-dit	MUSS OUST MUSE MUTE ATOM
K	DAH-di-DAH	TAUT MAST MASS SUET SAM WIND
O	DAH-DAH-DAH	SEA TUM SAW OAT SUE SAT WED
R	di-DAH-dit	SUM MUD IOU USE SEAM WOOD DARK
S	di-di-dit	GEORGE DOWN KIND SORT DOOR MASK
U	di-di-DAH	WORK GROW WOMAN EDGE GAGE
W	di-DAH-DAH	WIGS WORM WAGER WAKE KEG

Long sounds		*Practice words*
B	DAH-di-di-dit	VAT VET VIM HAM SIX SAY
C	DAH-di-DAH-dit	HAS HAT EVE CUT CAM VEST
F	di-di-DAH-dit	HEAT HAVE MUCH THAT EACH
H	di-di-di-dit	COAT ACHE SAVE HUSH ACME
J	di-DAH-DAH-DAH	CUTE BAKER CHARLIE FIVE
L	di-DAH-di-dit	
P	di-DAH-DAH-dit	
Q	DAH-DAH-di-DAH	
V	di-di-di-DAH	
X	DAH-di-di-DAH	

Y DAH-di-DAH-DAH
Z DAH-DAH-di-dit

HOW JIMMY LIKE PAPA QUICK
QUILL VICTORY XRAY YOUNG
ZERO BUZZ GARGLE FIZZLE
LYNX OXYGEN WAX QUAY
JERKY WHIP QUEBEC

Figure sounds

1. di-DAH-DAH-DAH-DAH
2. di-di-DAH-DAH-DAH
3. di-di-di-DAH-DAH
4. di-di-di-di-DAH
5. di-di-di-di-dit
6. DAH-di-di-di-dit
7. DAH-DAH-di-di-dit
8. DAH-DAH-DAH-di-dit
9. DAH-DAH-DAH-DAH-dit

Ø. DAH-DAH-DAH-DAH-DAH

You've probably noticed by now that numerals slow your speech in oral transmission. That is understandable—they also slow the speed of radio transmission. Headings and procedure signs containing calls and numerals are transmitted at a slower rate of speed than straight alphabetical characters.

RECEIVING

If you have carried out the recommendations made up to this point, you are ready to receive code transmitted to you on an oscillator. The ship or station to which you are attached will almost certainly have practice oscillators for your use.

There will be an experienced Radioman who will key code groups to you for your training. The sound produced by an oscillator closely resembles the sound of code from the radio receiver. The operator keying to you for practice should transmit each individual character at the standard rate of 20 words per minute, and he should maintain a fairly long interval between characters. As you progress, you gain speed by shortening spaces BETWEEN characters.

This standard character speed is shown in figure 5–1. Note that the characters themselves may be keyed at 20 words per minute but that the longer intervals between characters and words materially decrease the beginner's over-all speed.

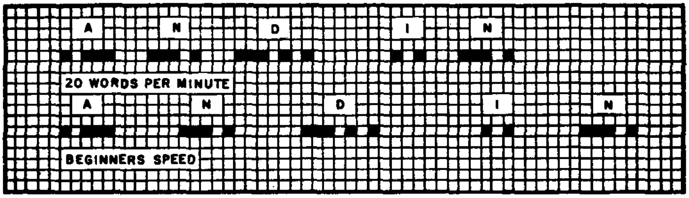


Figure 5–1.—Correct keying of Morse characters.

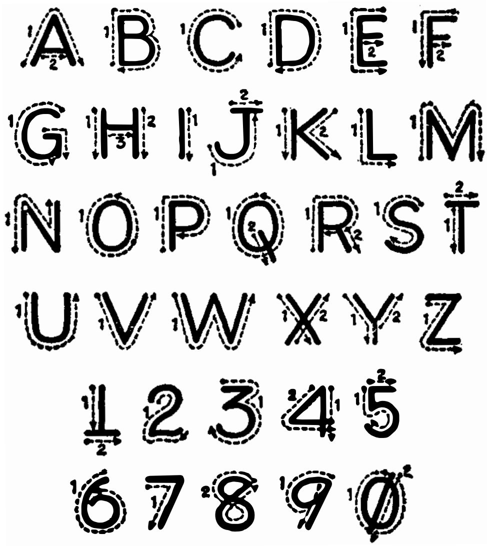
Also note that the code, compared against time in the case of the 20-word-per-minute transmission, is in the proper form of having the dit as a unit. There is one unit between each element of a character, three units between each character, and seven units between each group or word.

After learning the sound of each character at this rate of speed, it is not difficult to reduce the time between characters and to copy code at a much faster speed.

As you advance in rating, you will be required to increase your transmission and reception speed. If you learn the fundamentals well, it will be fairly easy for you to increase your speed. When copying code, if you miss a character, don't stop to worry about it; get the next character and let that missed one go by. BE A COMPETENT OPERATOR. Make every transmission and every reception an accurate one. Do not seek speed before accuracy.

PRINT CLEARLY

Learn to print clearly and rapidly. The messages you handle are important and someone must read what you have written without puzzling it out. Examine figure 5–2 and compare the printed letters with your own. Notice that the sequence of strokes for some letters may be different from the way you are accustomed to form them. This is an aid to rapid printing; the more of the



LETTERS MAY BE SLANTED
IF DESIRED

Figure 5–2.—How to form printed characters.

letter you can form with a single stroke the better. Use this illustration as a guide to avoid confusions between printed letters and printed numerals. Especially watch the letter Z and the numeral 2. If you wish, write Z with a line through the stem. Even more important is the distinction between the letter "O" and the figure zero. Zero is always written with a slant through it (Ø). Also exercise care to avoid confusion between I and 1 and S and 5.

As your code speed increases, you will find it impossible to print that rapidly; therefore, typewriting is a skill also required of ALL Radiomen. To help you master touch-typing, get a copy of *Twentieth Century Typewriting,* by Lessenberry, and begin practicing. USAFI also offers a typing course for beginners; see the reading list in the front of this book.

Your ability to send will depend mainly upon two things. First, you must KNOW THE CORRECT SOUND OF THE CHARACTER you are attempting to transmit. Second, you must KNOW THE PROPER METHOD FOR KEYING WITH PERFECT CONTROL. Practicing the code out loud, as well as having received it by oscillator, has given you a good knowledge of code sound. The proper method for keying is your next concern.

The first key you will use is the UNSHIELDED TELEGRAPH KEY normally employed on practice oscillators and on shipboard and station circuits. It must be properly adjusted before you can transmit clear-cut characters. Use the screws on the key to obtain good control. The gap between contacts should be adjusted to suit your wrist movement. Some operators like a closed key, others an open. "Closed" and "open" are terms for a short gap and a long gap.

Side screws should be centered and adjusted by tightening to prevent the keying bar from moving sideways. The spring screw should place just enough tension on the key so that the key is easily depressed yet springs upward at the end of each dit or dah.

Learn from the beginning the correct way to grasp the key.

Do not hold the key tightly, but let your fingers rest lightly on the key knob. Your thumb rests against the side, your forefinger rests on top of the key, with your

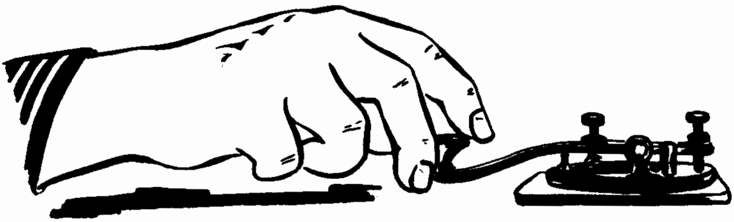


Figure 5–3.—Correct keying.

third finger bent and relaxed lightly with the remaining two fingers. Check figures 5–3 and 5–4 for the correct method of keying. To ensure correct movement of your wrist and forearm, your arm should lie on the operating desk. The muscle of your forearm—not your elbow—should support the weight of your arm. Your elbow should not protrude over the edge of the table, as the pressure of the underside of your forearm will obstruct circulation and cause fatigue. Sit upright, with your arm in line with the key.

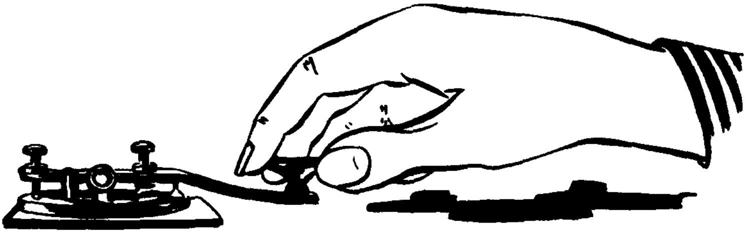


Figure 5–4.—Your thumb rests against the side.

YOUR ABILITY TO TRANSMIT DEPENDS TO A VERY LARGE EXTENT ON ACQUIRING THE PROPER MOVEMENTS OF YOUR WRIST AND HAND WHILE OPERATING THE KEY. To close the key, your wrist moves upward and your hand rocks downward toward your finger tips. To open the key, these two movements are reversed—your wrist comes down and your hand rocks back.

Make your wrist flexible. Limber it up. Correct wrist action may be developed by exercising your wrist up and down like a hinge. Another exercise is rotating your hand in clockwise circles, with your wrist held in a stationary position. These exercises will relieve any undue tension you may experience when first beginning to transmit.

Tips on Sending

Good operators have "sending rhythm," and you can acquire it in just one way. That is by PRACTICING.

It may be difficult for you to key correctly at first, because your wrist is unfamiliar with the type of movement required for sending telegraphic code. Your wrist will be stiff and you'll have to get rid of that stiffness by concentrated practice. Don't favor the stiffness of your wrist. If you do, your sending will be choppy.

The following exercises have been carefully prepared. Use them as an instruction guide.

E

The dit characters require an adept "fist." They must be transmitted quickly and rhythmically. Make a series of E's (dits). These are made with a pronounced movement of your wrist upward, returning to the normal position after each dit. At first, maintain a fairly long interval between dits. To assist you in limbering your wrist, exaggerate the movement upward. To prevent tenseness and tiredness of your wrist, remove your hand from the key periodically and flex your wrist. After practicing E's for 15 or 20 minutes, decrease the interval between dits until you are making them rather rapidly. Each sound should continue to be a definite dit, however. Keep at it until you can control each dit.

I

When you feel that your wrist is limbering up, make the character I (di-dit). Start with your wrist in the normal relaxed position, raise it for the first dit, lower it quickly halfway back, and make the second dit with another quick movement of your wrist upward. Your transmission, made slowly, will produce the sound dit-dit. As you practice and develop more rhythm, this character will have the sound of di-dit.

T

Send a series of T's (DAH) with a good interval between them. Instead of a quick movement of your wrist upward, make a slower, more definite movement of your wrist and exert more pressure on the key. Send dahs for a few minutes, gradually diminishing the interval between characters.

M

Now try sending strings of M's (DAH-DAH). As with the character I, you will not return your wrist to the beginning position at the end of the first dah, but will bring it to the halfway point and then make the last dah. With practice, you'll soon change the hesitant DAH DAH sound to the snappy DAH-DAH. DON'T FORGET THE CORRECT WRIST MOVEMENTS. If you find that your sending requires exertion of forearm muscles or that your shoulder is moving, STOP and recheck your wrist motions.

Now try these practice groups several times, backward and forward. Make them clearly and distinctly, spending more time on characters which cause you any trouble.

M E E T   E M I T   M I T E   I T E M

A

The character A (di-DAH) will give you practice in making a dit and a dah together. Sending motions in their proper order are (1) a slight pressure of your fingers alongside the key, (2) a quick surge upward of your wrist, (3) a slight relaxing of your wrist to the halfway point, and (4) a final definite upward movement of your wrist. This will produce the sound dit DAH when you begin to practice it. But keep at it—you'll soon have the proper di-DAH sound. Avoid tenseness; relax your forearm muscles when sending.

U

You're ready for the character U (di-di-DAH). Start slowly, sending dit dit DAH. Practice it until you're getting a di-di-DAH sound.

N

The character N (DAH-dit) requires little pressure on the sides of the key, a strong wrist movement upward, a half return, and a quick, short, upward motion for the dit. Practice this for several minutes until you are able to send DAH-dit easily and with complete relaxation.

D

Try the letter D (DAH-di-dit). At first, with the correct wrist movement, it will be DAH dit dit. But the sound you want to hear is DAH-di-dit—with a swing. Send D's until you can transmit them with perfect control.

Check yourself on the following groups. You should have less difficulty than you did with the first groups.

MINED UNITE TIMER
MAUDE TEAMED

S

Go back to the dits for S which is di-di-dit. Get a good position on the key and put your wrist to work. See how quickly you can change the dit dit dit sound to di-di-dit. Relax your forearm.

V

The letter V is di-di-di-DAH, so you'd better learn how to send it that way. Relax. If you've got your wrist tied up in a knot, you'll be sending dit dit dit DAH. Move your wrist up and down easily until you are sending di-di-di-DAH with perfect control. Practice this letter carefully. It is used in every radio test.

O

DAH-DAH-DAH is O. Keep at it until it stops sounding like three T's.

Test your skill with these words:

VITAMIN ISSUED INUNDATE
UNANIMOUS VIVA INSISTED

H

Character H is di-di-di-dit. Send one. If it sounds similar to four E's, your wrist is too stiff. Develop the di-di-di-dit sound.

B

Send DAH-di-di-dit. That's the Morse code equivalent of B.

Practice for perfect control, then try the groups below.

S O U S E   B A S S I N E T   V I N E   B E S T E D
H E S I T A N T   D I V A N   N A U S E O U S

K

At this point you should be prepared to tackle the other characters. They are mostly combinations of the letters you have practiced. Each one has a distinct overall sound. For instance, K should not have the sound DAH-dit-DAH. It should be DAH-di-DAH. Think of the tune *Over There.* DAH-di-DAH has the same rhythm as oh-ver THERE—DAH-di-DAH.

Q

Q (DAH-DAH-di-DAH) has the same rhythm as the words, "Payday today." Say in a monotone "payday today," and then say DAH-DAH-di-DAH. When transmitted, these combinations have the same swing given them as when speaking or chanting.

Practice the remaining letters of the alphabet and the numerals. When you think you're ready for it, practice the code exercises on the following pages.

The above 15 characters have taught you proper wrist movement. You know the remaining 11 letters and 10 figures. Following are 14 practice exercises. Use these for self-drill.

CODE PRACTICE

1. E E E T T T A A A N N N I I I S S S H H H
M M M O O O E E E T T T A A A N N N I I I
S S S H H H M M M O O O E E E T T T I I I
M M M A A A N N N S S S O O O H H H E E E
T T T E E E T T T I I I M M M I I I M M M
A A A N N N A A A N N N S S S O O O S S S

2. U U U V V V D D D B B B K K K C C C W W W
J J J P P P U U U V V V D D D B B B K K K
C C C W W W J J J P P P W W W J J J P P P
U U U V V V K K K C C C B B B D D D U U U
D D D V V V B B B P P P J J J C C C K K K
W W W D D D B B B V V V U U U W W W J J J

3. R R R L L L F F F G G G Z Z Z X X X Y Y Y
Q Q Q R R R L L L F F F G G G Z Z Z X X X
Y Y Y Q Q Q G G G Z Z Z F F F L L L R R R
Y Y Y Q Q Q R R R X X X Z Z Z R R R F F F
L L L Q Q Q Y Y Y G G G Q Q Q Y Y Y R R R

4. 1 1 1 2 2 2 3 3 3 4 4 4 5 5 5 6 6 6 7 7 7
8 8 8 9 9 9 Ø Ø Ø 1 1 1 2 2 2 3 3 3 4 4 4
5 5 5 6 6 6 7 7 7 8 8 8 9 9 9 Ø Ø Ø 1 1 1
2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9 Ø Ø 1 1 2
2 3 3 4 4 5 5 6 6 7 7 8 8 9 9 Ø Ø 1 2 3 4
5 6 7 8 9 Ø 1 2 3 4 5 6 7 8 9 1 2 3 4 5 6

5. V U I Y Q Z C X G R S L K J P Q X Z R I F
C V B W F K D S H Q Z A L K F B V R S T U
O T M E G Y Z X V E G N I W S L H M U A E
V U A E W Q G H V C I X Z L N R Y U K V U

6. E 8 Y 7 B 6 X 1 W Ø Z 2 A 3 C 5 S 4 I 2 F
U 1 F 5 D 8 Q 4 T 6 U 9 Q 2 E Ø S 5 U 1 Y
G 2 J 4 S 3 E 5 T 7 Z 8 K 6 M 9 R 1 A 2 R
S 7 W 8 E 9 R 2 A 3 Z 3 X 6 U 8 B 7 C 6 T

7. MI AN SY NL TY CE DO PS CX ZW QA PK LN HU WC VN
BM ZS CD QA IU SD LM UH GY TR DC VT AR YU FD SA
IG WQ XT ZI NY OT ED BM LP YU GH BY RE DF LS WQ
XS ZI TY BG NH JV KL MD MI AN SY NL TY CE DO PS

8. EF TS 16 29 83 ZJ 45 Ø7 WR ND KW IC UX 91 Ø2 IB
LO FG 84 63 XW AC TM SU 5Ø 72 XR RJ ZM 43 65 VH
97 LM 12 46 7Ø FC FE EY 34 56 27 FT FY JU IT 98
76 75 52 DE WE QT 13 36 57 KF RI YT 19 93 35 41
FK YU 96 Ø1 MC AR TH 19 25 3Ø UR BO UL 32 Ø5 21

9. NDT EGH RTS LYB FCC ZEX PIH CWE LKJ QIE NUG CVT EPL
SZW QAU SH
GBT VRT GIK GYO DCM XSD ZAU YER DLN URG HNB VDX ZWS
QTA GHI PT
MBY PLK RDC ESX IUP PKJ NYH GHT DFR VED SWN VBT XFZ
RDA SEN FU

GBC YRF DSE WNJ GVA SWQ QIX ZOT MEH GKD BGV CFI ATA RUR SAC LT

NVR DAB GLM INY EGB LKO MWD SKZ QLD YGB NDT EGH RRS FLM FCC ME

10.

O V L H	M Y B L	U R X O	H I Z O	V I C T
F I N X	X C X S	H T Y V	I Q N T	U B M L
A B L B	E J L N	C Y Z B	Z W C N	J N D Z
U T L Z	K L A B	D E F Z	V N U W	K F R E

11.

J I C O Y	T X S T Y	3 8 Ø 9 5	R D I H A	J X T D Z
O X Y D W	X P Z S Y	R S P H D	8 9 7 Ø 6	C U S P I
R N B R J	6 5 2 8 9	Z O N I G	F Y E Q U	A R Q N V
R N L P T	K A K O Z	8 7 8 4 Ø	B V G A N	W K O Q T
S R Q M T	U J V W N	4 5 8 7 2	Y X B C X	A F K O Z
O G L C T	N I H G P	1 2 3 4 9	A T U S K	S L E W Q

12.

O L M X	M V N H	U W Q R	N V U T	K U X F
C D E H	L Y H E	D I P A	Z Q W I	A Y S K
Q I Q A	W M N W	Z I H Z	C A K D	B T G W
W N L I	P W B U	O X A D	X F R J	I Q C A

13.

Z M J X I	U R Y N C	9 3 4 7 Ø	P Q A Z M	D E G V M
N C B V G	H U G H Y	1 3 2 6 7	P H R A N	Q U E C C
1 2 8 9 Ø	M C N D H	E U I R Y	W Q A Z X	I R S V Z
M C U R I	7 2 4 3 9	O Y T R W	P I Q A W	C N J W O
O W Q A J	O I S K M	1 Ø 7 Ø 6	D G F H G	K S B O U

14.

U T H A	V N C B	R F D S	E D C D	C X V D
R W Q I	M N J F	S T R O	T N B L	U J H K
N I O Q	J U Y R	G B N S	V C X T	R J T U
B C D V	C G F H	5 7 8 1	J H V X	H G J D

CONTINUE YOUR STUDY

Continue sending to yourself with the practice key and oscillator. If you can operate with another striker, so much the better. Sit down at an unused operation position and tune in some slow code; it is not hard to find, especially on amateur frequencies. Copy as best you can. Don't worry too much about missing letters. Get what you can no matter how fragmentary it is. As your speed picks up, tune in faster code. If you find you are copying a certain speed solidly, the code is too slow. Keep it faster than you can copy comfortably.

Make the transition from pencil copying to the typewriter as soon as possible.

You are going to need lots of practice. Class A Radioman schools ashore run a full day, and for months a man copies code several hours daily.

As you gain proficiency, try copying the 18- to 20-WPM fleet broadcasts. This does not mean for an hour now and then; it means for as much time as possible—15 or 20 hours per week. Don't be afraid to use some of your off-duty time. At the same time begin to learn how to hold down a circuit. One of the best ways to do this is to spend several watches logging circuits that other operators are manning. At the end of every watch compare your log with that of the regular operator and question him about anything you do not understand. That way you see procedure in use and get practice in copying many fists.

Learn to COPY BEHIND. If you are recording B as D, S as I, J as W, and so on, you are copying too close. The farther behind the better. At first listen to one character while setting down the previous one. Try to fall back one letter more. Listen for the character while carrying one in your head and setting down the one still before. Once you get the knack you will find copying behind to be easier, faster, and more accurate. The faster the code the farther you must stay behind. Watch an oldtimer copy 35- or 40-WPM press. You will find he is carrying anywhere from five words to a sentence in his head.

One thing further: It is common for a student learning code to hit a PLATEAU. The regular progress to higher speeds stops and for a time the student finds himself unable to copy faster than a certain speed. If this happens to you, just stay with it until your speed picks up. Never lose confidence in the fact that any man of ordinary aptitude can learn the code if he puts in the necessary time and work.

QUIZ

1. A dit is what fraction of the length of a dah?
2. In receiving code, why should you never count the dits and dahs?
3. Counting a dit as a unit, how many units are there between each element of a character? Between each character? Between groups or words?
4. When printing, how can you avoid confusion between zero and the letter O?
5. What is meant by the terms CLOSED and OPEN as applied to a telegraph key?
6. How much tension should you place on the spring screw of the key?
7. When you are operating a key, why must you be sure that your elbow does not protrude over the edge of the table?
8. What is a good way to learn to hold down a circuit?

CHAPTER 6

RADIOTELEGRAPH, PART I

A message is a written thought or idea, expressed briefly and to the point, and prepared for transmission by the most suitable form of telecommunication.

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 the message—but who do not have the 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, very 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:

1. Single address;
2. Multiple address;
3. Book;
4. General.

A SINGLE ADDRESS message is sent to one addressee only.

A MULTIPLE-ADDRESS message is sent to two or more addressees, each of whom is informed of the others. Each addressee must be designated either as action or information.

A BOOK message is sent to two or more addressees, and is of such a nature that no addressee needs to know who the others are—although every addressee is informed whether he receives the message for action or for information.

The station sending a book message divides addressees into groups according to relay stations which serve them. A separate message is prepared and transmitted to each relay station, the message changed only to drop addressees that are the concern of some other station. Upon receiving a book message a relay station may further reduce the number of addressees by repeating the process or by making up single address messages for each of its tributaries addressed. Since many book messages are meant for dozens of addressees, substantial time and expense are saved by the shortened headings.

A GENERAL message has a wide standard dissemination. There are many types of general messages, each of which carries an identifying title and which is intended for a certain standard set of addressees (fig. 6–1). Messages of most titles are serially numbered through the calendar years, such as ALNAV 12–56, signifying the twelfth ALNAV sent during 1956.

If the general message is not operational or tactical, and is of such a nature that a short delay in delivery will do no harm, the originator may designate it a BASEGRAM. Strategically located shore stations acting as basegram delivery authorities will furnish copies to ships that (1) missed the message or that (2) seeing the message to be a basegram, did not decrypt it because it would be available in plain language form ashore.

Maintenance of general message files is often a Radioman's duty. General messages are grouped according to type and filed in order of serial numbers. They are kept until canceled or superseded.

SUMMARY OF 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's, but of no interest to the Marine Corps.
	ALNAVSTA	Administrative traffic 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's, but distribution list does not include attachés, missions, observers, or minor shore activities.
	ALCOM	Promulgate communication information throughout the Navy.
	ALCOMLANT and ALCOMPAC.	Similar to the ALCOM series for, respectively, Atlantic-Mediterranean areas and Pacific area.

Figure 6–1.

SUMMARY OF GENERAL MESSAGES

Originator	Title of Series	Description
CINCPAC	JANPAC	Messages pertaining to the unified command under CINCPAC.
CINCPACFLT	ALPACFLT	Messages for general distribution to commands under CINCPACFLT.
CINCLANTFLT	ALLANTFLT	Messages for general distribution to commands under CINCLANTFLT.
Commandant, Marine Corps	ALMAR	Messages for general dissemination within the Marine Corps. Similar in content to ALNAV's.
	ALMARCON	Messages for Marine Corps activities such as the Fleet Marine Force units (air/ground). Also given to naval air bases and stations.
Commandant, Coast Guard	ALCOAST	Messages for general dissemination within the Coast Guard. Also similar to ALNAV's.
	ALDIST	Provide Coast Guard district commanders with policy instructions and other information.
Commandant, Western Area, Coast Guard	PACOS	Messages for all Coast Guard vessels in the Pacific.

Figure 6–1.—Continued.

Originator	Title of Series	Description
Commandant, Eastern Area, Coast Guard	LANTOS	Messages for all Coast Guard vessels in the Atlantic.
Joint Communication-Electronics Committee	ALJAP	Promulgates to holders information pertaining to JCEC-adopted publications.
Commandant, MSTS	ALMSTS	Messages for all MSTS commands and offices.

Figure 6–1.—Continued.

CALL SIGNS AND ADDRESS GROUPS

Call signs and address groups are both used to identify addressees and to assist in transmission and delivery of messages.

Call Signs

Call signs—letters, letter-number combinations, or one or more pronounceable words—identify some communication activity. This is true in both civil and military use, but military call signs may also designate the command(s) served by the station. There are several categories of call signs. Some call signs belong to more than one category.

1. 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 the whole of the K, W, and N

blocks. The United States reserves A calls for the Army and Air Force. W and K blocks are assigned to commercial and private stations, merchant ships, and others, and the N block is for use only by the Navy, Marine Corps, and Coast Guard. Naval shore communication stations have 3-letter N calls; naval vessels have 4-letter N calls. EXAMPLES:

NAVCOMMSTA, San Francisco --------NPG
USS *Dukes County* (LST 735) --------NGCY

International call signs for USN, USMC, and USCG aircraft consist of the service designator N, NM, or NC respectively, followed by the last four digits of the serial or bureau number of the aircraft.

2. INDEFINITE CALL SIGNS represent no specified facility, command, authority, or unit, but may represent any one or any group of these. EXAMPLES:

NERK ----------(To) any or all U.S. Naval ship(s)

NA through NZ --(From) any U.S. Naval ship

NQO -------------Any or all U.S. Naval shore radio station(s)

Indefinite call signs are often used as "dummy" calls in codress message headings to conceal the identity of originators and addressees. In such cases this information is placed in the encrypted text.

The call NQO might be sent by a ship unable to raise a shore station. Any Navy shore station hearing the transmission would answer and accept the traffic.

3. NET CALL SIGNS represent all stations within a net. (A net is a group of stations in direct communication with one another on a common channel.) EXAMPLES:

YAPD --------All U.S. Naval stations on this (radiotelegraph) circuit

OVERWORK --All U.S. Naval stations on this (radiotelephone) circuit

4. TACTICAL CALL SIGNS are composed of letters, numerals, letter-numeral combinations, or pronounceable words. They identify tactical commands or communication facilities.
5. RADIOTELEPHONE CALL SIGNS are words or combinations of words—such as SUNSHINE or HIGHHAT—used only in radiotelephone communications.
6. VISUAL CALL SIGNS are groups of letters, numerals, special flags and pennants, or combinations of any of these, for use in visual communications.

Address Groups

Call signs and address groups are used by the Navy in exactly the same way. Most holders of address groups are shore-based commands, authorities, or activities not served by their own communication facilities, such as the following: (1) senior commands and commanders ashore, such as the Secretaries of Defense and of the Navy, bureaus 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 messages.

Among other uses, address groups facilitate delivery of messages in instances where a communication center serves so many activities that its own call sign is not enough to identify the addressee.

Holders of address groups are not always ashore; all commands afloat (other than individual ships) hold address groups as well as call signs.

Address groups, like call signs, are divided into types.

1. COLLECTIVE ADDRESS GROUPS represent two or more commands, authorities, activities, units, or combinations of these. The group includes the commander and his subordinate commanders. EXAMPLE:

   DSWN ----------------------DESRON 16

2. CONJUNCTIVE ADDRESS GROUPS are used only with one or more other address groups. The conjunctive address group DRHG, for example, represents the naval control of shipping officer at ------. This particular group must be followed by a geographic address group.

3. GEOGRAPHIC ADDRESS GROUPS represent geographical locations or areas, and are always preceded by conjunctive address groups. Assuming the geographic address group for Kodiak, Alaska to be SAAN, the naval control of shipping officer there would be addressed DRHG SAAN.

4. ADDRESS INDICATING GROUPS (AIG's) represent a specific set of action and/or information addressees. The originator may or may not be included. YRHG is the AIG for eight particular oilers as action addressees and Commander, Service Force Pacific Fleet and Commander, Military Sea Transportation Service as information addressees. The originator is Commander, Military Sea Transportation Service, Pacific Area. In this case ten call signs and address groups are eliminated from the heading of the message by use of one AIG.

In addition to the above are the SPECIAL OPERATING GROUPS which are used by certain U.S. allies. These are 4-letter groups, identical in appearance to address groups, and provided to pass special instructions in headings of messages. EXAMPLE:

EUBJ -----------------Pass to the first addressee

ORIGINATOR; DRAFTER; RELEASING OFFICER

The ORIGINATOR of a message is the command by whose authority the message is sent. The DRAFTER—usually the communication officer or a department head—is the person who actually prepares the message for release. The RELEASING OFFICER authorizes transmission of the message for and in the name of the originator. The commanding officer is usually releasing officer, but he may delegate releasing authority if he wishes.

A Radioman charged with accepting locally originated messages must know who has releasing authority. Check every message for his signature.

TIME IN MESSAGES

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

The initial time zone lies 7½°E and 7½°W of the Greenwich (England) meridian. It is called zone zero because the difference between standard time of this zone and Greenwich mean time is zero. Each zone, in turn, is designated by the number which represents the difference between the local zone time and Greenwich mean time.

Zones lying 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 the zero zone are also numbered from 1 to 12, but are designated plus, since the zone number must be added to local zone time to get GMT. In addition to the time zone number, each zone is also designated by letter. A through M (J omitted) indicate minus zones, N through Y indicate plus zones (fig. 6–2).

The twelfth 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.

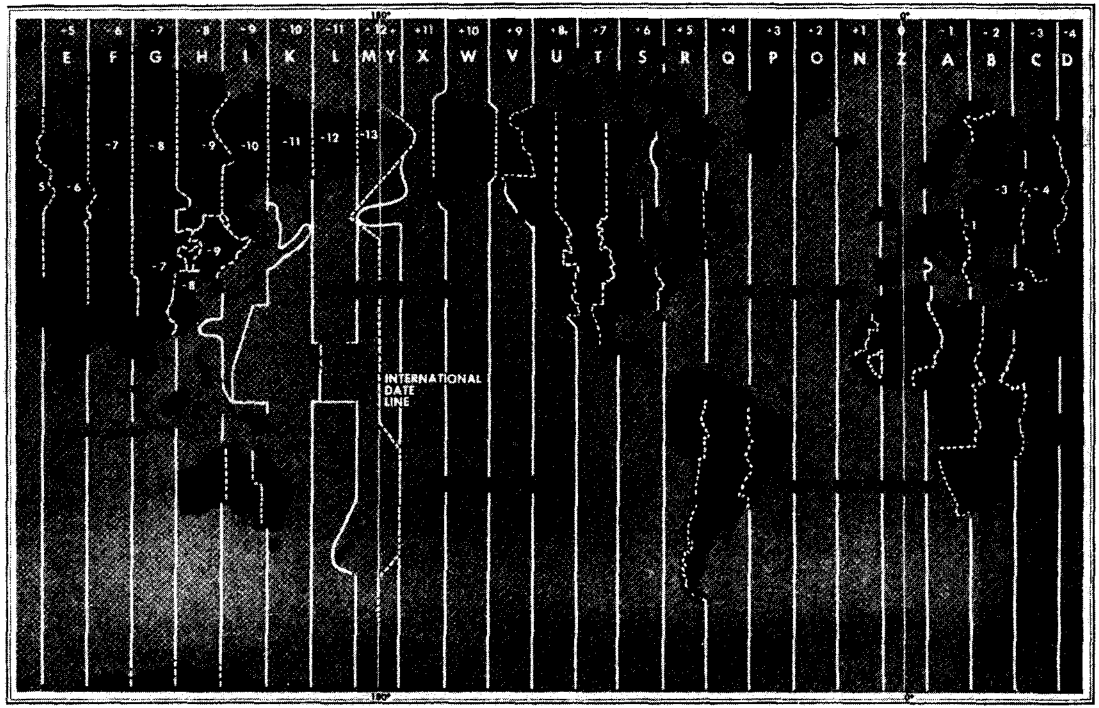


Figure 6–2.—Time zone chart of the world.

A westbound ship crossing the line gains a day; an eastbound ship loses a day.

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

So that the same time may be kept throughout the service, GMT is used to indicate the time of origin of most naval messages. This eliminates any doubt as to which time the originator is using. The designating letter for GMT is Z.

The approved method of expressing time in the 24-hour system is with the hours and minutes expressed as a 4-digit group. The first two figures of the group denote the hour and the second two the minutes. Thus 6:30 AM becomes 0630; noon is 1200; and 6:30 PM is 1830. Midnight is usually expressed as 0000—rarely as 2400—and 1 minute past midnight becomes 0001. The time designation 1327Z indicates 27 minutes past 1:00 PM, 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 means the seventeenth day of the current month plus the time in GMT. Dates from the first to the ninth of the month are preceded by the numeral 0.

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

PRECEDENCE

PRECEDENCE is one of the most important concepts in naval communications. To communication personnel it indicates the relative order in which a message must be handled and delivered, and to the addressees 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. The various precedences have the same force through all the means of transmission.

Use of higher precedences is limited to certain types of urgent traffic, and standards for handling each precedence are prescribed. Study table (fig. 6–3) below.

PRECEDENCE TABLE

Pro-sign	Designation	Definition and use	Handling requirements
Z	FLASH	A FLASH message must be SHORT and must deal with an emergency situation of vital proportions. The precedence is reserved for (1) initial enemy contact reports, and (2) special emergency operational-combat traffic originated by specifically designated high commanders, or by operational commanders of units directly affected.	FLASH messages must be hand-carried, processed, transmitted, and delivered in the order received, and ahead of all other messages. Messages of lower precedence are interrupted as necessary until the FLASH message is cleared.
Y	EMERGENCY.	Reserved for messages which demand immediate delivery to the addressee, such as those meeting one or more of the following qualifications: (1) amplifying reports of initial enemy contact; (2) emergency communications which affect current implementation of a tactical action; (3) distress traffic; (4) messages which gravely affect the national security; and	EMERGENCY messages are processed, transmitted, and delivered in the order received and ahead of all messages of lower precedence, even to the extent of interrupting processing and transmission of lower precedence messages.

Pro-sign	Designation	Definition and use	Handling requirements
		(5) messages concerning weather of a destructive nature—hurricanes, typhoons, tidal waves, etc.	
O--	OPERATIONAL IMMEDIATE.	Used only for messages whose value depends on prompt delivery, such as (1) tactical messages pertaining to operations in progress; (2) traffic concerning immediate movements of ships, aircraft, or ground forces; (3) most weather messages; and rarely (4) important administrative messages bearing directly on tactical operations.	OPERATIONAL IMMEDIATE messages are processed, transmitted, and delivered in the order received, and ahead of messages of lower precedence, even to the extent of interrupting processing and transmission of lower precedence messages.
P--	PRIORITY---	Reserved for important messages which must have precedence over routine traffic. PRIORITY IS THE HIGHEST PRECEDENCE WHICH NORMALLY MAY BE ASSIGNED TO MESSAGES OF AN ADMINISTRATIVE NATURE.	PRIORITY messages are processed, transmitted, and delivered in the order received and ahead of all messages of lower precedence. ROUTINE messages being transmitted should not be interrupted unless they are very long.
R--	ROUTINE---	Reserved for all types of messages which are not of sufficient urgency to justify a higher precedence, but must be delivered to the addressee without delay.	ROUTINE messages are processed, transmitted, and delivered in the order received and after all messages of higher precedence.

Pro-sign	Designation	Definition and use	Handling requirements
M	DEFERRED	To be employed for all types of messages which justify transmission by rapid means, but which will admit of the delay necessary for prior transmission of messages of higher precedence.	DEFERRED messages are processed and transmitted in such order as will clear traffic with due regard for messages of a higher precedence.

Figure 6–3.

PROSIGNS

Procedure signs, or PROSIGNS, are groups which convey in short standard form certain frequently sent orders, instructions, requests, reports, and the like relating to communications. In radiotelegraph, an overscore means that the prosign is sent as one character—that is, without the normal pause between the letters. Overscores are ignored in teletypewriter work.

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

PRECEDENCE PROSIGNS

Z--------FLASH.
Y--------EMERGENCY.
O--------OPERATIONAL IMMEDIATE.
P--------PRIORITY.
R--------ROUTINE.
M--------DEFERRED.

PROSIGNS USED TO IDENTIFY PORTIONS OF A TRANSMISSION

AA--------All after.
AB--------All before.
WA--------Word after.
WB--------Word before.

Ending prosigns

- K — Invitation to transmit.
- $\overline{\text{AR}}$ — End of transmission; no reply expected.

Pause prosigns

- $\overline{\text{AS}}$ — I must pause for a few seconds.
- $\overline{\text{AS}}$ $\overline{\text{AR}}$ — I must pause longer than a few seconds.

Separation prosigns

- $\overline{\text{BT}}$ — Long break. (Separates text of message from heading and ending.)
- II (Written in messages as a short dash) — Separative sign. (Used for all other separations in messages.)

Prosigns always followed by one or more call signs and/or address groups

- DE — From (in call).
- FM — Originator's sign.
- INFO — The addressee designations immediately following are addressed for information.
- XMT — Exempt.
- TO — The addressee designations immediately following are addressed for action.

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.

Group count prosigns

- GR (plus numeral) Group count.
- GRNC — The groups in this message have not been counted.

PROSIGNS USED WITH THE EXECUTIVE METHOD

$\overline{\text{IX}}$ -------- Action on the message or signal which follows is to be carried out upon receipt of "Execute."

$\overline{\text{IX}}$ plus 5-second dash ---- "Execute"—carry out the purport of the message or signal to which this applies.

GENERAL

$\overline{\text{AA}}$ ---------------- Unknown station.

B ------------------ More to follow.

C ------------------ Correct.

EEEEEEEE -------- Error.

EEEEEEEE $\overline{\text{AR}}$ ---- This transmission is in error. Disregard it.

$\overline{\text{HH}}$ $\overline{\text{HM}}$ $\overline{\text{HM}}$ -------- Emergency silence sign.

$\overline{\text{IMI}}$ ---------------- Repeat.

$\overline{\text{INT}}$ ---------------- Interrogatory.

J ------------------ Verify with originator and repeat.

NR ----------------- Station serial number.

CFN ---------------- Confirmatory material to follow. (Used in teletypewriter operation only.)

OPERATING SIGNALS

Radio operators and teletypists very frequently exchange routine advice and operating information, and occasionally relay emergency communication instructions or reports to other ships and stations and to aircraft. Traffic of this nature is transmitted in condensed standard form by the use of OPERATING SIGNALS—3-letter groups beginning with Q or Z. These signals—of which there are several hundred—represent words, phrases, or complete sentences, and are a form of shorthand, eliminating time-consuming plain language transmissions. Q signals are employed in both military and civil communications, and are understood by ships and shore stations of any nationality. Z signals are used only in United States and allied military communications, and represent meanings not found in the Q code. Operating signals are published in ACP 131. This publication has decode sections for both Q and Z signals tabbed alphabetically, and an encode section tabbed by subject matter.

Use of Operating Signals

Operating signals are prescribed for every form of electrical telecommunication except radiotelephone. Instead, the radiotelephone operator transmits operating information in brief spoken phrases. An exception is when a message containing an operating signal is relayed by radiotelephone; in this case 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 $\overline{\text{INT}}$ before the signal places it in the form of a question. EXAMPLE: USS *Midway* (CVA 41) asks Radio Washington (NSS)

NSS DE NIIW $\overline{\text{INT}}$ QRT-----Shall I stop sending?

REPLY:

NIIW DE NSS QRT---------------Stop sending.

The signal ZUG is used as a negative answer when there is no operating signal with the desired negative meaning:

NIIW DE NSS ZUG QRT-----Do not stop sending.

Some signals must be accompanied by a numeral suffix which is used to complete, amplify, or vary the basic meaning. EXAMPLE: A teletypewriter operator checks circuit operation with the query $\overline{\text{INT}}$ ZBK, meaning "Are you receiving my traffic clear?" The receiving station has a choice of replies: ZEBK1 means "I am receiving your traffic clear," or ZEBK2, "I am receiving your traffic garbled."

Many operating signals contain blank portions in their meanings which are filled in to convey specific information. $\overline{\text{INT}}$ 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 ____ KCS (MCS)." The operator fills in the necessary information:

NAAT DE NFDR ZRE 847Ø_______I hear you best on 8470 KCS.

Other signals have, in their meanings, blanks enclosed in parentheses. Filling in such a blank is optional. $\overline{\text{INT}}$ ZHA means, "Shall I decrease frequency very slightly (or ____ KCS) to clear interference?" The operator receiving the signal $\overline{\text{INT}}$ ZHA without the frequency added knows it means, "Shall I decrease frequency very slightly?"

During wartime, operating signals are often encrypted, especially those which reveal—

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

At all other times operating signals must be regarded as the equivalent of plain language.

Some of the most commonly used operating signals are listed in figure 6–4 (on pages 140 and 141). Remember that the Q code is used internationally, and speaks of "telegrams" where a U.S. Navy communicator would say "messages."

SOME COMMONLY USED OPERATING SIGNALS

Signal	Question	Answer, advice, or order
QCB__	----------------------------	Delay is being caused by ____ (1. your transmitting out of turn. 2. your slowness in answering. 3. lack of your reply to my ____.)
QRH_	Does my frequency vary?	Your frequency varies.
QRK_	What is the readability of my signals (or those of ____)?	The readability of your signals (or those of ____) is __ (1 to 5).
QRL__	Are you busy?	I am busy (or I am busy with ____). Please do not interfere.
QRM_	Are you being interfered with?	I am being interfered with.
QRN_	Are you troubled by static?	I am troubled by static.
QRO_	Shall I increase power?	Increase power.
QRP__	Shall I decrease power?	Decrease power.
QRQ_	Shall I send faster?	Send faster (__ WPM).
QRS__	Shall I send more slowly?	Send more slowly (__ WPM).
QRU_	Have you anything for me?	I have nothing for you.
QRW_	Shall I inform ____ that you are calling him on __ KCS (or MCS)?	Please inform ____ that I am calling him on ____ KCS (or MCS).
QRY_	What is my turn?	Your turn is No. __.
QRZ__	Who is calling me?	You are being called by ____ on __ KCS (or MCS).
QSA__	What is the strength of my signals (or those of ____)?	The strength of my signals (or those of ____) is __ (1 to 5).
QSB__	Are my signals fading?	Your signals are fading.
QSO__	Can you communicate with ____ direct or by relay?	I can communicate with ____ direct (or by relay through __).
QSY__	Shall I change to transmission on another frequency?	Change to transmission on another frequency (or on __ KCS (or MCS)).
QTB__	Do you agree with my counting of words?	I do not agree with your counting of words; I will repeat the first letter or digit of each word or group.
QTC__	How many telegrams have you to send?	I have __ telegrams for you (or for __).
ZAA__	----------------------------	You are not observing proper circuit discipline.

Signal	Question	Answer, advice, or order
ZAL--	----------------------------	I am closing down (until --) due to ----.
ZAN--	----------------------------	Transmit only messages of and above precedence --.
ZAQ--	----------------------------	The last word (or group) -- (1. Received from you was ----; 2. Transmitted to you was --.)
ZAX--	----------------------------	You are ---- (1. Causing interference. Listen before sending; 2. Causing interference by inattention to order to wait; 3. Sending at the same time as -- (call sign); 4. Causing delay by slowness in answering; 5. Causing delay by slowness in answering my service or procedure messages; 6. Answering out of turn.)
ZBD--	Will you repeat what you (or --) sent (at --)?	Following is what I (or --) sent (at --).
ZBH--	----------------------------	Make preliminary call before transmitting traffic.
ZBM-	----------------------------	Place ---- on watch on this frequency. (1. A qualified speed key operator; 2. A competent operator.)
ZBO--	Of what precedence and for whom are your messages?	I have (or -- has) -- message(s) (numeral indicating number of message(s) may be followed by Y, O, P, R, or M to indicate precedence for you (or for----).)
ZBP--	----------------------------	Your ---- (1. Characters are indistinct; 2. Spacing is bad.)
ZBQ--	When and on what frequency was message -- received?	Message was received at -- on -- KCS (or MCS).
ZUG--	----------------------------	Negative (No).

Figure 6—4.

BASIC MESSAGE FORMAT

With a few exceptions, military messages sent by electrical telecommunications are arranged according to a standard joint form called the BASIC MESSAGE FORMAT. The form is substantially the same whether the message goes by radiotelegraph, radiotelephone, manual teletypewriter, or by automatic tape equipment, although the format exists in four versions—one adapted to the special requirements of each of these primary transmission media. Here we will study the radiotelegraph message format, the one of first and most immediate importance to the Radioman. You will meet the other formats in later chapters, but if you learn the one given here you will have little trouble understanding any message.

All messages in joint form have three parts: HEADING, TEXT, and ENDING. (Of the three the most complex is the heading, which often uses as many as 10 of the format's 16 lines.) Heading, text, and ending are divided into COMPONENTS. Each component, in turn, contains one or more ELEMENTS. From left to right, the accompanying table (fig. 6–5) divides the message into its parts, components, and elements. The heading, for example, consists of the following components: procedure, preamble, address, and prefix. Elements of the procedure (see "Elements" column) consist of the call, transmission identification, and transmission instructions. Contents of the call are station(s) called, prosign XMT and exempted calls, and the prosign DE and designation of station called.

It is well to consider each item in the heading separately, for each has a special meaning and its relative position is significant. Prosigns, call signs, address group, and other contents that make up a typical heading must always appear in the order specified for the means of transmission.

It should be understood that there is no relationship between format lines and typed or handwritten lines. Format line 12, for example, is the text of the message and may consist of many written lines.

The form of the message and its transmission requirements dictate which components, elements, and contents will be used in the heading. Format line 1 is reserved for teletypewriter and tape relay work, and is omitted in radiotelephone and radiotelegraph. The abbreviated plaindress heading (which we will meet just a little later) may omit any or all of the following: precedence, DTG, and group count. Many messages not in abbreviated plaindress will omit such elements as transmission instructions, information addressee data, and final instructions because there is no occasion for them. The messages themselves are, for this reason, much simpler than the basic message format, which must provide for everything. You will seldom see a message that uses every format line, and you may never see one that uses all the contents. But remember that the sequence actually used in any one message must be in accordance with the proper message format.

It is not possible in a training course such as this to show you how to construct headings to meet every eventuality. Doctrinal communication publications will be available to you on the job, and are the ONLY valid, up-to-date reference sources for operational communication information. However, a few sample messages follow. Compare them to figure 6–5 on pages 144 and 145 as you read. If you learn them well you will have a good grounding in the construction of the radiotelegraph message.

RADIOTELEGRAPH MESSAGE EXAMPLES

Radiotelegraph communication is usually established by a callup prior to transmission of the message. The station with a message to transmit identifies itself to the station for which it has a message—if in direct com-

BASIC FORMAT FOR THE RADIOTELEGRAPH MESSAGE

Parts	Components	Elements	Format line	Contents
H			1	Not used.
	Procedure	a. Call	2 3	Station(s) called; prosign XMT (exempt) and exempted calls. Prosign DE (from) and designation of station calling.
E A		b. Transmission identification c. Transmission instructions	4	Station serial number. Prosign T (relay); G (repeat this transmission back to me exactly as received); F (do not answer); operating signals; call signs, address groups, address indicating groups, routing indicators; plain language.
	Preamble	a. Precedence; date-time group; message instructions.	5	Precedence prosign; date-time group and zone suffix; operating signals.
D	Address	a. Originator's sign; originator.	6	Prosign FM (originator of this message is); originator's designation expressed as call sign, address group, or plain language.
I		b. Action addressee sign; action addressee(s).	7	Prosign TO; action addressee designation(s).
N		c. Information addressee sign; information addressee.	8	Prosign INFO (this message addressed for information to); information addressee designation(s).
		d. Exempted addressee sign; exempted addressee(s).	9	Prosign XMT; exempted addressee designation(s).
G	Prefix	a. Accounting information; group count; SVC.	10	Accounting symbol; group count; ~~SVC (this is a service message).~~
SEPARATION			11	Prosign $\overline{BT}$ (Break).
T E X T	Text	a. Subject matter	12	Internal instructions; basic idea of originator.

Parts	Components	Elements	Format line	Contents
SEPARATION			13-----	Prosign $\overline{\text{BT}}$.
ENDING	Procedure--	a. Time group--------	14-----	Hours and minutes expressed in digits and zone suffix, when appropriate.
		b. Final instructions---	15-----	Prosigns B (more to follow); $\overline{\text{AS}}$ (I must pause); C (I am about to correct a transmission error in some foregoing part of this message); operating signals.
		c. Ending sign--------	16-----	Prosign K (go ahead and transmit), or $\overline{\text{AR}}$ (end of transmission).

Figure 6–5.

munication—or otherwise, to the station that will effect relay or delivery of the message. Let us begin here with a simple callup:

NACH DE NKKC K

From the previous discussion of call signs, it is apparent that this transmission is sent from one U.S. Navy ship to another. A check of the call sign book shows that NACH is USS *Hailey* (DD 556), and NKKC is USS *Lewis Hancock* (DD 675). This callup translates literally, "*Hailey* from *Hancock*, go ahead and transmit." From the very fact *Hancock* is attempting to establish communication, *Hailey*'s operator knows *Hancock* has a message to send. Accordingly, he inserts a message blank in his typewriter and tells *Hancock* to go ahead:

NKKC DE NACH K

With communication established, *Hancock* commences clearing traffic. The message may be analyzed as follows:

Format line	*Transmission*	*Explanation*
2 and 3	NACH DE NKKC	*Hailey* from *Hancock.*
5	–M–	DEFERRED precedence.
5	222345Z	DTG, indicating that this message was originated at 2245 GMT, on the 22d day of the month.
10	GR7	Group count. This message has seven groups in the text. (A plain language word counts as one group.)
11	$\overline{BT}$	Break. Separation between heading and text.
12	GUARD MAIL FOR YOU AT FIRST LIGHT	Text.
13	BT	Break. Separation between text and ending.
16	K	Go ahead and transmit.

On hearing the prosign K, *Hailey*'s operator checks the message and counts the groups. If he has missed some of the mesage, or is in doubt whether he received some part correctly, he obtains repetitions of those portions. When he is sure he has the message complete and correct, he sends a transmission to *Hancock,* so informing her operator. This transmission is called a RECEIPT.

In the above example two ships are in direct communication and *Hancock*'s call sign has served to address the message to that ship. A message that must undergo relay to reach the addressee will require a somewhat longer and differently constructed heading, inasmuch as it must be apparent to every station handling the message (1) who originated the message; (2) who receives the message for relay purposes; and (3) to whom the message is ultimately destined.

Assume that USS *Leyte* (CVS 32), steaming off Cristobal, Panama, has completed her mission of qualifying carrier pilots and wishes to so report to COMAIRLANT (in Norfolk) and to the Naval Air Station, Jacksonville, Fla. Communication is established with NAVCOMMSTA, Balboa, C.Z.—the nearest U.S. Navy radio station—and transmission of the message commences. Note the use of the information addressee prosign. Address groups in subsequent examples are fictitious because the actual ones are classified.

Format line	*Transmission*	*Explanation*
2 and 3	NBA DE NHRB	Radio Balboa from *Leyte*.
4	NR2–	Station serial number. This is the second message sent to Radio Balboa from *Leyte* during current 24-hour period. (Station serial numbers are used only between ships and shore stations, and between shore stations.)
4	T–	This message is for relay.
5	R–	ROUTINE precedence.
5	Ø11234Z–	DTG.
6	FM NHRB–	Originator, USS *Leyte*.
7	TO CABR–	Action to COMAIRLANT.
8	INFO DUNE	Information to NAS Jacksonville.
10	GR6	Group count.
11	$\overline{\text{BT}}$	Long break.
12	CARQUALS COMPLETED X ETA GTMO Ø314ØØZ	Text. Certain authorized abbreviations, standard throughout the services, are often used in messages for sake of brevity. The version as sent is 62 percent shorter than the

Format line	*Transmission*	*Explanation*
(12—Continued)		expanded text, which reads: CARRIER QUALIFICATION LANDINGS COMPLETED X ESTIMATED TIME OF ARRIVAL GUANTANAMO BAY CUBA Ø314ØØZ.
13	$\overline{\text{BT}}$	Long break.
16	K	Go ahead and transmit.

NBA gives *Leyte* a receipt for the message, and by doing so assumes responsibility for relay.

Here is an example of a type of message which you may be seeing often. This is a fleet broadcast message from NAVCOMMSTA, Washington, D.C., originated by CNO. Note the use of conjunctive address groups and the exempted addressee prosign. CW fleet broadcast messages repeat such element of the heading.

Format line	*Transmission*	*Explanation*
2 and 3	NERK NERK NERK DE NSS NSS	Any or all U.S. Navy ships from Radio Washington. (This call is sent with the first message of each hourly schedule, omitted thereafter.)
4	W NR522 W NR522–	Radio Washington serial number 522—that is, the 522d message placed on this broadcast schedule since the first of the current month.
5	P P–	PRIORITY precedence to action addressees.
5	R R–	ROUTINE precedence to information addressees.
5	11Ø847Z 11Ø847Z–	DTG.

Format line	Transmission	Explanation
6	FM FM	Originator's prosign.
6	BOSS BOSS	CNO.
7	TO TO	Action addressee prosign.
7	EATG EATG	All ships operating under ____.
7	CABR CABR	COMAIRLANT [and]
7	HIME HIME	COMBATCRULANT.
8	INFO INFO	Information addressee prosign.
8	SKAT SKAT	NAS GTMO.
9	XMT XMT	Exempted addressee prosign, meaning that stations or addressees which follow are exempted from foregoing collective address—in this case, the action address.
9	PINS PINS	CRUDIV 10 (a CRUDIV operating under COMBATCRULANT).
9	NHCY NHCY	USS *Antietam* (CVS 36) operating under COMAIRLANT.
10	GR156 GR156	Group count.
11	$\overline{\text{BT}}$	Break.
12	(156 encrypted groups)	Text.
13	$\overline{\text{BT}}$	Break.
15	B	Prosign meaning another message is to follow.
16	$\overline{\text{AR}}$	This is the end of this transmission and no reply is expected.

MESSAGE PARTS THAT MAY NOT BE CHANGED

Certain portions of a message are fixed by the originator and may not be changed by anyone else. This rule is necessary to the reliability of communications. No one knows better than the originator what the message should say, to whom it should be delivered, or what precedence it should carry. Changes in the following message parts are forbidden:

1. Preamble;
2. Address;
3. Prefix;
4. Text.

PLAINDRESS, ABBREVIATED PLAINDRESS, AND CODRESS

A military message may be drawn up in any one of the following forms: PLAINDRESS, ABBREVIATED PLAINDRESS, or CODRESS.

Plaindress

A plaindress message has originator and addressee designations in the heading. Unless the call serves as the address, the message contains all the components (but not necessarily the elements) prescribed by the message format—with one exception: The prefix may be omitted. All foregoing examples of radiotelegraph messages are in plaindress form. Call signs and address groups in plaindress messages may be encrypted for a degree of security.

Abbreviated Plaindress

Operational requirements for speed of handling—of contact reports, for example—may dictate the abbreviation of plaindress message headings. In such cases any or all of the following may be omitted from the heading: precedence, date, DTG, and group count.

Codress

Codress is an encrypted message form in which originator and addressee designations (as well as additional passing instructions, if any) are buried in the encrypted text. Codress is a valuable security device. It conceals the identity of units and prevents an enemy from making inferences from originator-addressee patterns.

Plaindress and codress may be compared from the following message prepared in both versions. TG 72.1 is conducting exercises in the Mediterranean. CTG 72.1 wishes to order the beginning of a new phase of operations, the message to go action to TG 72.1, information to COMANTISUBLANT and COMDESLANT. USS *Massey* (DD 778) while a part of the task group, is on detached duty and will not participate. Assume the following call signs and address groups:

CTG 72.1	E2L4.
TG 72.1	K3M3 (collective).
COMANTISUBLANT	FLOT.
COMDESLANT	HOPE.
USS *Massey*	NTSS.

PLAINDRESS version—text will be encrypted and group count added.

K3M3 DE E2L4–P–18Ø934Z–FM E2L4–TO K3M3–INFO FLOT HOPE–XMT NTSS GR __ $\overline{\text{BT}}$
COMMENCE PHASE TWO HUNTER KILLER OPERATIONS 191ØØØZ $\overline{\text{BT}}$ K

(The message will also go, with a slightly different heading, on a separate circuit to NAVCOMMSTA, Port Lyautey, for relay to information addressees.)

CODRESS version—NERK and NA are indefinite ships' call signs. Group count will be added after encryption.

NERK DE NA–P–18Ø934Z GR____$\overline{\text{BT}}$
FM CTG 72.1 TO TG 72.1 INFO COMANTISUBLANT COMDESLANT XMT MASSEY DD 778 X
COMMENCE PHASE TWO (etc.) . . . $\overline{\text{BT}}$ $\overline{\text{AR}}$

The only information an enemy might recover from this encrypted message is that (1) it has been sent from one U.S. Navy ship to another; (2) is of PRIORITY precedence; and (3) was originated at 18Ø934Z. This is also the only information available to bona fide recipients, who must break the message to learn for whom it is intended. (*Massey* need break only far enough to find she is exempted.)

Notice that codress messages spell out addresses in the text instead of identifying them by call sign or address group.

CLASSES OF MESSAGES

Our subject now turns to CLASSES of messages, of which there are five: 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 traffic handled by the Navy is class A, consisting of official messages of the Navy, Army, and Air Force.

Class B includes official messages of the United States Government excluding those originated by the Department of Defense.

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

Class D's are private messages for which the Navy collects tolls. The group includes radiograms 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, will handle the message over part of its route. For example, suppose your ship is in the Atlantic and has a class E message addressed to a man at a naval air station in Cuba. Your ship transmits the message to Radio Washington, which relays it via San Juan, P.R., to a station at Guantanamo Bay, Cuba, that effects delivery to the naval air station. The message never leaves Navy channels and the originator pays nothing. But if the message were addressed to Louisville, 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 DNC for payment to Western Union in accordance with instructions found in the effective edition of DNC 26.

The class E message privilege is primarily for purposes of morale. It affords naval personnel at sea a means of communication regarding urgent personal matters without incurring prohibitive expense. It is not available 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 the 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.

Class D and E messages are not drafted in the class A form which you have learned in this chapter. If you are charged with accepting and abstracting this traffic your guide is the effective edition of DNC 26.

SPECIAL-PURPOSE MESSAGES

Contact and Amplifying Reports

A CONTACT REPORT is a message reporting the first sighting of an enemy force. Speed of handling such a message is of utmost importance. Contact reports take priority over every other type of traffic handled by naval communications

An AMPLIFYING REPORT follows up a contact report. It contains further information about the 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. It is often 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 both to command and to efficient administration to have an up-to-the-hour knowledge of the location of every vessel.

This large-scale change of address work is carried on by the movement report system. When a ship stands out to sea, a movement report message is sent stating the time of departure, destination, route, speed of advance, and any other information the ship may be directed to furnish.

For reporting purposes the world is divided into four zones, each controlled by a movement report center (MRC). Each zone is further subdivided into areas controlled by movement report offices (MRO's). Each MRC receives information on movements all over the world, but MRO's have information only on movements in their own areas of responsibility.

The originator of a movement report sends it to an MRO or MRC. From here information on the ship's movements is relayed to military and civilian activities with an official interest in the location of the vessel, such as supply centers, customs authorities, fleet post offices, and fleet broadcast stations.

Notices to Airmen

Notices to Airmen (NOTAM's) are originated by military activities and civil agencies concerned with the safety of aircraft. NOTAM's contain information relating to aerological facilities, services, and hazards.

Q Messages

Q messages, which are classified, contain information on changes in navigational warning systems of the allied nations. Do not confuse Q messages with Q signals.

All Ships Present Messages

All ships present messages are for all ships present within a certain harbor or anchorage. They are originated by the senior officer present afloat, and relate to such matters as storms, port security regulations, and local liberty policy.

Procedure Messages and Service Messages

Procedure messages are used to obtain and provide CORRECTIONS, VERIFICATIONS, and/or REPETITIONS. The text of a procedure message contains only prosigns, operating signals, address designations, identification of messages or parts of messages, and any necessary amplifying data. It may contain any of the components shown in the basic format, except that the long break is used only if the DTG is included. The DTG, in turn, is employed only when it is necessary to show time of origin, or when further references may be made to the message.

Service messages pertain to any phase of traffic handling, communication facilities, or circuit conditions. They are prepared and transmitted as regular messages, and may be encrypted. Most service messages concern traffic originated at, destined to, or refiled by a station (but remember they do not request or give corrections, verifications, or repetitions). A service message pertaining to another message usually carries an equal precedence. You can recognize a service message by one or more of the following:

1. Reference to another service message;
2. The abbreviation SVC in the prefix or as the first word of the text;
3. The fact that it is specifically addressed to a communication center.

QUIZ

1. Distinguish between action and information addressees.
2. Messages may be divided into types according to the way they are addressed. Name the types.
3. What is a geographic address group? It is always preceded by a __________.
4. What does the abbreviation AIG stand for?
5. Define: originator, drafter, releasing officer.
6. What KIND of time is generally used in naval communications?
7. What does precedence indicate to communication personnel? To addressees?
8. What prosign gives an operating signal a questioning or interrogatory meaning?
9. What is the difference between Q and Z signals?
10. What are the three major parts of a message?
11. Certain parts of a message cannot be changed by anyone except the originator. Name them.
12. What is a contact report? What precedence is it assigned?
13. What are Q messages?
14. How is a service message identified?
15. Name two types of messages that facilitate traffic handling.
16. Name three forms in which a military message may be drawn up.
17. Name the five classes of messages.

CHAPTER 7

RADIOTELEGRAPH, PART II

NETS

A net is an organization of two or more stations in direct communication on a common channel. One station in the net—the NET CONTROL STATION—is in charge. The station serving the senior commander is usually designated as net control, although it may be another station if another station is in better position to control the net. The duties of the net control station are to speed flow of traffic on the net, to limit transmissions to the essential minimum, to settle disputes incident to traffic handling, and to monitor the net so that corrective action can be taken against poor operating practices.

Directed and Free Nets

Large nets and nets handling many messages usually operate as in DIRECTED nets, which means that no station may transmit a message without calling and obtaining permission from net control. Nets which do not require strict control may operate as FREE nets; in this case the controlling station authorizes member stations to send their messages without obtaining prior permission.

Command, Common, and Functional Nets

Nets are classified into three types according to mission or purpose: (1) COMMAND, (2) COMMON, and (3) FUNCTIONAL.

A command net links a commander with his immediate subordinates in the chain of command, and with any other units that may be designated. For example, a task force command net is activated by the task force commander and guarded by the task group commanders.

A common net links all ships (and in amphibious operations, troop units) of the same task organization. For example, a task group common net is activated by the task group commander and is guarded by all ships and troop units in the task group.

A functional net is for direct communication between personnel in charge of the specific task for which the net is provided.

CIRCUIT DISCIPLINE

Every operator must govern himself by the following rules:

1. Obey promptly orders and instructions of the control station.
2. These practices are forbidden:
   a. Violation of radio silence;
   b. Incorrect and unauthorized procedure;
   c. Gossip between operators;
   d. Excessive tuning and testing;
   e. Misuse or confusion of call signs and address groups;
   f. Unauthorized plain language;
   g. Unnecessary procedure transmissions, particularly those dealing with readability and signal strength;
   h. Unnecessary breaking in;
   i. Transmission at speeds beyond the capability of the receiving operator;
   j. Tuning a transmitter with emission from the antenna.
3. A station given a message for relay is responsible for clearance of that message until either a receipt

has been obtained or instructions are received to take no further action.

4. Answer calls immediately (provided radio silence is not in effect).

CORRECTING AN ERROR

When an error is made in transmitting, the operator sends a series of eight or more E's. This is the error sign. It is sent immediately after the error. The operator goes back to the last correctly sent word, group, or prosign, repeats it, and continues with the correct version. EXAMPLE:

NTMU DE NUBP–P–241217Z GR27 $\overline{\text{BT}}$
RETURNING TO BASTEEEEEEEE TO BASE X
(Etc.)

This procedure applies regardless of where the error occurs—in the heading, text, or ending. When followed by the prosign $\overline{\text{AR}}$, the error sign means "This entire transmission is in error; disregard it." EXAMPLE:

NPG DE NTMU–R–241529Z EEEEEEEE $\overline{\text{AR}}$

COUNTING GROUPS

The group count of a message is the number of groups in the text, and is found in the message just before the first long break prosign ($\overline{\text{BT}}$). In a message, GR followed by numerals (s), means "This message contains the number of groups indicated." In a message containing a text of six words the group count is written GR6. If the message is encrypted, the group count indicates the number of code groups in the text. Rules to follow when counting groups:

1. Count groups between $\overline{\text{BT}}$ and $\overline{\text{BT}}$.
2. For military use, the letter X is frequently used to represent punctuation marks and is counted as a group.

3. Count every word and every group of letters, figures, and symbols as one group.
4. Hyphenated words and hyphenated names, when transmitted as one word, count as one group.

The LONG BREAK prosign $\overline{\text{BT}}$ is placed before and after the text of a message, but is not a part of the text. It is the prosign separating the heading from the text and the prosign separating the text from the ending. The text of a message is always between the two long break prosigns.

ACKNOWLEDGMENT

An acknowledgment is a communication announcing that the message to which it refers has been received and is understood. An acknowledgment must be sent by the addressee of the message. It goes back to the originator, and assures him not only that the addressee has received the message, but that he UNDERSTANDS it.

You will receipt for a message containing a request for an acknowledgment just as you would any other. The meaning of "received" contained in an acknowledgment is an additional receipt from your commanding officer.

Acknowledgments are usually obtained by means of a request within the text. The acknowledgment itself is made by the transmission YOUR (DTG) ACKNOWLEDGED.

An acknowledgment may be requested AFTER transmission of the message. Perhaps there was no need for an acknowledgment at the time the message was sent, but the need came up later. On the other hand, an acknowledgment may have been requested in the first message, but the addressee was slow in complying. After transmission of a message, an acknowledgment may be gained either by an operating signal or another message. In the next sample, D4B (assumed to be the call sign of a task group commander) requests NTMU to acknowledge a message which has been transmitted. Instructions to acknowledge were not included in the text.

NTMU DE D4B $\overline{\text{INT}}$ ZEV Ø51218Z K ("Request you acknowledge message with date-time group Ø51218Z")

After receipting for the above, NTMU acknowledges the message indicated:

D4B DE NTMU ZEV Ø51218Z K

If it is desired to hasten an acknowledgment previously requested, the same procedure as indicated in the example above, or the following message form may be used:

NTMU DE D4B–P–Ø51248Z GR3 $\overline{\text{BT}}$ MY Ø51218Z COMPLY $\overline{\text{BT}}$ K

After receipting for the above, NTMU originates the following acknowledgment:

D4B DE NTMU–P–Ø51255Z GR3 $\overline{\text{BT}}$ YOUR Ø51218Z ACKNOWLEDGED $\overline{\text{BT}}$ K

VERIFICATIONS AND REPETITIONS

There are occasions when messages or parts of messages must be verified, corrected, or repeated. To do this the prosigns AA (all after), AB (all before), WB (word before), and WA (word after) are used in procedure messages in conjunction with $\overline{\text{IMI}}$, C, J, and certain operating signals. $\overline{\text{IMI}}$ or J used alone means "Repeat" or "Verify and repeat" the entire transmission.

When a message must be verified, corrected, or repeated, it is necessary to identify the message in question. This may be done by using the date-time group and/or the station serial number. In either case, the message may be further identified by adding the call sign of the originating station, the group count, or both. If even more identification is needed, the complete preamble, or address, or the complete (or partial) next may be included.

When it is necessary to use a code group of an encrypted message as a reference point, reference is made to it by number—that is, according to the numerical order in which it appears in the text. Use of numbers as reference to encrypted groups will be illustrated in a moment.

For a plain language message the reference point is a plain language word. If a word or group used to identify a part of a message appears more than once in that message, the first occurrence of that word or group is meant. If otherwise intended, amplifying data such as adjacent words or groups must be included.

The following message is transmitted:

> NTMU DE NUBP–P–121Ø15Z–FM NUBP–TO NTMU–INFO NBHA GR5 $\overline{\mathrm{BT}}$ XRDT MNCR TYQO MNSA PWCT $\overline{\mathrm{BT}}$ B K

The prosign $\overline{\mathrm{BT}}$ is used in the message twice. Therefore a request using (1) AB $\overline{\mathrm{BT}}$ denotes all before the text (the first $\overline{\mathrm{BT}}$); (2) AA $\overline{\mathrm{BT}}$ denotes all after the heading (the first $\overline{\mathrm{BT}}$); (3) AA PWCT $\overline{\mathrm{BT}}$ denotes the message ending, where PWCT is the last group in the text (the second $\overline{\mathrm{BT}}$).

It is important that you learn the correct usage of these prosigns. Make sure you understand the rules and examples that follow. Here is the encrypted message that will be used throughout the examples:

> NTMU DE NUPB–P–271545Z–FM NUBP–TO NTMU–INFO NBHA GR11 $\overline{\mathrm{BT}}$ JAPY BOQU LAJY KUPY FOQO MUCU KAWC GUZO XAVA RATU SABO $\overline{\mathrm{BT}}$ K

Use of $\overline{\mathrm{IMI}}$

The prosign $\overline{\mathrm{IMI}}$ means REPEAT. It may be used by the receiving operator to mean "Repeat last transmission," or, with identifying data, to mean "Repeat portion indicated." It may be used by the sending operator to mean "I will repeat the difficult plain language word I just transmitted," or "I am going to repeat this message." $\overline{\mathrm{IMI}}$ is never used to request repetition of a message for which a receipt has been given.

NTMU desires the entire message (given above) to be repeated. He sends:

NUPB DE NTMU $\overline{\text{IMI}}$ K

NUPB replies with the message, just as he sent it the first time.

NTMU desires a repetition of the heading.

REQUEST: NUBP DE NTMU $\overline{\text{IMI}}$ AB $\overline{\text{BT}}$ K

REPLY: NTMU DE NUBP AB $\overline{\text{BT}}$–NTMU DE NUPB–P–271545Z–FM NUBP–TO NTMU–INFO NBHA GR11 K

NTMU desires all after the eighth group repeated.

REQUEST: DE NTMU $\overline{\text{IMI}}$ AA 8 K

REPLY: DE NUPB AA 8–XAVA RATU SABO $\overline{\text{BT}}$ K

NTMU asks for the ninth group to be repeated.

REQUEST: DE NTMU $\overline{\text{IMI}}$ 9 K

REPLY: DE NUBP 9–XAVA K

NTMU wants portion of message from third to eighth group repeated.

REQUEST: DE NTMU $\overline{\text{IMI}}$ 3 TO 8 K

REPLY: DE NUBP 3 TO 8–LAJY KUPY FOQO MUCU KAWC GUXO K

Use of J

J means VERIFY AND REPEAT. It is used when an addressee does not understand all or a portion of a message which he has received. It is important to understand that the operator does not originate the request. It must be released just as any other message. It is not an exchange of information between operators; it goes back to the originator of the message.

When used with AA, AB, WB, and WA, J means "Verify and repeat message or portions indicated." An operating signal is used when the encipherment alone needs checking.

NTMU wants the message verified by the originator and repeated.

Request:

NUBP DE NTMU J 271545Z K (date-time group is used as reference).

Reply: (NUBP finds message correct):

NTMU DE NUBP C 271545Z–P–271545Z–FM NUBP–TO NTMU–INFO NBHA GR11 $\overline{\text{BT}}$

JAPY BOQU LAJY KUPY FOQO MUCU KAWC GUXO XAVA RATU SABO $\overline{\text{BT}}$ K

NTMU desires the text of the message verified by the originator and repeated.

Request:

NUBP DE NTMU J 271545Z AA $\overline{\text{BT}}$ K

Reply (originator finds text correct):

NTMU DE NUBP C 271545Z AA $\overline{\text{BT}}$–JAPY BOQU LAJY KUPY FOQO MUCU KAWC GUXO XAVA RATU SABO $\overline{\text{BT}}$ K

NTMU wants the heading of the message verified by the originator and repeated.

Request:

NUBP DE NTMU J 271545Z AB $\overline{\text{BT}}$ K

Reply (heading found to be correct):

NTMU DE NUBP C 271545Z AB $\overline{\text{BT}}$–271545Z–FM NUBP–TO NTMU–INFO NBHA GR11 K

NTMU desires that the third group and groups six to eight of the message be verified by the originator.

Request:

NUBP DE NTMU J 271545Z 3–6 TO 8 K

Reply (groups found by originator to be correct):

NTMU DE NUBP C 271545Z 3–LAJY–6 TO 8–MUCU KAWC GUXO K

Should the portion be found INCORRECT by the originator, the same procedure is used, the originator sending back the corrected version.

In plain language messages, portions of the text are identified as words rather than as group numbers.

REQUEST:

NUBP DE NTMU $\overline{\text{IMI}}$ WA CARRY K

REPLY:

NTMU DE NUBP WA CARRY–OUT K

REQUEST:

NUBP DE NTMU $\overline{\text{IMI}}$ CARRY TO SIXTEEN K

REPLY:

NTMU DE NUBP CARRY TO SIXTEEN–CARRY OUT PLAN SIXTEEN K

You have already learned that the prosign $\overline{\text{INT}}$ means "Interrogatory." It is used to question transmissions—messages or parts thereof. For instance, in a plain language message you believe the word after "carry" is "out," but you are not sure.

NUBP DE NTMU $\overline{\text{INT}}$ WA CARRY–OUT K
NTMU DE NUBP C K

or, if the word happens to be "off," NUBP would reply:

NTMU DE NUBP WA CARRY–OFF K

RELAY

When a message begins the journey from point of origin to destination, it may or may not need to be handled by other stations along the way. If a message is transmitted from one station to another WITHOUT the aid of a relaying station, the two stations are said to be in DIRECT communication. In this case, remember, the originator may use the call as the address, and the originator's sign FM is not necessary. However, in order to do this, the originator must be in direct communication with ALL addressees.

If a relay is required, it is known as INDIRECT communication. In such a case the complete address as well as appropriate transmission instructions must be included.

The SPECIFIC relay requires use of the prosign T. When a message is received with the prosign T alone, it means "Station called transmit this message to all addressees." Suppose NUBP sends a message to NTMU with instructions for NTMU to relay to all addressees—in this case, NHKE:

> NTMU DE NUBP–T–P–23141ØZ–FM NUBP–TO NHKE GR4 $\overline{\text{BT}}$
> GOLF WHISKEY FOXTROT TWELVE $\overline{\text{BT}}$ K

The prosign T followed by one or more address designations means "Station called transmit this message to addressee(s) whose address designation(s) follow." NUBP transmits a message to NTMU with instructions for NTMU to relay to one of the addressees—in this case, NBHA:

> NTMU DE NUPB–T–NBHA–P–23141ØZ–FM NUBP–TO NBHA NHKE GR4 $\overline{\text{BT}}$ (Etc.)

NUBP has made other arrangements to get the message to NHKE, so this station is not included in the relay.

T, preceded by a call sign, and followed by one or more address designations, means "Station whose call sign precedes T transmit this message to addressee(s) whose address designation(s) follow(s) T. NUBP sends a message to NBHA and NTMU. NUBP instructs NBHA to relay to NHKE:

> NBHA NTMU DE NUBP–NBHA–T–NHKE–P–23141ØZ–FM NUBP–TO NBHA NHKE NTMU GR4 $\overline{\text{BT}}$ (Etc.)

When this has been accomplished, all addressees will have received the message. NUBP is in direct communication with NBHA and NTMU; NBHA is in touch with NHKE.

The prosign XMT (exempt) is not used in conjunction with T. T instructions may be modified by use of the operating signal ZWL to denote that no forwarding action is required to addressee designation(s) immediately following ZWL.

The GENERAL relay requires an operating signal which means "Station(s) called relay this message to addressees for whom you are responsible." The guardship for a number of vessels may therefore be instructed to relay general messages to all such stations without the necessity of individual call signs. In the example below, the operating signal ZOC is assumed to mean "Station(s) called relay this message to addressees for whom you are responsible." NBA is responsible for ships and stations operating under the collective call sign SKID. Operating signals having no importance to the addressees, but necessary for operators, are placed in the calling procedure as shown. EXAMPLE:

NBA DE NPG NR16–ZOC–M–151435Z–FM LOTS HOSS–TO SKID GR25 $\overline{\text{BT}}$ TEXT $\overline{\text{BT}}$ K

EXECUTIVE METHOD

To speed tactical movements of ships and planes, the executive method is frequently used. It is sent when some action must be executed at a certain instant, especially when two or more ships must take action at the same time. While the executive message is usually associated with visual and radiotelephone messages, it may be used with radiotelegraph.

The procedure for executive method messages may seem complicated at first. Actually, the steps are simple, and a few drills will do much toward squaring you away on this method. You can start by getting in mind three rules for handling executive messages:

1. Only abbreviated PLAINDRESS messages may be sent by this method.
2. A message which requires a signal of execution carries $\overline{\text{IX}}$ immediately before the first $\overline{\text{BT}}$.

3. In executive method messages, a group count and date group are NEVER used. However, a time group may be used. Normally, if a time group is used it is placed either in the preamble or ending but not in both.

The signal of execution is known as the EXECUTIVE SIGNAL and consists of $\overline{\text{IX}}$ followed by a 5-second dash. When transmitted by radio, it is always preceded by a full call. The instant of execution is the termination of the 5-second dash. The executive signal ($\overline{\text{IX}}$ 5-second dash) alone after a call means "Execute all unexecuted messages which I have transmitted." $\overline{\text{IX}}$ may be repeated a few times while awaiting transmission of the 5-second dash.

Assume G7F is the call sign for task unit 74.1.3 and D4L is the call sign for commander task unit 74.1.3. EXAMPLE:

G7F DE D4L $\overline{\text{IX}}$ $\overline{\text{IX}}$ $\overline{\text{IX}}$ (5-second dash) $\overline{\text{AR}}$

An executive method message is identified if it is one of several outstanding unexecuted messages. It is also identified if a considerable length of time passes between transmission of the message and the time to execute it. Should there be any doubt about the correct reception of an executive method message, a repetition of the COMPLETE message must be obtained. In other words, the only transmission made for requesting repetitions of an $\overline{\text{IX}}$ $\overline{\text{BT}}$ message will be as follows:

DE NHKE $\overline{\text{IMI}}$ K

The signal of execution does not ordinarily require a receipt. However, when a receipt is requested, it is indicated by transmission of K after the 5-second dash, instead of $\overline{\text{AR}}$.

Once the executive signal has been given, it cannot be annulled. If the originator wishes to cancel all outstanding UNEXECUTED messages, he will transmit NEGAT. EXAMPLE:

G7F DE D4L $\overline{\text{IX}}$ $\overline{\text{BT}}$ FORM ONE EIGHT ZERO
$\overline{\text{BT}}$ K

Before executing the signal, D4L desires to annul it. He transmits:

G7F DE D4L $\overline{\text{BT}}$ NEGAT $\overline{\text{BT}}$ K

Each ship in the task unit then receipts for the annulment in alphabetical/numerical order.

To annul a particular signal or one of several outstanding unexecuted signals, NEGAT is transmitted, followed immediately by the signal which is to be annulled. Assume D4L sent the following message and had executed none:

G7F DE D4L $\overline{\text{IX}}$ $\overline{\text{BT}}$ PAPA OSCAR TACK DELTA
GOLF $\overline{\text{BT}}$ K

G7F DE D4L $\overline{\text{IX}}$ $\overline{\text{BT}}$ TURN SIX $\overline{\text{BT}}$ 1617Z K

G7F DE D4L $\overline{\text{IX}}$ $\overline{\text{BT}}$ SPEED TWO SIX TACK
GOLF KILO $\overline{\text{BT}}$ K

D4L, desiring to annul TURN SIX sends:

G7F DE D4L $\overline{\text{BT}}$ NEGAT TURN SIX $\overline{\text{BT}}$ 1623Z K

To show verification of an executive method message by using the prosign J, let us assume D4B transmits a message with the time group 1616Z to NTMU and one other ship. All receipt, but later NTMU wants the message verified. The request is:

D4B DE NTMU J 1616Z K

The message as originally transmitted is found to be correct and NTMU is informed as follows:

NTMU DE D4B C 1616Z–NHKE NTMU $\overline{\text{IX}}$ $\overline{\text{BT}}$
FOXTROT CHARLIE UNIFORM $\overline{\text{BT}}$ 1616Z K

If the message had been found incorrect, it would have had to be annulled to all addressees and a new message transmitted.

BREAK IN

There are times when you will need to break in on someone's transmission. This is permissible if you observe break-in procedure.

When only two stations are concerned in a transmission, breaking in is permitted, IF NECESSARY. The station desiring to break in makes a series of dashes. When the transmitting operator hears these dashes between his transmitted characters, he stops—at least momentarily—to discover the reason for the break-in. This pause allows the station breaking to wait, arrange for a shift of frequency, request repeats, and so forth. When two stations are working directly on a circuit, the most frequent use of the break-in procedure is for on-the-spot "fills" or repeats of portions missed.

Any station on the circuit having a message of higher precedence than the one being handled has the privilege of breaking in and transmitting his message. Of course, discretion is to be used on these cases. If a low-precedence message lacks only a few groups of being completed, the station transmitting it should not be expected to give way for the higher-precedence message unless it is of an urgent nature. This would cause unnecessary loss of circuit time.

During poor reception a station may break in to request that the transmitting station send the standard test signal (a series of V's) in order that the receiver may be retuned for better reception.

MESSAGES IN STRINGS

When communication is good, it frequently speeds traffic handling for one station to send several messages to another without interruption. Normally five messages should comprise a string (or sequence). However, the receiving station may use an operating signal to indicate the number of messages to be sent in a given string. NTSY has ten messages for NUYO. NTSY transmits:

NUYO DE NTSY QTC1Ø K

NUYO replies:

NTSY DE NUYO QSG5 K

The prosign B is placed in the ending of each message sent as part of a string. This is followed by the precedence of the next message. When the last message of the sequence has been sent, a receipt is requested before the next string is begun. The last message of each sequence is ended, accordingly, with the prosigns B and K, meaning, "There is more to follow; receipt for what I have sent." EXAMPLE: NTSY sends the first of a string of five messages.

NUYO DE NTSY–P–112214Z–FM YOBV–TO NUYO GR15 $\overline{\text{BT}}$ (Text) $\overline{\text{BT}}$ B P

NTSY pauses briefly to allow any station to break in to transmit traffic of higher precedence. If no station interrupts, NTSY proceeds. He may make a full call, as before, or simply make a separative sign and begin with the precedence of the next message:

–P–112216Z–FM YOBV–(Etc.)

On reaching the ending of the first string, NTSY sends $\overline{\text{BT}}$ B M K.

NUYO requests any needed repetitions if break-in procedure has not been employed. Otherwise, NUYO receipts for the sequence:

NTSY DE NUYO R K

SERVICING THE MESSAGE

There are certain minor jobs in connection with transmission and reception of messages that are important and necessary. For instance, it's impossible for you to remember the exact time of reception of each message that passes through your hands. A written record must be kept of all messages so that they will be readily available at all times. SERVICING THE MESSAGE is the term, and it means putting down certain data on the original message as is necessary to indicate how the operator handled it.

Some of the terms you should know are:

1. TOD. The TIME OF DELIVERY is the time the transmitting station completes delivery of the message.
2. TOR. The TIME OF RECEIPT is the time the receiving station completes reception of the message.

When an operator services a sent message, he enters the following data:

1. TOD—Greenwich mean time.
2. Initials, or identifying sign of operator.
3. Radio frequency used for transmission.
4. The station to which message was sent. (See fig. 7-1.)

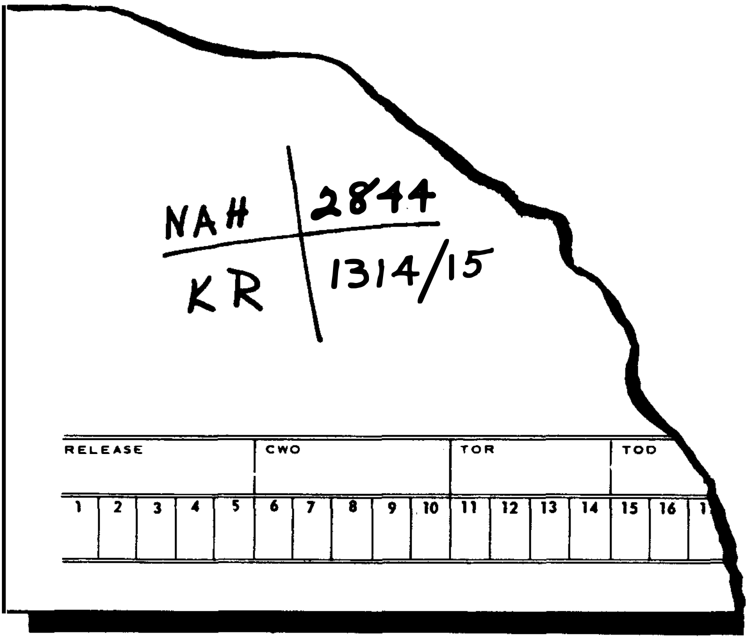


Figure 7-1.—Servicing the message.

When a message is RECEIVED, the following data **are** entered on the message form:

1. TOR—Greenwich mean time.
2. Initials or identifying sign of operator.
3. The radio frequency on which the message was received.

COMMERCIAL FORM

As a Navy communicator you will find frequently that traffic from commercial radio circuits will be channeled over Navy systems, and Navy traffic, in turn, must make use of commercial facilities. The procedure and message forms used by the Navy and by commercial activities are not the same. To handle such traffic efficiently you need an understanding of commercial practices.

The subject in itself is a big one. The next few pages will give you an introduction to the commercial form message. Your best source of information on commercial traffic is *Commercial Traffic Regulations* (effective edition of DNC 26), which explains traffic involving tolls.

There are only two types of commercial form messages: INTERNATIONAL and DOMESTIC. They both have four parts: Preamble, address, text, and signature. The difference in these two forms is in the makeup of the preamble and the method of counting words. Following is an example of a preamble from an international commercial form message:

NPG DE NCBL NR26 USS MISSOURI CK 2∅ NL GOVT 15 14∅∅

After the call, the preamble breaks down as follows:

Preamble	*Meaning*
NR26	Station serial number.
USS MISSOURI	Office of origin.
CK 2∅	Check, or word count; the number of groups in the address, text, and signature.
NL	Service indicator (night letter). Roughly, this corresponds to military precedence prosigns.

GOVT --------------Special indicator showing content of message concerns official Government business.

15 14ØØ -------------Date and hour of filing. Corresponds to Navy date-time group. (Note separation of date from time group.)

When this same preamble is converted to domestic form, the first thing you'll notice is that the order of the parts has changed. Instead of the office of origin following the transmission identification number, the check and service indicators come first. The next item is the time of filing, but instead of using GMT (as in international form), local civil time is used. The name of the month is also included.

The same preamble, when placed in domestic form, reads:

NR157 CK 8 NL GOVT SAN FRANCISCO CALIF 73Ø P MARCH 16 1956

At first glance this doesn't seem to be the same preamble. Actually, it is. The order of each part has changed, and some of the parts have been altered. Before explaining HOW these changes are made, let's see WHY they were made. This message is addressed to:

JAMES JOHNSON 1227 EAST TENTH STREET EUREKA CALIF

The text reads:

YOUR LEAVE EXPIRES ON BOARD Ø8ØØ 20 MARCH

The signature is USS MISSOURI.

This message was sent by radio—in INTERNATIONAL form—to RDO San Francisco. To get it to James Johnson it had to be forwarded via Western Union to Eureka. The message is handled by Western Union in domestic form. Western Union assigns a new station serial number: NR157. Western Union does not charge for the words in the address—only for those in the text. The new word count, then is: CK 8. The office of origin now becomes San Francisco—because that's where domestic charges begin (San Francisco to Eureka). Local civil time (LCT) is now used instead of GMT. The P stands for P.M., A is used in domestic form for A.M. As previously explained, the name of the month is also used.

Both messages are printed below for your comparison. Remember, the big difference in international and domestic forms is in the makeup of the preamble and the method of counting words. For the purpose of determining the word count, note that the international form messages has THREE $\overline{\text{BT}}$'s. The first $\overline{\text{BT}}$ is located between the preamble and the address, the second between the address and the text, and, finally, a third between the text and signature. The word count begins with the first $\overline{\text{BT}}$ and includes all of the address, text, and signature. In the domestic form the word count includes only the actual text of the message.

INTERNATIONAL FORM:

NPG DE NCBL NR26 USS MISSOURI CK 2Ø NL GOVT 15 14ØØ $\overline{\text{BT}}$

GOVT NAVY JAMES JOHNSON 1227 EAST TENTH ST EUREKA CALIF $\overline{\text{BT}}$

YOUR LEAVE EXPIRES ON BOARD Ø8ØØ 20 MARCH

$\overline{\text{BT}}$

USS MISSOURI K

DOMESTIC FORM:

NR157 CK 8 NL GOVT SAN FRANCISCO CALIF 93Ø P

MARCH 15 1956

JAMES JOHNSON 1227 EAST TENTH ST EUREKA CALIF

YOUR LEAVE EXPIRES ON BOARD Ø8ØØ 20 MARCH

USS MISSOURI K

INTERNATIONAL PROCEDURE

International procedure is used for communication between naval and commercial ships or stations. There are a few differences you should note.

A typical call might read KSE DE NUBP K. The prosign $\overline{\text{IMI}}$ is used instead of $\overline{\text{INT}}$ to ask a question in international procedure. In a long message—plain language, code, or cipher—the operator will stop at regular intervals (after each group of 50 plain language words, or 20 coded groups) to send $\overline{\text{IMI}}$, meaning "Have you received the radiotelegram correctly up to this point?"

A message is always ended in international procedure by transmitting $\overline{\text{AR}}$, FOLLOWED BY THE CALL SIGN OF THE TRANSMITTING STATION, and then K.

To acknowledge receipt of a radiotelegram the prosign R is used. For example, NUBP receipts for radiotelegram NR1 transmitted by KSE:

KSE DE NUBP R NR1 $\overline{\text{AR}}$.

DISTRESS COMMUNICATIONS

To increase safety at sea and in the air, methods of communication have been worked out for use in times of distress. The international (and primary) distress frequency is 500 KCS. However, the frequency has another use. In routine communications merchantmen contact each other over 500 KCS and then shift to a "working" frequency. To make sure that other use of the frequency will not interfere with distress traffic, two SILENT periods have been designated. These periods of 3 minutes each 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. Except for actual distress messages, all traffic ceases at this time on frequencies between 480 and 520 KCS.

Guarding the distress frequency is an important function of Coast Guard shore radio stations. Some naval shore radio stations stand continuous distress watches. Others maintain only a "speaker" watch.

When a Navy ship is operating singly at sea, a continuous watch is stood if operators and equipment are available. In any case, a receiver watch is always stood during the silent periods. When ships are operating in a group, the officer in tactical command arranges for a distress guard. Usually, one ship will guard 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 radio station.

The answer to a distress message takes this international form: call sign of the distressed ship (three times), DE, the call sign of your own ship (three times), followed by RRR $\overline{\text{SOS}}$. Suppose, for instance, the SS *Blank,* call sign WUBN, is in distress. The call sign of your ship is NULT. Your answer to the distress message would be:

WUBN WUBN WUBN DE NULT NULT NULT RRR $\overline{\text{SOS}}$ $\overline{\text{AR}}$

The answer to a distress message will usually be followed by the name of your ship, position, and maximum speed at which you are proceeding toward the vessel in distress. This answer, of course, will be originated by your commanding officer.

If your ship is not in position to give assistance to the SS *Blank,* your 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 power on the transmitter. The authority to relay the message must come from your commanding officer.

To handle rescue operations successfully, distress traffic must be controlled. The vessel making the distress call is the control station for distress traffic. However, control may be exercised by another ship at the scene. Any ship can impose silence on any radio stations in the zone, or on a particular station which happens to be interfering with the distress traffic. To impose silence, the signal QRT is used, followed by the word DISTRESS. This may be addressed TO ALL (CQ) or to a particular station.

When distress traffic is ended (or radio silence is no longer necessary) a message is sent to inform all ships. This message is originated by the control vessel. Assume your ship (NULT) was control vessel for WUBN. At the end of distress traffic, your commanding officer would originate the following:

$\overline{\text{SOS}}$ CQ CQ CQ DE NULT SS BLANK WUBN QUM

Note that DE is followed by the call sign of the ship transmitting and this in turn is followed by the name and call of the ship that originated the distress call. QUM means "Distress traffic is ended."

A naval vessel in distress does not ordinarily use the international distress signal $\overline{\text{SOS}}$. Instead, Navy communication channels and cryptoaids are used.

While $\overline{\text{SOS}}$ is the international distress signal sent by radiotelegraph, in radiotelephone the signal is the spoken word MAYDAY. This is the same as the native pronunciation of the French word *m'aider* ("Help me"). MAYDAY is also used by aircraft in distress.

Class of distress	Distress signal	When used
Warship raider	RRRR	On sighting or when attacked by an enemy warship.
Armed merchant ship raids	QQQQ	On sighting or when attacked by an armed merchant ship raider.
Submarine	SSSS	On sighting or when attacked by a submarine.
Aircraft	AAAA	On sighting or when attacked by aircraft.

Further information concerning international regulations for distress, emergency, and safety traffic can be found in a Hydrographic Office publication, *Radio Navi-*

gational Aids—H. O. 205. In addition to the information contained in this publication, there are four signals used by merchant vessels in wartime to indicate distress due to enemy action.

FACSIMILE PROCEDURE

FAX Broadcasts

Let us now move on to a discussion of a relative newcomer to naval communications: FACSIMILE, or FAX. This is, as you learned in chapter 4, a system for sending pictorial matter by radio and landline.

There are FAX broadcasts just as there are radiotelegraph and RATT broadcasts. Primary FAX broadcasts are sent out by the following stations:

STATION OR FACILITY	CALL	BROADCAST DESIGNATOR
NAVCOMMSTA, Washington	NSS	WP
NAVCOMMSTA, Balboa	NBA	BP
NAVCOMMSTA, San Francisco	NPG	FP
NAVCOMMSTA, Pearl Harbor	NPM	HP
NAVCOMMSTA, Guam	NPN	GP
NAVCOMMFAC, Port Lyautey	NHY	KP
NAVCOMMFAC, Yokosuka	NDT	YP
NAVCOMMSTA, Kodiak	NHB	LP

The areas covered are the same as those covered by the primary RATT and CW broadcast schedules. Content of the broadcasts is almost exclusively weather charts and press. Schedules are not continuous, and transmission times vary among the stations. A station typically broadcasts for 8 or 9 hours of the 24. All stations transmit simultaneously on either three or four frequencies. At least one schedule is intercepted by one or more stations to satisfy requirements of local weather activities or for purposes of training personnel in the operation and maintenance of facsimile equipment.

Prior to commencing a schedule a station makes a 5-minute series of test calls consisting of V's followed by

DE and its call and the letter designator of the broadcast made three times. EXAMPLE:

VVV VVV VVV DE NSS NSS NSS WP WP WP

After the series of test calls has been transmitted, and at least 2 minutes before scheduled time, the synchronous signal is transmitted to permit receiving stations to synchronize their equipment with the transmitting station.

The last item of each day's transmissions is the station log of messages sent. The log shows the station serial numbers, a short description of the contents of each item of traffic, and the TOD. This permits receiving stations to request repetitions of messages missed which would still be of value to them. Much weather information is timely for only a few hours, and charts whose valid times have expired are not usually requested.

Requests for repetitions received by the transmitting station normally are answered on the first schedule following receipt of the request.

The foregoing communication stations and facilities will accept facsimile traffic from ships in their areas. There is also some FAX communication among ships. A vessel wishing to transmit to a shore station or to another ship makes prior arrangement, advising the accepting station of the time of intended transmission and the frequency to be used.

Preparation of FAX Copy

A character in facsimile copy, such as a number, letter, or geometrical shape, is a SYMBOL. Facsimile will transmit somewhat finer detail, but the minimum size of a symbol is preferably three-sixteenths inch, or about the size of the characters in the chapter heads of this text. Symbols must be carefully formed, particularly digits and letters. The space within loops of symbols should be at least three thirty-seconds inch.

A combination of symbols arranged to convey intelligence is a MODEL. Examples are the weather chart in figure 7–2, or a shipping control model showing status and location of shipping in a harbor.

Many models take the form of charts or overlays on charts. It is not desirable for grids of latitude and longitude to be continuous on the face of the copy. On a scale of 1:12,500,000, 10° squares are indicated by crosses made with lines a sixteenth inch wide and one-half inch long. For other chart scales, latitude-longitude intersections need not be closer than 3 inches apart. Intersections interfering with plotted information are blocked out.

It may be desirable under some circumstances to transmit a model on plain white paper. A 25 percent rag bond stock is best. Three reference points are sufficient to enable the recipient to place a transparent grid of latitude and longitude over the chart to orient the plot in space.

Present facsimile equipment will handle copy in dimensions up to 12″ x 18″. Larger copy can be photographically reduced, but not past the point where symbols are less than three-sixteenths inch. If the copy cannot be reduced sufficiently because of this limitation, it is cut and

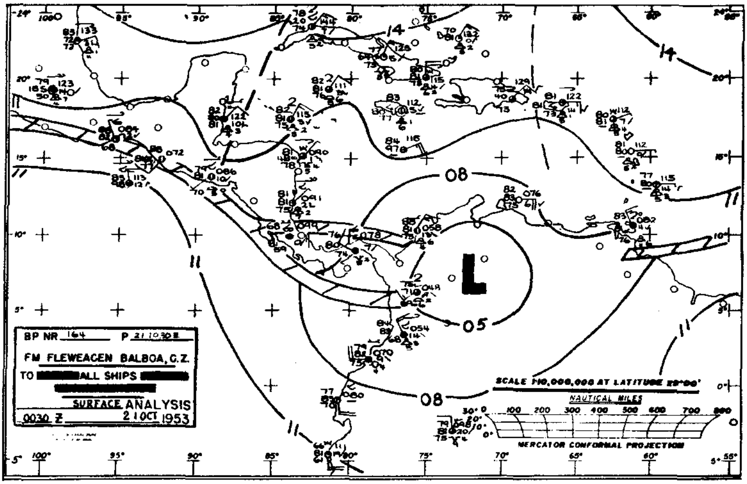


Figure 7–2.—Weather chart transmitted on NBA primary FAX broadcast.

sent in sections. A 12″ x 18″ model takes about 20 minutes to transmit.

Color copy is acceptable for facsimile transmission, but colors are received as shades of gray. It is not possible to interpret the color sent from the shade of gray received, for shades for given colors vary widely owing to such factors as atmospheric conditions and opacity of inks. Dark colors, in general, transmit practically like black. Green transmits as light gray. Yellow transmits poorly, but if some black is admixed, the result is a desirable grayish-black suitable as a background for plotted material. Graphite pencil marks do not transmit well; the lines have poor definition, and thicken as the user wears down the point. There is little difference in definition between transmissions of black data on a white background and white data on a black background.

Each item of traffic carries an identification block in the lower left corner. (Refer again to fig. 7–2.) The block carries the standard message heading format, and other lines as may be necessary.

The standard message format for facsimile is not used when the transmission is material which is introduced into the Naval Communication System but which is not processed by a naval communication center—for example, the direct retransmission of material from the National Facsimile Network. Weather centrals add the headings for weather charts which they originate. Headings for other messages are put on by the station.

QUIZ

1. What are the duties of a net control station?
2. What is a directed net? A free net?
3. Nets are classified into three types according to mission or purpose. Name the types.
4. What is the radiotelegraph error sign?
5. Who originates a message acknowledgment?
6. What prosign means "Repeat?" What prosign means "Verify and repeat?"
7. The specific relay requires use of what prosign?
8. What is the instant of execution of an executive message?
9. A station desiring to break in makes what transmission?
10. How many messages normally comprise a string or sequence?
11. What is the international radiotelegraph distress signal? The international radiotelephone distress signal?
12. What is a facsimile symbol? A model?

CHAPTER 8

ADMINISTRATION

Good records and good message-handling practices make a good communication organization. In this chapter you will learn what some of these records are and how they are used. You must bear in mind, however, that different stations do things in different ways. There is no "one" way to log a message; there is no "one" message blank or net log form. Here we discuss mostly those practices and procedures that have become, through regulation and custom, fairly well standardized. If there is more than one way to do a thing, we show you a good way.

MESSAGE FILES

Every message handled by the ship or station is placed in one or more files. There are several individual files, but they can be divided into MANDATORY files, which must be kept, and OPTIONAL files, which are kept as necessary to meet the needs of individual communication organizations. Files are summarized in the tables on page 185, but some will require further explanation.

Communication Center and Cryptocenter Files

The communication center file contains a copy of every message addressed to or originated by the command or by activities served by the station. It does not matter whether the messages were sent plain or encrypted, by radio, by visual, mail, or any other means. All are filed

File	Contents	Destruction authorized when—
Communication center file	A copy of every message addressed to or originated by the command, or by activities served by the station; filed chronologically by DTG. Classified messages are filed by filler, dummy, or by encrypted version.	1 year old.
Cryptocenter file	The plain language edited version of each classified message addressed to or originated by the command; filed by DTG. This file may be physically subdivided as necessary, in order to comply with stowage requirements of the *U.S. Navy Security Manual for Classified Matter*. In effect the cryptocenter file is the classified version of the communication center file.	1 year old.
Radio station file	Radio circuit copy of each message received, transmitted, or relayed by the station.	6 months old.
General message file	A copy of each general message appropriate to the command, segregated by types (ALNAV's, ALCOM's, NAVOP's, etc.).	Canceled or superseded.
Visual station file	The visual copy of each message received, transmitted, or relayed by the station.	6 months old.

together in order of DTG, and for this reason the file is sometimes called the date-time group file. Classified messages are filed here in either of two ways: in encrypted form, or by dummy or filler. A dummy or filler copy is a form showing only the heading of the message.

Plain language translations of classified messages are stowed in the cryptocenter file. Top Secret messages are stowed here separately; messages of other classifications are usually filed together.

If you do not know the file location of some message need, check first the communication center file. If the message is unclassified, you will find it here; if classified, there will be an encrypted or dummy version. You know from that to look for the message in the cryptocenter file.

Station Files

Messages in the communication center and cryptocenter files are duplicate copies of actual messages sent and received by operators. The originals, or circuit copies, go in the radio station or visual station files. Circuit copies are working copies. They bear the heading put on by the CWO (on the outgoing messages), and the operator's servicing—time the message was sent or received, frequency, and the operator's initials. If you were looking for a message to learn what it SAID, you would look in the communication center or cryptocenter file; if a question arose about its HANDLING, you would consult the copy in the radio station or visual station file.

Disposal of Mandatory Files

Stowage space is often scarce about a communication office, and particularly so aboard ship. Since there is rarely occasion to refer to a message more than a few weeks old, CNO authorizes destruction of sections of the files after a certain period has elapsed. About the first of July, for example, the communication center and cryptocenter files for June of the previous year would be destroyed, along with the radio and visual station files for the previous December. Messages pertaining to distress and any messages of legal or historical interest should be preserved.

OPTIONAL FILES

File	Contents	Retained in file until—
Tickler file	Messages awaiting reply or acknowledgment.	Reply or acknowledgment is sent or received.
"Proof" file	Originator's rough drafts	Destroyed with regular file copy.
Relay file	Messages awaiting relay	Relayed.
Broadcast file	Messages received by broadcast method.	Placed in regular files at close of each month.
Press file	Copy of daily press, as distributed.	No longer of interest.
Intercept file	Messages not addressed to, but of interest to the command.	Do.
Awaiting information officer's signature file.	Messages awaiting signature by one or more information officers.	Signed for.
Box file	Messages received since previous midnight.	Placed in regular files.

Tickler File

The tickler is a temporary file holding copies of messages requiring a reply. It is usually kept on a clipboard near the CWO's desk.

Assume the ship has just received a BUMED message bearing DTG 081704Z. It reads: REPT QUANTITY

PLASMA ABOARD IN EXCESS NORMAL REQUIREMENTS NEXT THREE MONTHS.

This message is routed to the medical officer for action, and a flimsy goes into the incoming section of the tickler file. As soon as the medical officer prepares a reply, the tickler copy is removed and placed in a permanent file.

If our own ship has sent a message requiring a reply from another command, a copy goes into the outgoing section of the tickler, to be removed when the reply is received. If the message requires replies from several addressees, the outgoing section of the tickler will tell you who has or has not answered.

"Proof" File

Every now and then the drafter of a message says something different from what he meant to say, or leaves out something he thought he put in. The "proof" file sometimes called the "alibi" or "evidence" file, consists of originators' rough drafts, and is just what its name suggests: the communicator's proof in case an originator thinks his message did not go out as he wrote it.

Some ships file these copies separately; others staple them to smooth copies in one of the permanent files.

Intercept File

A considerable amount of information of value to the flag, if aboard, can be gained from intercepted messages to and from ships in company. The commanding officer and flag officer will leave instructions as to which types of messages are to be copied and placed in the file.

Press File

The only source of news aboard comes from press broadcasts. Press material is copied by CW or by RATT, then duplicated and distributed throughout the ship. One copy of the press is placed in the press file, to be retained until no longer timely. One of the commanding officer's responsibilities is to keep himself informed of current events, with particular emphasis on the international situation and on what may be happening in countries the ship is scheduled to visit. For this reason a duplicate press file is sometimes kept for the captain's special use. Press material is the property of commercial companies who extend to the U.S. Navy the privilege of copying. For this reason it must not be permitted to fall into the hands of unauthorized persons. All copies of press copied by shore stations should be marked: FOR OFFICIAL USE ONLY. DESTROY AFTER LAST MAN READS.

Awaiting Information Officer's Signature File

Information officers usually do not need to see a message as promptly as the action officer. If an information officer is asleep or ashore, his copy is placed in the awaiting information officer's signature file, to be signed for when he awakens or returns. The file is kept near the CWO's desk, or on the messenger's clipboard. There is no awaiting action officer's signature file; if the action officer cannot be reached, action will be taken by the OOD or by an assistant department head.

Box File

For convenience in locating current traffic, many message centers keep a box file for temporary stowage of messages (fig. 8–1). The box contains 24 pigeonholes numbered by the hour. Copies of all messages received are temporarily stowed in the appropriate pigeonhole by

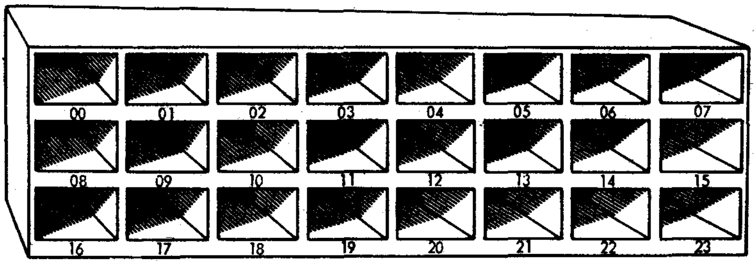


Figure 8–1.—Box file.

DTG. A message with DTG 132146Z, for instance, goes in the 21 slot. Each day the messages are cleared from the box file and filed permanently.

If the amount of traffic justifies it, separate boxes may be maintained for incoming and outgoing messages.

Keep the Files Straight

It is hard to overstate the importance of well-kept files, and of cooperation by the various watch sections to keep them that way. You should be able to locate any message in a minute or two. Aboard ship sloppy files mean delays in processing traffic, some of which may be operational in nature and of high precedence. A large shore station may file messages at the rate of 50,000 a month. Here a misfiled message too often means a lost message.

NET LOGS

A net log is a continuous record of everything that happens on the radiotelegraph or radiotelephone net. A log should show the following information:

1. All transmissions heard, regardless of origin or completeness.
2. Times of opening and closing of stations.
3. Cause of any delay on the net.
4. Adjustments and changes of frequency.
5. Any unusual happenings, such as procedure and security violations, enemy interference, etc.

When opening a net, or when starting a new day's log, the operator writes his name in full in the log. He signs the log when relieved or on securing the net. This procedure is repeated at every change of the watch.

A message that is addressed to, or must be relayed by, the station copying is recorded on a message blank. Only the heading is entered in the log. The same applies to messages transmitted. All other messages are logged in full. An entry must be made at least every 5 minutes; if the net is quiet the operator logs "No signals." Figure 8–2 shows how a well-kept radiotelegraph log should appear.

Radiotelephone messages sometimes are dictated at a fairly lively writing pace, often much too fast to be logged in longhand. If at all possible a net should be logged on a typewriter. A regular telegraph mill (which prints caps only) is best. You can save time by logging equivalent prosigns in place of the prowords you hear. Thus EXECUTE TO FOLLOW can be copied as IX, BREAK as BT, and so on. Don't spell out numbers;

RADIO LOG

USS ROCHESTER (CA 124)

POSITION #5 RDO CENTRAL — DATE 15 JUN 56

OPERATOR R. BICKERT RM2 — SHEET 1

SIGN RB — FREQ. 847Ø KCS

TIME (GMT)	TRANSMISSIONS AND REMARKS
1245	NO SIGNALS
5Ø	R. BICKERT RM2 OFF TO R. HOWE RM3. RCVR CHECKED WITH FREQ METER.
	NO TRAFFIC ON HAND.
	R. Bickert RM2
54	NAAT NPCM NUBK DE NAH K
	NAH DE NAAT K
	NAH DE NPCM K
55	NAH DE NUBK K
	NAAT NPCM NUBK DE NAH NR1Ø NR8 NR9-M-131229Z-FM LOOM-TO NAAT NUBK-
13ØØ	INFO NPCM GR18 BT (SEE FILES)
	NAH DE NAAT R NR1Ø AR
	NAH DE NPCM R NR8 AR
	NUBK DE NAH INT R NR9 K
	DE NUBK AS
	DE NUBK IMI WA SUBMIT K
Ø3	NUBK DE NAH WA SUBMIT-EARLPRADATE K
	NAH DE NUBK R NR9 AR
Ø8	NO SIGNALS
13	NO SIGNALS
14	NAH DE NPCM K
	NPCM DE NAH K
	NAH DE NPCM NR3-T-NSS-P-1513Ø3Z-FM NPCM-TO DERM-INFO STAR GR44 BT
	DORAB BRAVO SIERRA MIKE LIMA GOLF SNOLT MOXWN EOASU REZTB
	PJBVT QZWXE CRVTB YNUMI POLJG DASFH KOMUB TVCTX QETUO PWIRY
	ZCBML JUBSE OMNYE QPOMN TYVCE KJBHY OIMVE UBVDS UPPMZ ETOWN
	TNEMP IUEEP SWOLI CJCIH YLAIR SKOOB GWOMA MMYEB WAUBS SHDUL
19	UFCXU INBYR INJVD DORAB BT K
	NPCM DE NAH INT 22-JUBSE K
	NAH DE NPCM C K
2Ø	NPCM DE NAH R NR3 AR
25	NO SIGNALS
3Ø	NO SIGNALS
34	T T T T T T T T T T T (AA TUNING XMTR)
39	NO SIGNALS
44	NO SIGNALS

Figure 8–2.—Radiotelegraph log.

record them as figures. Use commonly understood abbreviations. Such shortcuts are perfectly all right as long as your log meets one simple test: There must be no doubt of what was transmitted. Figure 8–3 shows you a radiotelephone log.

Why Keep a Good Log?

Communication logs offer the best means by which the Navy can study circuit and operator efficiency, atmospheric disturbances, and enemy efforts to obstruct our communications. They are also used to resolve questions of fact. In case of collision one of the earliest acts of the court of inquiry will be to call in communication logs.

RADIO LOG

USS ROCHESTER (CA 124)

POSITION	#2 FLAG PLOT	DATE	7 JUN 56
OPERATOR	H. NASH RM3	SHEET	1
SIGN	HN	FREQ.	253 MCS

TIME (GMT)	TRANSMISSIONS AND REMARKS	
15ØØZ	SET WATCH--ASSUMED NET CONTROL (OTC)	
	SHOEBLACK THIS IS GIRLCRAZY	THIS IS A DIRECTED NET OF WHAT PRECEDENCE AND FOR WHOM ARE YOUR MESSAGES OVER
	THIS IS HAYSTACK	NO TRAFFIC OVER
	THIS IS SNOWCAP	1 P FOR YOU OVER
	THIS IS WESTWIND	1 R FOR HAYSTACK OVER
Ø2	SUNSHINE SUNSHINE THIS IS GIRLCRAZY GIRLCRAZY OVER	
	THIS IS SUNSHINE	NO TRAFFIC OVER
	SHOEBLACK THIS IS GIRLCRAZY	ROGER SNOWCAP SEND YOUR MSG OVER
	GIRLCRAZY THIS IS SNOWCAP	MSG FOLLOWS P TIME Ø71455Z FM SNOWCAP TO GIRLCRAZY INFO BEECHNUT GROUPS 15 BT (SEE FILES)
Ø7	THIS IS GIRLCRAZY	ROGER OUT
	WESTWIND THIS IS GIRLCRAZY	SEND YOUR MESSAGE OUT
	HAYSTACK THIS IS WESTWIND	R TIME Ø71452Z GROUPS 5 BT REPORT SHACKLE IDPW RNZT UNSHACKLE BT OVER
Ø9	THIS IS HAYSTACK	ROGER OUT
1Ø	H. NASH OFF TO W.R. O'DELL--ONE ROUTINE ON HAND FOR SNOWCAP	
		H. Nash RM3
11	SNOWCAP THIS IS GIRLCRAZY	R TIME Ø715Ø1Z FM GIRLCRAZY TO SNOWCAP GROUPS 18 BT (SEE FILES)
	THIS IS SNOWCAP	SAY AGAIN WA AT OVER
	THIS IS GIRLCRAZY	I SAY AGAIN WA AT 183ØZ OVER
14	THIS IS SNOWCAP	ROGER OUT
19	NO SIGNALS	
24	NO SIGNALS	
29	NO SIGNALS	

Figure 8–3.—Radiotelephone log.

On occasion logs have been examined by congressional investigators and by historians.

Erasures are not permitted in logs, but recording errors sometimes make corrections necessary. Line out the incorrect portion but leave it readable. Enter the change above or next to it, together with your initials. It is desirable for a log to be as neat as possible. It is absolutely necessary that it be complete and accurate.

Signal Log

A log in which you have an indirect interest is the signal log, which is a record of all transmissions sent and received by flashing light, flaghoist, and semaphore. It is kept on the signal bridge, and maintained by signal personnel. Typical entries in the log include date and time of signal, time of execution, originator, addressees, means by which signal was sent, and the signal itself (see fig. 8–4). The MEANING of the signal is never recorded. A new page is used at the beginning of each day.

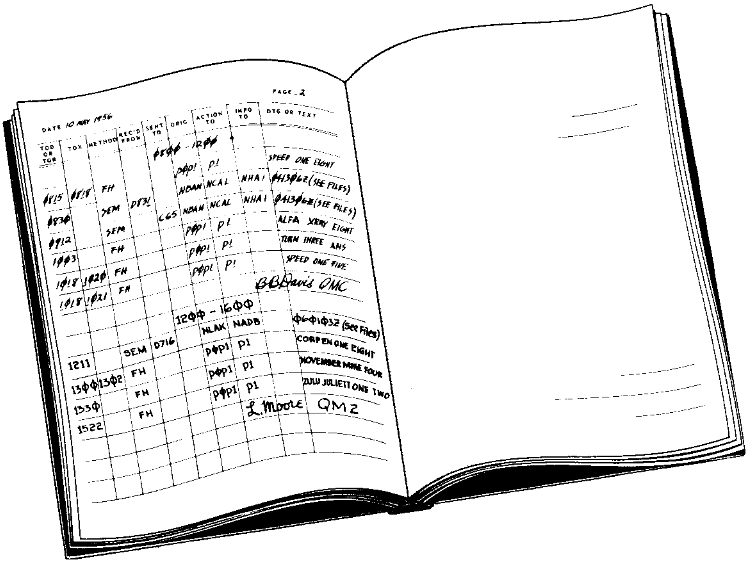


Figure 8–4.—Signal log.

MESSAGE BLANK

Commands vary widely in message-handling procedures and systems of internal routing. Each has individual requirements as to what should be shown on the message form. If the blanks which may be drawn from district publications and printing offices are not suitable, commands may design their own forms and have them reproduced.

Figure 8–5 shows you three typical forms. For illus-

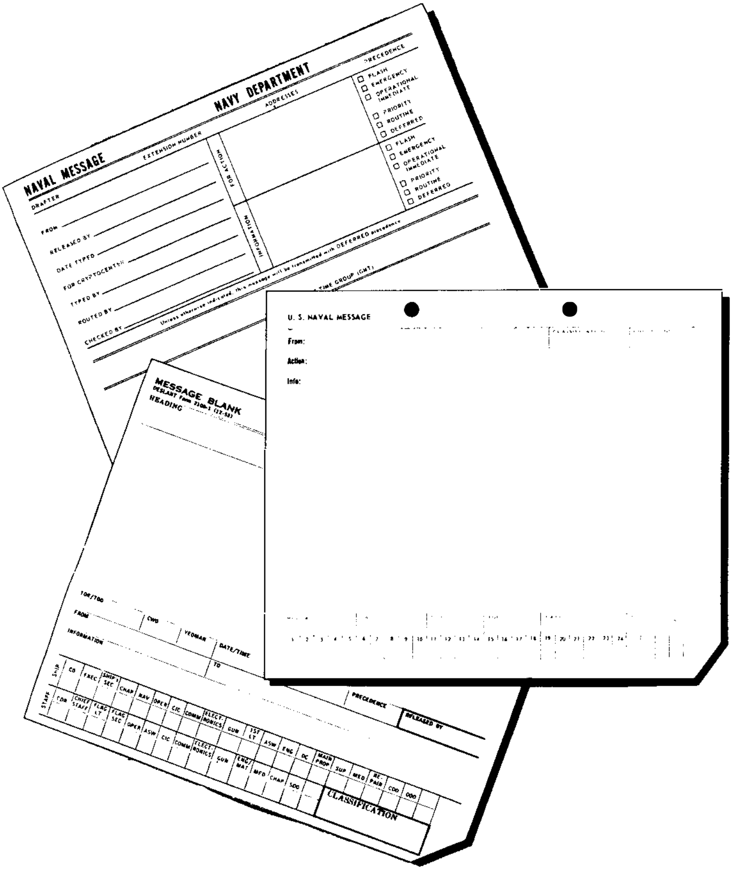


Figure 8–5.—Three typical message forms.

trative purposes we will use the one headed "U. S. Naval Message." The upper spaces of this form are for the originator, addressees, classification, and precedence. About three-quarters of the blank is left clear for the text. Across the bottom are spaces for initials of releasing officer and CWO, time of receipt if the message is incoming (or time of delivery if outgoing), and the date and DTG.

Immediately below is a row of boxes in which action and information officers are indicated. The commanding officer and executive officer always receive boxes 1 and 2; the rest are assigned according to the needs of the command. Following is a typical shipboard assignment of boxes. Notice that assignment is made by functional title rather than by name.

1. Commanding officer
2. Executive officer
3. Operations officer
4. OOD
5. Communication officer
6. Navigator
7. Gunnery officer
8. Engineer officer
9. Supply officer
10. Medical officer
11. CIC officer
12. Aerological officer
13. First lieutenant
14. Damage control assistant
15. Chaplain
16. Custodian
17. Disbursing officer
18. Electronics material officer
19. Main propulsion assistant
20. Postal officer
21. Air defense officer
22. Electrical officer

23. Fire control officer
24. Ship's secretary
25–29. Used as necessary routing to officers and men not indicated above.

Blanks are made up in advance into message "books," each book consisting of a cover and a standard number of flimsies, with sheets of carbon paper inserted. Flimsies are often colored as a help to the messenger making delivery. The action officer's copy, for example, may be red, the captain's copy yellow, the executive officer's copy blue, the communication officer's copy green, and information officers' copies white. Different ships use different color assignments.

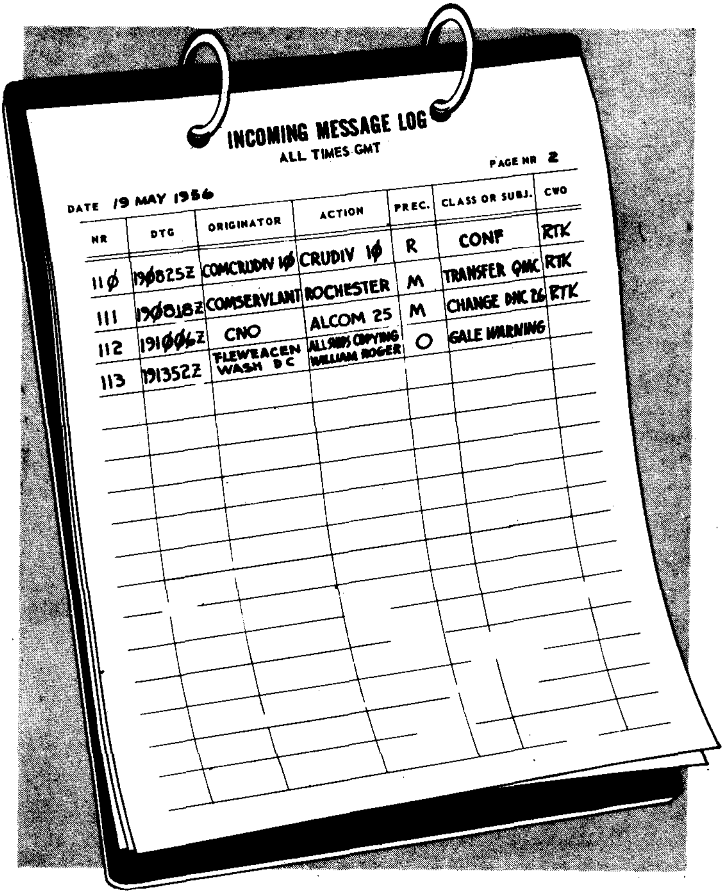
INCOMING MESSAGES

All CW, RATT, and FAX traffic addressed to the ship is processed through the message center. Except for tactical signals that must be executed within a few minutes, visual and radiotelephone messages are handled similarly. An incoming message is typically processed through these steps:

1. On arrival of the message in the message center, the CWO or one of his assistants translates the call signs and address groups in the heading. The CWO checks the message, logs it, and marks action and information officers. It is given to the communication clerk, who makes a smooth copy with as many carbons 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 of the copies typed by the communication clerk. 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. On large ships the orderlies of the captain and executive officer sign for the messages and make delivery themselves to these officers.

4. After distributing all copies and obtaining initials, the messenger returns the completely initialed original to the message center. There the CWO checks it for completeness of delivery. This master copy



INCOMING MESSAGE LOG
ALL TIMES GMT

PAGE NR 2

DATE 19 MAY 1956

NR	DTG	ORIGINATOR	ACTION	PREC.	CLASS OR SUBJ.	CWO
11Ø	19Ø825Z	COMCRUDIV 1Ø	CRUDIV 1Ø	R	CONF	RTK
111	19Ø018Z	COMSERVLANT	ROCHESTER	M	TRANSFER QMC	RTK
112	191ØØ6Z	CNO	ALCOM 25	M	CHANGE DNC 26	RTK
113	191352Z	FLEWEACEN WASH DC	ALL SHIPS COPYING WILLIAM ROGER	O	GALE WARNING	

Figure 8–6.—Incoming message log.

becomes a permanent part of the message center file, and the circuit copy is placed in the radio station file.

After checking over an incoming message, the CWO logs it as shown in figure 8–6. The first column of the log is for the local serial number, assigned by the CWO for purposes of reference and accounting. The numbers begin with 1 for the first message received after the midnight beginning a new month, and continuing in sequence to the midnight that closes the month. The second column is for the DTG; the third and fourth are for originator and action addressee(s). Column 5 is for the precedence. Column 6 is for the security classification of a classified message; or, if the message is unclassified, for a 3- or 4-word summary of the text. The last column, 7, is for the CWO's initials when the message has been completely routed and filed.

Information shown on the incoming message log is at the discretion of the communication officer, and will vary from ship to ship. Some vessels may omit some items shown in figure 8–6 and substitute others, such as these:

1. Time message was sent into and returned from cryptocenter (classified messages only).
2. Number of groups.
3. Location of message in files.
4. Time delivery was made to captain and/or action officer.
5. Broadcast number (for messages received by fleet broadcast method).

Internal Routing

It is customary to route a message for action to the department head having direct responsibility for the subject matter of the message, and for information to the captain, executive officer, communication officer, and to officers with an indirect interest in the message.

Call signs and address groups in the 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 text and decide who is primarily responsible and who is officially interested. Some incoming messages are borderline cases; that is, more than one department must take action of some kind. 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 right number of copies of a message be made. If a message is underrouted the result may be delay and the trouble of getting the message out of the files and making more 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.

U. S. NAVAL MESSAGE

From: FLEWEACEN WASHDC	CLASSIFICATION UNCLASSIFIED	PRECEDENCE OPER IMMED

Action: ALL SHIPS COPYING THIS BROADCAST

Info: COMEASTSEAFRON; FLEWEACENS NORVA, MIAMI, PORT LYAUTEY

191352Z

191400Z X WESTERN NORTH ATLANTIC WARNING X GALE FORTY NINE NORTH FORTY TWO WEST STATIONARY X WIND THIRTY FIVE TO FORTY FIVE KNOTS WITHIN FOUR HUNDRED MILES OF CENTER SOUTHWEST QUADRANT AND THREE HUNDRED MILES OTHER QUADRANTS

RELEASE	CWO	TOR	TOD	DATE	DTG
				19 JUN 56	191352Z

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
I	I	A	I	I	I	I	I	I			I			I									

Figure 8–7.—Incoming message.

An example of internal routing may be helpful. Refer to the incoming message log (fig. 8–6) and note that the last incoming message was NR 113 bearing DTG 191352Z. As written up, the message appears in figure 8–7. The routing, "A" for action "I" for information, is as follows:

Box			
1	Commanding officer	I	Receives all messages. Responsible for everything that goes on in his command and, therefore, necessarily informed of everything.
2	Executive officer	I	Receives all messages. In charge of administering the ship, and 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	OOD	I	Responsible for safety of the ship during period of his watch. (A message routed "OOD" will be be seen by all OOD's.)
5	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; will plot diversionary route, if necessary.
7	Gunnery officer	I	Must see that exposed ordnance equipment is properly covered, and that magazines are stowed and secured; that ground tackle is secured, if not required; that rafts, boats, and other gear on the weather decks are secure from damage.

Box			
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 engineroom power panels; must see that shaft alleys, workshops, and storerooms are ready for heavy weather.
9	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	Aerological officer	I	Receives all messages relating to weather. Must advise command in matters relating to his specialty: anticipated storm track, probable state of sea, etc.
15	Medical officer	I	Must see that bedridden patients are caused a minimum of discomfort by roll and pitch of the ship, and that the sick bay, medical storerooms, and other spaces are secure from heavy weather damage.

Final responsibility for routing rests with the CWO, even though an enlisted assistant is performing the work. Some CWO's do the routing themselves, using a Radioman primarily 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 Radioman First or Chief to act as CWO, and to assume responsibility not only for routing but also for supervision of the watch.

Shore Station Routing

The principles of internal routing are about the same everywhere, but routing at a shore station often presents difficulties because of traffic volume, and number and diversity of activities the station may serve. The station may not route at all for some activities, but only make delivery in accordance with address groups. In this case actual routing to action and information officers is a function of the addressee. For other activities the station will make internal routing, but the message may go for action and information, not to individuals, but to offices, divisions, or sections.

Many stations, especially the larger ones, maintain a routing file based on subject matter of messages. Each card shows the activities interested in that 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.

OUTGOING MESSAGES

Typically, an outgoing message is processed through these steps:

1. After determining that a message is necessary, the drafter prepares it, assigns appropriate classification and precedence, and sends it to the releasing officer.
2. The releasing officer checks the message for content, precedence, classification, brevity, and clarity, making any changes he sees fit. If he thinks the message unnecessary, or that it can go by slower means, he returns it to the drafter. If he approves the message, or approves it with changes, he sends it to the message center.

3. As soon as the message arrives, the CWO enters it in the outgoing log, which contains the same general type of information as the incoming message log.
4. If the message is classified, the CWO prepares it for encryption and sends it into the cryptocenter. The encrypted version is passed back out to the CWO, together with the originator's draft. The CWO drafts a heading, places it on the encrypted copy, and sends it to the watch supervisor in the radio room for transmission. If the message is unclassified it is not necessary, of course, to route it through the cryptocenter.
5. 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 this is a duty of the CWO, who routes an outgoing message just as he would an incoming.
6. In the radio room the message is placed on the air. The time of delivery, accepting station, frequency, and operator's sign are noted on the face of the form, and the message is returned temporarily to the message center for completion of the CWO's outgoing message log.
7. Copies bearing time of delivery are routed for information to interested officers aboard.
8. The originator's draft goes into the proof file; the original encrypted copy, if any, goes to the radio supervisor for the radio station file; a filler, dummy, or encrypted copy goes into the communication center file; and a plain language copy goes into the proper section of the cryptocenter file. If the message is plain language a copy goes into the radio station file, as before, and a copy goes into the communication center file.

Check for Release

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. Aboard ship the authority to release messages is vested in the commanding officer, but for sake of convenience the authority often is delegated. Following is a typical large ship releasing arrangement:

1. Captain and executive officer—may release any message.
2. Aerological officer—may release routine weather reports.
3. Navigator—may release routine position reports.
4. OOD—may release visual and radiotelephone messages concerning operations.
5. Communication officer—may release service and class E (personal) messages.

Shore stations maintain a signature file of releasing officers. This file is used in much the same way a bank uses its signature file of depositors. Each local command or activity served by the station submits a signature card for every officer authorized to release. Besides signatures, these cards also carry information regarding any limitations on the officer's releasing authority. 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.

REFERENCES

Many messages you may handle will refer directly to a previous incoming or outgoing message. It saves bother for everyone if half a dozen officers do not have 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, you will remove the referenced message from the files and show identifying extracts across the face of the routed copies. The same applies to outgoings. You do not have to copy the reference in its entirety, but quote the gist so that action and information officers will remember what is said.

There are two additional reasons why you must check references in outgoing messages. First, it assures accuracy. Second, it is a security measure; unclassified replies to certain types of classified messages are forbidden.

RUBBER STAMPS

A good collection of rubber stamps in the message center will speed traffic handling and go a long way toward eliminating mistakes. There is always a chance that someone will miss the word SECRET if it is typed on the face of a message; if it is stamped on in half-inch high letters, the reader cannot fail to know he is handling classified information.

Besides stamps bearing each classification, there should be others carrying each precedence—spelled out. The following will also be found useful:

1. INCOMING
2. OUTGOING
3. BY MAIL
4. BY VISUAL
5. TICKLER
6. COPY
7. CONFIRMATION COPY
8. WHEN NO LONGER REQUIRED RETURN TO MESSAGE CENTER
9. ANSWERED BY MSG---------(fill in DTG)
10. REF CHECKED BY--------(fill in sign)
11. PARAPHRASE--------REQUIRED; CONSULT CRYPTOCENTER BEFORE DECLASSIFYING (fill in "is" or "is not")

If you need certain stamps, consult your supervisor about requisitioning them.

TRAFFIC CHECKER

The traffic checker is his station's final safeguard against error. Every message handled by his station passes through his hands for a last thorough check before going into the files.

Shore stations often have from one to four men checking traffic full time. There is usually some specialization to meet local needs—one or two men, for instance, may check only encrypted traffic, while the others 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 message leaves the station, saving service messages and corrected copies.

A traffic checker must know his station's message-handling procedures inside and 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. He must stay abreast of all of these.

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 is generally 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 error 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 ad vised to destroy them.

A 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 continuity and legibility of station serial numbers; see that the number agrees with the number logged.
6. Compare originator's rough draft against hard copy or circuit copy.
7. Compare numbers in text to those in CFN line.
8. If the message contains a ZFF, see that it has been answered. (ZFF: an operating signal meaning, in effect, "When did addressee receive message?")
9. Check operator's sign and servicing.
10. Check internal routing for omissions.
11. In shore stations, watch for duplicate messages. If your station receives the same message twice, someone else may have a nondelivery.
12. Watch for excessive in-station delays; compare the time your station received or accepted the message against the time it was delivered or sent.
13. Always be alert for security violations.

DNC 5

The effective edition of DNC 5, *U.S. Naval Communication Instructions,* is one of the most important communication publications to the man at the operating level. This unclassified, nonregistered publication is originated by the Chief of Naval Operations (DNC) and contains several hundred pages of information, advice, and instructions on virtually every phase of naval communications. About half the total content of the publication deals with communication procedures.

You are required to have a knowledge of the content of this publication. This is not as imposing a requirement as it may seem, for some of the information contained in it is so basic that you will soon learn it by just being around a communication office. You will also refer to it frequently in the course of your work, and further your acquaintance with its contents in that manner.

DNC 5 is divided into six chapters and six annexes. These are—

Chapter 1	Command and Naval Communications
Chapter 2	Organization of Communications
Chapter 3	Duties of Communication Personnel
Chapter 4	Communication Security
Chapter 5	Means and Methods of Communication
Chapter 6	General Operating Instructions
Annex A	COMMUNICATION PROCEDURES (Appendix I-VII)
Annex B	MERCHANT SHIP PROCEDURES
Annex C	MAIL
Annex D	COMMERCIAL TRAFFIC REGULATIONS
Annex E	JOINT AND COMBINED COMMUNICATION POLICY
Annex F	MISCELLANEOUS

Each chapter is further subdivided into sections and numbered paragraphs. Paragraphs are sequentially numbered throughout the book as an aid to ready reference. Indexed items are referenced not in terms of pages, as is customary in nondoctrinal publications, but by paragraphs. If you were looking for information on radio logs you would find it indexed under "Logs, Radio." Then you would thumb to the paragraph indicated.

If you need a considerable amount of study in this publication to prepare yourself for the fleetwide competitive examination, you are advised to get an early start. Before you study or use it in your work make sure the latest changes and corrections have been entered.

As you advance in rating you are expected to assume more responsibility and to become more proficient in your field. As Radioman 2 you will be required to take charge of a watch, supervise traffic handling, and act as a minor engineer 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 have had an opportunity to serve on the watch before taking it over, you are probably 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 book and regulations of your duty station, and know the contents of departmental and division notices and directives.

Upon the supervisor of any watch falls the responsibility for keeping the 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 a manufacturer's instruction book 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 the information possible 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 have been relieved, and that your operators have 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. Watch traffic flow and don't let logjams develop. Do not allow letterwriting, nor the reading of books and magazines other than official publications. See that files are kept orderly and that out-of-date sections get burned on time.

When an outgoing message is given to you, look it over carefully before giving it to an operator for transmission; after the message has been 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 its close. Constant checking and rechecking are the best means of preventing mistakes that can embarrass not only you but the entire chain of command up to the captain.

Traffic is usually filed on the morning after the day handled. After the daily files are complete, a final check should be made for nondeliveries. If at any time a delayed delivery or nondelivery is discovered, that fact, with the attendant circumstances, should be reported at once to the CWO and the radio officer. Fear of the consequences of a mistake should not be a deterrent to such a report. If an honest mistake has been made, punishment is seldom 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 will recognize the fact that, although the error was avoidable, his supervisor is nevertheless 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.

Now let us pass on to a few special topics of interest to the supervisor.

OPLAN Communication Annex

An OPERATION PLAN (OPLAN) is a directive outlining procedures to be followed for some particular operation, such as an invasion, air strike, or convoy. That part of the OPLAN of interest to you is the communication annex, which is usually one of several annexes. The communication annex sets forth instructions that will govern radio and visual communications during the operation. It typically deals with such topics as—

1. Contact reports—to whom made, how authenticated and acknowledged, and whether to be sent plain or encrypted.
2. Recognition and identification, including IFF.
3. When radio silence will be observed.
4. Use of UHF.
5. Radio procedures and circuit discipline.
6. Use of command circuits.
7. Use of call signs and address groups.
8. Use of radiotelephone codes and ciphers.
9. Visual communications.
10. Frequency plans for surface ship nets, CIC communications, and for aircraft communications.
11. Movement reports.

Departures from, or modifications of, communication doctrine for a particular operation are carefully described in the annex. Departures from standard doctrine are not made except for good reason.

The information you are required to have from the annex will be furnished you through the chain of command. From the communication officer it passes through the signal and radio officers to the watch officers and the leading PO. The leading PO will disseminate the information to the watch sections.

WWV

You should be familiar with the services offered by the National Bureau of Standards through its radio station WWV at Beltsville, Md., near Washington. These include—

1. Standard radio frequencies. Eight frequencies are broadcast continuously, day and night—2.5, 5, 10, 15, 20, 25, 30, and 35 MCS.
2. Time announcements.
3. Standard time intervals.
4. Two standard audio frequencies, 440 and 600 cycles per second, alternated each 5 minutes.

5. Radio propagation disturbance warning notices for the North Atlantic area.

STANDARD RADIO FREQUENCIES. Any desired radio frequency may be measured accurately in terms of the standard frequencies, which are accurate to better than one part in 50,000,000. You will find this service of particular value in checking your frequency meters.

TIME ANNOUNCEMENTS AND STANDARD TIME INTERVALS. When you tune in WWV you will hear the audio frequency of 440 or 600 cycles as a steady tone. Superimposed on the tone is a series of clocklike ticks. You can determine time and intervals of time to the finest degree through (1) regular interruptions of the audio frequency, (2) regular interruptions of the ticking, and (3) Morse code and voice time announcements.

The audio frequency is interrupted at exactly 1 minute before the hour and resumed exactly on the hour. This is repeated at 5-minute intervals, so that the effect is 4 minutes of tone and 1 minute of no tone around the clock. You can see that by listening an operator is given exact time intervals of 1 minute, 4 minutes, and 5 minutes.

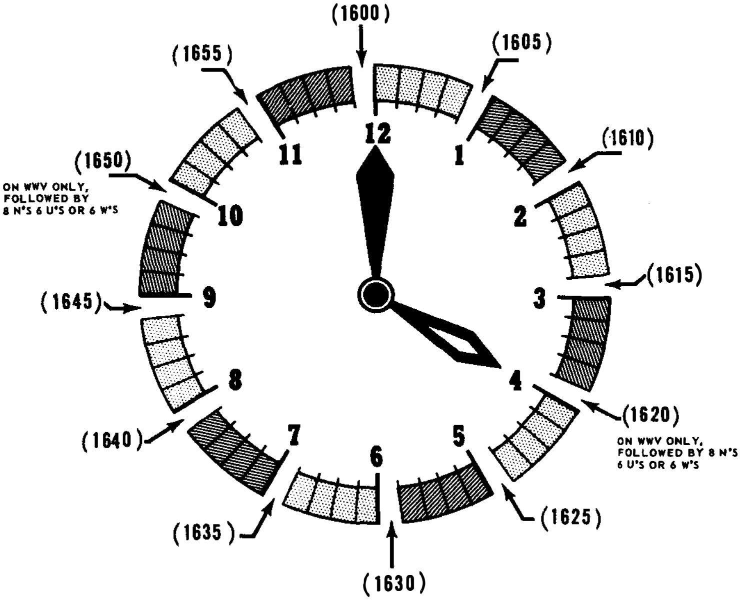
The time in GMT is broadcast in telegraphic code each 5 minutes, and is followed by a voice announcement of the eastern standard time. These transmissions are made in the silent period when the audio frequency is off, and refer to the time it WILL BE when the audio frequency, or tone, returns. For example, just before 1655Z you will hear 1655 in Morse code followed by a voice: "National Bureau of Standards WWV; when the tone returns it will be 8:55 PM eastern standard time; 8:55 PM." If you were correcting the message center clock you would preset hour and second hands to exactly 1655 while the announcements were going on; you would start the clock the instant the tone resumed.

The ticking is a pulse on the carrier frequency of 0.005-second duration, which occurs at intervals of precisely 1 second. Ticks may be used as a time signal for such exact work as determining the rate of gain (or loss) of the ship's chronometers. The pulse is omitted at the beginning of the last second of every minute. When the observer hears the ticking stop, he stands by; the ticking will resume 1 second later, and the second hand of a perfectly accurate chronometer will, at the instant of the first tick, be straight up and down. However, your chances of working with the ship's chronometers are small. Your duties in this regard will probably be limited to tuning a receiver and making the connections that will pipe the sound to earphones on the bridge.

RADIO PROPAGATION DISTURBANCE WARNING. These notices tell users of radio transmission paths over the North Atlantic the condition of the ionosphere at the time of the announcement, and also how good, or how bad, communication conditions are expected to be for the next 12 hours. They are prepared four times daily and are sent at 19.5 and 49.5 minutes past the hour. Report of current conditions is made by one of the letters N, U, and W, signifying normal, unsettled, or disturbed, respectively. A digit is the forecast of expected quality of transmitting conditions on a scale of 1 (impossible) to 9 (excellent), as in the table following.

Digit (forecast)	Propagation condition	Letter (current)
1	Impossible	W
2	Very poor	W
3	Poor	W
4	Fair to poor	W
5	Fair	U
6	Fair to good	N
7	Good	N
8	Very good	N
9	Excellent	N

If, for example, propagation conditions at time of forecast are "good," but are expected to be only "fair to poor" within the next 12 hours, the forecast statement would be broadcast at N4 in Morse code, sent five times: N4 N4 N4 N4 N4.



DURATION OF 600 CPS TONE

DURATION OF 440 CPS TONE

(1600) ETC. NUMBERS IN PARENTHESES INDICATE MORSE CODE TRANSMISSIONS (GMT)

Figure 8–8.—Structure of signals WWV and WWVH.

RADIO STATION WWVH. Station WWVH, on the island of Maui, Territory of Hawaii, is WWV's sister station serving the Pacific. Except for propagation warnings, services are the same as those offered by WWV, but schedules are somewhat different. Further information about both stations may be found in *Radio Navigational Aids,* H.O. 205.

Figure 8–8 shows the structure of WWV and WWVH signals.

Press

If the ship is in an area where it can be obtained, get press by RATT. Otherwise it must be copied by a CW operator.

You can't put a 20-WPM man on a press circuit. Press is sent faster by most stations, and it therefore takes a man with more experience to copy press.

Copying press is an excellent way to build operating speed. All operators who can hold the circuit down should be assigned to it in turn. Slower operators can serve as back-up men until their speeds increase.

Weather

The operations officer (or aerological officer, if there is one aboard) will arrange with the communication officer for certain weather schedules to be copied. Getting weather by CW is tricky. Transmissions may be in plain language, code groups, number groups, or combination letter-number groups. Get it by RATT or by FAX if you can.

Frequency Adherence

One of the supervisor's duties is to be sure that transmitters and receivers are exactly on frequency. Badly off-frequency operation may result in a ship's transmission not being heard at all. Less extreme cases are also dangerous because they lead to use of excessive power to blast through what the off-frequency station believes to be poor receiving conditions. Acceptable frequency tolerance for shipboard stations varies from 0.10 to 0.75 percent, depending on the band.

Ships are provided with a frequency-measuring instrument—the frequency meter, principally used to measure frequencies of transmitters and receivers. It is a calibrated device to which an oscillating circuit may be compared, either to determine its frequency, or to adjust it to a frequency desired. The frequency meter is not itself an ultimate standard of accuracy. It may become unreliable, and should be checked weekly against the standard radio frequency broadcasts of WWV. You can find more information about frequency meters in chapter 13 of *Basic Electronics,* NavPers 10087.

Transmitters, as a rule, have a wide coverage. Two thousand to 18,000 KCS is common. Each transmitter aboard should be calibrated every 10 KCS through its entire frequency range, and to commonly used frequencies. If possible, transmitters should be calibrated to frequencies mentioned in the current OPLAN before leaving port.

Crystal-controlled transmitters should be calibrated to all frequencies for which crystals are held. Calibration instructions for each type of transmitter are found in the instruction book furnished with the equipment.

USS SHILOH

PUBLICATION CUSTODY LOG FOR Radio Central
(Location)

Publications:

ACP 103	DNC 5 (2)
ACP 113	DNC 13
ACP 114	
ACP 121	JANAP 169
ACP 124	JANAP 195
ACP 125	Reg. No. A99950
ACP 126	
ACP 131 (3)	

The leading petty officer of each watch will acknowledge custody of the above publications by initialing this log at the beginning of his watch. Each publication must be sighted, and if registered, its register number checked.

April	00-04	04-08	08-12	12-16	16-18	18-20	20-00
1	DK	J.F.	NES	HS	DK	J.F.	NES
2	HS	DK	J.F.	NES	HS	DK	J.F.
3	NES	HS	DK	J.F.	NES	HS	DK
4	J.F.	NES	HS	DK	J.F.	NES	HS
5	DK	J.F.	NES	HS	DK	J.F.	NES
6							
7							
26							
27							
28							
29							
30							
31							

Figure 8-9.—Publication custody log

Publication Custody Log

The watch supervisor is personally accountable for official publications in use by his section. In order to provide a measure of effective control, many ships use publication custody logs (fig. 8–9). 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 initials the log—and by doing so 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 are going to make trouble for yourself.

Communication Watches

At sea and in port communications is a 24-hour job. Radio and visual watches must be maintained around the clock, and the message center and cryptocenter never cease doing business.

You won't find it spelled out in any official publication, but throughout the Navy communication personnel often do not stand the usual 4-on-8-off watches. This is especially true on large ships.

Starting with the new day, the first or midwatch will run from midnight to breakfast. The morning watch runs from breakfast to dinner, and the afternoon watch from dinner to supper. The first dogwatch runs from supper to 1800, or until movie call, and second dogwatch runs until 2000. The evening watch runs from 2000 until midnight.

A variation of this system is not to have any dogwatches, or perhaps just one. If there are no dogwatches, the evening watch may run from supper until midnight. If there is one dogwatch, it usually runs from supper to 2000 and is followed by the evening watch that runs to midnight.

It is convenient if the men coming off the long midwatch are permitted to sleep in a few hours, but many commanding officers will not be convinced that anyone rates being in his bunk after reveille. Even if the privilege is granted, late sleepers are never excused from participating in general drills, inspections, and other all-hands evolutions.

Some Questions for Supervisors

Following is a list of questions worth asking yourself every time you stand your watch.

1. Does handling of traffic meet Navy requirements for reliability, security, and speed?
2. Are regulations for handling and stowing classified matter observed in the spaces for which you are responsible?
3. Are all logs and files properly kept?
4. Does all wastepaper go into the burn bag?
5. Are unauthorized personnel kept out of the communication spaces?
6. Are encrypted call signs broken rapidly and accurately?
7. Do all operators in your watch section understand communication procedures and authentication?
8. Can all your operators tune every transmitter aboard? Can all use a frequency meter?
9. Are frequency meters calibrated weekly against WWV?
10. Is all your equipment operative? If not, is something being done to get it in working order?
11. Are safety precautions and warning posters displayed?
12. In case of a sudden electrical accident would every man in your gang know what to do?
13. Do you know what condition of radio silence exists, and under what circumstances and by whose authority it may be broken?
14. Do you know what channels and frequencies are in use for every purpose? What standby frequencies are available? The call signs of ships in the force?

QUIZ

1. Name the two broad divisions of message files.
2. Where are plain language translations of classified messages stowed?
3. What is the tickler file?
4. What goes in the proof file?
5. How often must an operator make an entry in a net log? What does he log if the net is quiet?
6. How do you correct an error in a net log?
7. What officers aboard ship receive copies of all messages?
8. What is an operation plan? Which part of it is of concern to the communicator?
9. Name the services offered by WWV.
10. What should you do before you sign a publication custody log?
11. When is destruction authorized for the communication center file? The cryptocenter file? The radio station file? The general message file? The visual station file?
12. What is one of the most important publications to the man at the operating level?
13. What transmission would WWV send to indicate that North Atlantic radio propagation conditions are presently poor, but are expected to become fair to good within the next 12 hours?
14. What is WWV's sister station in the Pacific?
15. What is the acceptable frequency tolerance range for shipboard radio stations?

CHAPTER 9

TELETYPEWRITER OPERATION

TELETYPEWRITER SIGNALS AND THE TAPE CODE

To see how intelligence is sent over teletypewriter, let us first consider one of the simpler devices for electrical communications: the manual telegraph circuit. In this circuit, shown in figure 9–1, we have a telegraph key, a source of power (battery), a sounder, and a movable sounder armature. If the key is closed, current flows through the circuit and the armature is attracted to the sounder by magnetism. When the key is opened the armature is retracted by a spring. With these two electrical conditions of the circuit—closed and open—it is possible, by means of a code, to transmit intelligence. These two conditions of the circuit may be thought of as MARKING and SPACING. Remember: marking occurs when the circuit is closed and a current flows; spacing occurs when it is open and no current flows.

When a circuit operates on current and no-current basis, as in figure 9–1, it is called a NEUTRAL circuit. This type is generally used to operate teletypewriters, although the Navy's machines sometimes operate on a line condition called POLAR OPERATION. This refers to the system whereby marking signals are formed by current impulses of one polarity and spacing signals by current impulses of equal magnitude but opposite polarity.

If a teletypewriter signal could be drawn on paper, it

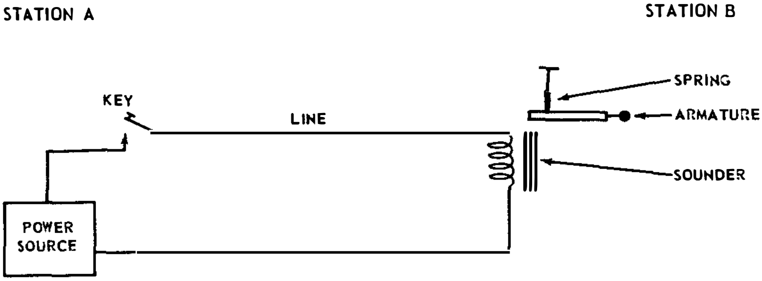


Figure 9–1.—A manual telegraph circuit.

would resemble figure 9–2. This is the code combination for the letter R. Shaded areas show intervals during which the circuit is closed (marking), and the blank areas show the intervals during which the circuit is open (spacing). There are a total of seven units in the signal. Five of these are numbered, and are called INTELLIGENCE units. The first and last units of the signal are labeled START and STOP. They are named after their functions:

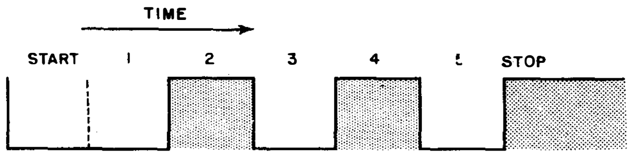


Figure 9–2.—Mark and space signals in the teletypewriter character R.

the first starts the signal and the last stops it. These are a part of every teletypewriter; the START unit is always spacing and the STOP unit is always marking. This method of teletypewriter communication—the so-called START-STOP method—gets its name from these units.

The start-stop method keeps teletypewriter machines and signals in synchronization with each other. With this method the selecting mechanism in the receiving machine comes to a complete stop after each character.

Different characters are transmitted from the keyboard by an automatic process that selects various combinations of marking and spacing in the five intelligence units (fig. 9–3). When you come to tape reading you will see that the mark and space units match the holes and blank spaces on the tape. This is because holes in the tape allow the transmitter-distributor pins to rise, sending a marking pulse. No holes mean no pulses—that is, spacing intervals. The machine, without benefit of tape perforations, automatically takes care of start and stop elements.

FIGURES	-	?	:	$	3	!	&	STOP	8	'	(	)	.	,	9	Ø
LETTERS	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
NUMBERS INDICATE MARKING IMPULSES	1	1		1	1	1				1	1					
	2		2				2		2	2	2	2				2
	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			3			3		3	3		3		3	3		3
		4	4	4		4	4			4	4		4	4	4	
		5					5	5				5	5		5	5

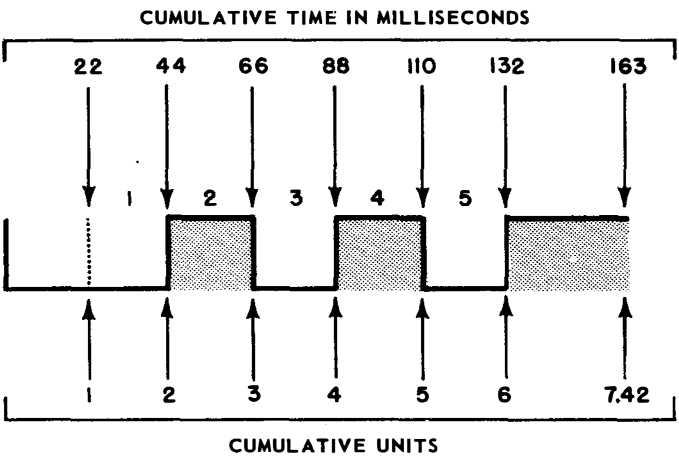
FIGURES	1	4	BELL	5	7	;	2	/	6	"						
LETTERS	Q	R	S	T	U	V	W	X	Y	Z	BLANK	LETTERS	FIGURES	SPACE	CAR RET	LF
NUMBERS INDICATE MARKING IMPULSES	1		1		1		1	1	1	1		1	1			
	2	2			2	2	2					2	2			2
	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	3		3		3	3		3	3			3		3		
		4				4		4				4	4		4	
	5			5		5	5	5	5	5		5	5			

Figure 9–3.—Mark and space combinations for characters on the teletypewriter keyboard.

A total of 32 combinations can be obtained from the five intelligence units, but by using upper and lower case the number of characters obtainable is nearly doubled. When a teletypewriter printing mechanism has been shifted to upper case as a result of having received a FIGS shift character, all succeeding characters received prior to a LTRS shift character will print in upper case—as numerals and punctuation marks. The machine does not, however, make such double use of all 32 possible combinations, since six are used for the functions of carriage return, line feed, figures shift, letters shift, space, and for one normally unused blank key. This leaves 26 of the 32 that can be employed in both upper and lower case. When the six special functions are added, the total is 58, which is the number of characters and functions that can be sent from a teletypewriter keyboard.

Examine figure 9–2 once more. This is theoretically a perfect signal. The quality of each element remains the same during its transmission, and the shift from marking to spacing (and vice versa) is instantaneous. These changes are called TRANSITIONS. They occur at the beginning and end of each of the solid blocks. Some are mark-to-space transitions, and others are space-to-mark transitions. For some other character combination a transition may occur between "start" and intelligence unit 1, but in any transmitted character there can be only two, four, or six transitions. Notice that the first six units of the signal are the same length, but the seventh (stop) unit is longer. Each of the first six units requires 22 milliseconds of circuit time for transmission. The stop unit requires 31 milliseconds. If you assign a value of 1 to each of the first six units, then the stop unit has a value of 1.42. The total number of units in the letter R (or any other teletypewriter character) is 7.42, requiring a transmission time of 163 milliseconds. There is no allowance for transition time, for a transition has zero time duration. See figure 9–4.

The telegraph circuit in figure 9–1 can be converted to a simple teletypewriter circuit by substituting a transmitting teletypewriter for the key at station A, and a



Figur 9–4.—Each teletypewriter signal has 7.42 units.

receiving teletypewriter for the sounder at station B. This arrangement is shown in figure 9–5.

Transmitter contacts are actually a set of mechanically controlled keys that can produce a different combination of the 7-unit signal for any letter or function lever de-

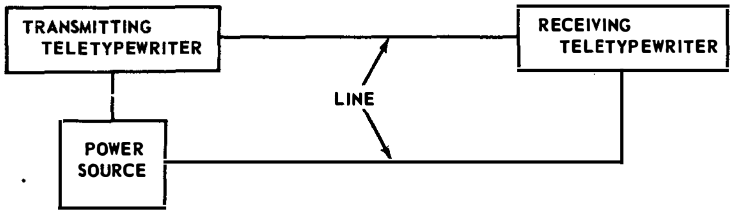


Figure 9–5.—Simple teletypewriter circuit.

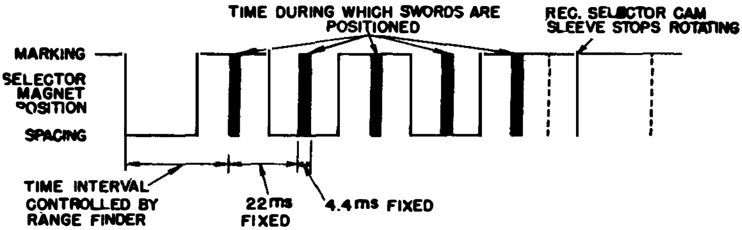


Figure 9–6.—Selecting intervals for letter Y.

pressed. As we have just seen, each character consists of a 22-millisecond spacing unit functioning as a start pulse to release the receiving mechanism, plus five 22-millisecond intelligence pulses—either marking or spacing—and a 31-millisecond marking pulse used to stop the receiving mechanism.

The selector magnet of the receiving teletypewriter mechanically releases a trip latch when the start pulse is received, thus allowing the selector cam sleeve to rotate through one revolution. During this revolution, five swords are positioned by the operation or release (marking or spacing) of the selector magnet armature as determined by each intelligence pulse received. The time required to position each sword is approximately 20 percent of the time of 1 intelligence pulse, or 4.4 milliseconds. Cams on the selector cam sleeve are so located that the time between each sword operation is fixed at 22 milliseconds. During 4.4 milliseconds of the first pulse the first sword will be positioned, during 4.4 milliseconds of the second pulse the second sword will be positioned, and so forth, until all five swords have been positioned (see fig. 9–6). These swords control the internal mechanism of the teletypewriter so as to select and at the proper time print the correct character.

DISTORTION

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 go over the wire. This lengthening and shortening of marks and spaces occurring during transmission reduces the quality of the signal, and is called DISTORTION. Distortion in teletypewriter signals may be CHARACTERISTIC distortion, FORTUITOUS distortion, or BIAS. The components of distortion cannot be briefly defined. They are the result of a variety of conditions in the circuit: crossfire, power interference, the tail of one signal interfering with another, and so on —all of which are problems of designers and maintenance men. You are concerned only with TOTAL distortion; that is, the total effect of all components of distortion upon the signal.

ORIENTATION RANGEFINDER

In figure 9–2, illustrating the signal for the letter R, each unit or element is perfect in every respect. To print the letter R, the selection mechanism could be set to operate on any 20-percent portion of each unit, and perfect copy would result. Under actual conditions, a signal is never this perfect, nor is a teletypewriter expected to

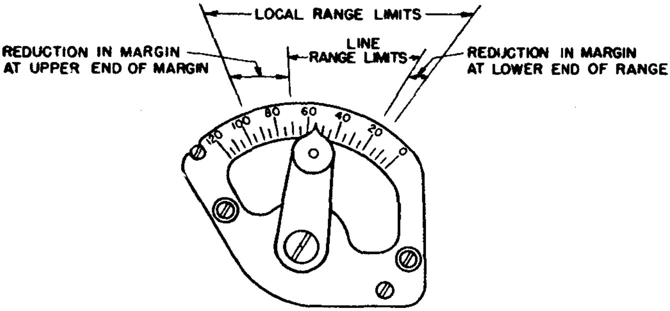


Figure 9–7.—The orientation rangefinder.

operate over the entire range of the unit. Rarely will more than 70 percent of each unit be usable by the selecting mechanism. This means that the selection point must be positioned so that the best portion of the element will be used by the selecting mechanism.

Each teletypewriter is equipped with an ORIENTATION RANGEFINDER that allows the machine to be set at the range of best reception. The rangefinder, located at the left side of the machine, is a device consisting of a scale and a finder arm. (The finder and its scale are illustrated in figure 9–7.) Degrees on the scale—0° to 120°—divide the first unit of the signal only, not the entire signal. When you adjust the finder arm, you shift the selection point of the first unit with respect to the starting unit. Figures 9–8 and 9–9 illustrate this. Since all other units of the signal follow at 22-millisecond intervals, this amounts to adjustment or orientation of the entire signal to the start pulse. Shifting the point of selection simply means you are moving the first black bar shown in figure

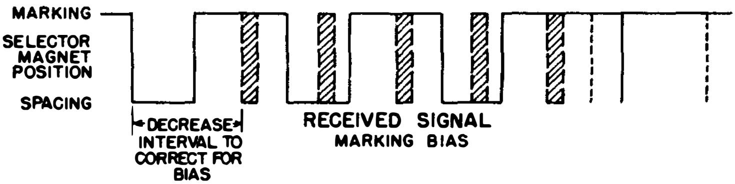


Figure 9–8.—Received signal with marking bias.

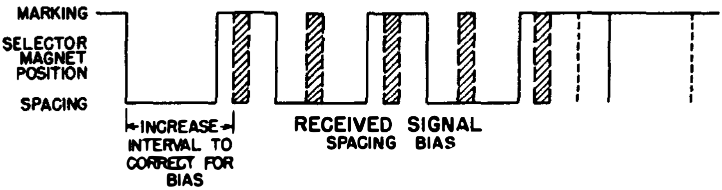


Figure 9–9.—Received signal with spacing bias.

9–6 back and forth across the first signal unit, looking for the most suitable position.

Since the scale goes up to 120 percent of one unit, you can shift far enough so that the selection interval moves entirely off the unit. If the signal were perfect, you could still shift the finder far enough to produce errors. The object is to place the selection interval on that portion of the unit that will give the selecting mechanism a maximum margin of safety while selecting that unit and the four which follow. With the selection point midway between the transitions, there is the least chance of error.

To determine the range limits, the finder arm is adjusted at the two extreme positions—at the lower and the upper end of the scale. In each case observations are made of the typed record and a reading is taken when about one error is typed per line of copy. This means about one error in 72 characters. Orientation ranges on properly adjusted teletypewriters for different degrees of signal distortion are as follows:

	POINTS
Very little distortion	80
Moderate distortion	60–70
Average distortion	50
Large distortion	Less than 40

As shown in figure 9–7, the orientation range limits with practically perfect signals and a teletypewriter in good condition should be 15 and 95. In this case, best operating results will be obtained when the finder arm of the receiving teletypewriter is set at the midpoint (55) of this range.

Actually, the orientation range is determined twice: First, range of the machine (local range) is determined, then range of machine when connected to the line (line range) is determined. Setting of the finder arm is the midpoint of the sum of these two ranges.

The orientation range is obtained locally by using keyboard signals. Normally, the letters R and Y are used since they give a complete reversal of impulses. R is S-M-S-M-S and Y is M-S-M-S-M. (Other characters can be selected which would also give a complete reversal of impulses.) If the range is not less than about 70 percent (from about 20 to 90 on the scale) it may be assumed that the machine is satisfactory.

The difference between the range determined by local test, and the corresponding range obtained when receiving signals over a line, represents the reduction in margin due to signal distortion. The reduction, as illustrated in figure 9–7, is a direct measure of total signal distortion. This illustration shows the line range limits to be 20 and 70 on the scale. The line range represents a reduction of local range limits by 5° on the lower end and 25° on the upper.

The manner in which typed errors occur in the neighborhood of the orientation limits may give indication of the nature of the distortion. If limits are fairly definite —the copy changes from good to bad when the rangefinder is moved only a small distance—bias, or distortion due to speed variations or faulty apparatus, is present. If there is a CERTAIN range at each limit over which CERTAIN characters are consistently in error, this is due to characteristic distortion. If limits are not definite—that is, there is a range over which errors occur, and errors do not occur consistently on certain characters—this is an indication of fortuitous distortion. As a general rule, characteristic and fortuitous distortion cause reduction of the range at both limits. On the other hand, bias affects one range more than the other. Marking bias reduces the upper range limit, and spacing bias reduces the lower range limit.

Maintenance men sometimes test distortion tolerance of a teletypewriter by applying predistorted signals. This predistortion ranges from zero to 40 percent. A well-adjusted machine will type correctly when signals from a test set are distorted as much as 35 percent.

Rangefinding a teletypewriter is not an everyday occurrence. Usually it's an operation performed in conjunction with maintenance of the machine. Unless something goes wrong with the circuit, rangefinding will be done during overhaul. When rangefinding a machine, care must be taken that the machine is in good adjustment, and range limits are read accurately.

CIRCUIT TYPES

The word "circuit" is used in two senses in the Radioman's work. First, in the electrical sense: a continuous conductor for the flow of electrons; second, in the communications sense: a path between two or more points, capable of providing one or more channels for the transmission of intelligence. In the discussion of teletypewriter operation we shall concentrate on the communication sense of the word.

A simplex circuit is a CW, voice, or RATT circuit capable of transmissions in both directions, but not simultaneously. Its landline counterpart is the half-duplex circuit.

A duplex circuit is a radio or landwire circuit capable of carrying transmissions in both directions at the same time.

You learned in chapter 4 that whenever a carrier is modulated, two sideband frequencies are produced that carry the intelligence present in the audio frequency. Only one sideband is necessary for transmission of the signal, and a transmitter in which the carrier has been suppressed may be used to send a separate message on each of the sidebands. The messages from the two audio channels are made to modulate the same carrier, but modulation takes place in different modulators.

The output of the two modulators contains sidebands formed by heterodyning the individual audio signals with a common carrier suppressed in the output. The filters remove the lower sideband from one modulator output and the upper sideband from the other. Thus, each of the two sidebands conveys a separate message and may be used as a separate channel. At the receiving end, the carrier frequency is reinserted and the intelligence recovered.

As used in the Naval Communication System, six teletypewriter channels are transmitted on one sideband of each SSB circuit through a frequency multiplexing system. Frequency multiplexing is a process for including multiple sets of transmissions on a single bandwidth by crowding, or "stacking" the discrete (individual) frequencies.

To give added range to landline transmissions, REPEATERS are inserted in the line to renew the strength of weak signals as they pass through the wire. Repeaters are of two kinds. First, there is the "straight" repeater, which strengthens (amplifies) the signal just as it is received. Unfortunately, this type also amplifies any interference the signal may have picked up along the wire.

The other repeater is the "regenerative" type. It builds, or regenerates, an entirely new signal from one that is worn out or distorted, and eliminates the interference. Both types of line repeaters retransmit signals automatically, using a local source of power. They may be placed at the end of the line (terminal), or at an intermediate point along the line.

Repeaters cannot be used with RATT transmissions. Radioteletypewriter is further handicapped by the same atmospheric disturbances which sometimes hamper radiotelegraph communications. Although RATT transmits on radio waves instead of wires, the basic equipments are the same as those used in landline teletypewriter operation. The difference is that RATT requires transmitters and receivers to send and pick up signals.

MODEL 15 TELETYPEWRITER

The teletypewriter, of course, is little more than an electrically operated typewriter. The prefix "tele" means "at a distance." Coupled with the word "typewriter" it forms a word meaning "typewriting at a distance." By operating a keyboard similar to that of a typewriter, signals are produced which print characters in page form, called HARD COPY.

These characters appear at both sending and receiving stations. In this way, one teletypewriter will actuate as many machines as may be connected together. An operator transmitting from New York to Boston will have his message repeated in Boston, letter by letter, virtually as soon as it is formed in New York. The same will apply at all receiving stations that tie into the network. The machine most commonly used is the Model 15 page teletypewriter, also called the Model 15 printer, a machine widely used by both military and commercial communication systems.

Two Keyboards

The Model 15 printer is equipped with either of two types of keyboards: COMMUNICATION and WEATHER. The first contains letters and punctuation marks common to the standard typewriter, while the weather keyboard provides necessary symbols for transmission of weather data. Similarities and differences in the two keyboards are illustrated in figure 9–10. Observe that the lower case characters are the same, and that letters of the alphabet appear in the same positions. The difference lies in the upper case of the bottom two rows, plus the

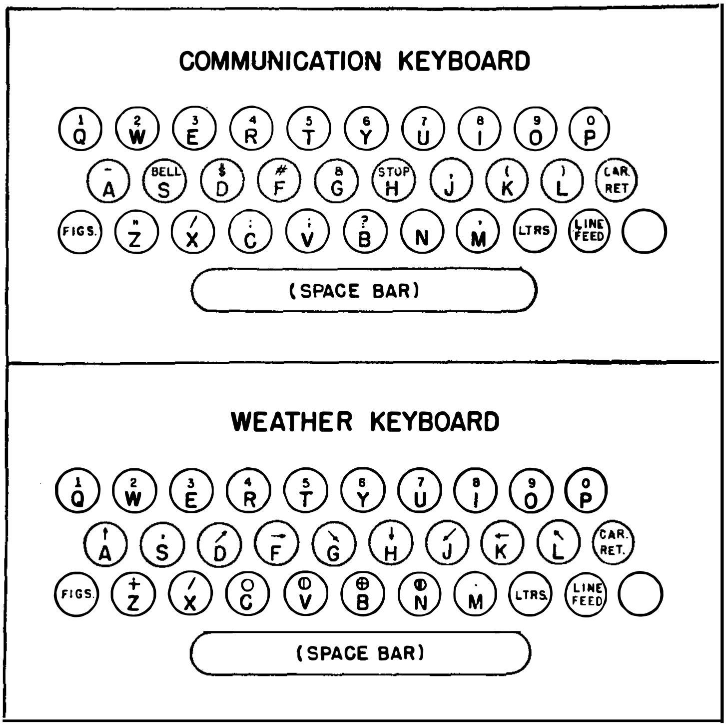


Figure 9–10.—Teletypewriter keyboards.

fact that the blank key of the weather keyboard does not function as such, but is used to print the minus (–) sign.

The teletypewriter keyboard differs from the standard typewriter in that it has one fewer row of keys, and in lower case types capitals only. In upper case it types numerals, the principal punctuation marks, and special characters. A trained operator can use either the communication or weather keyboard without loss of speed or efficiency.

How To Use the Model 15

To follow the discussion of the operation of the Model 15 printer, you should first study figure 9–11, which labels the principal parts of the machine. This illustra-

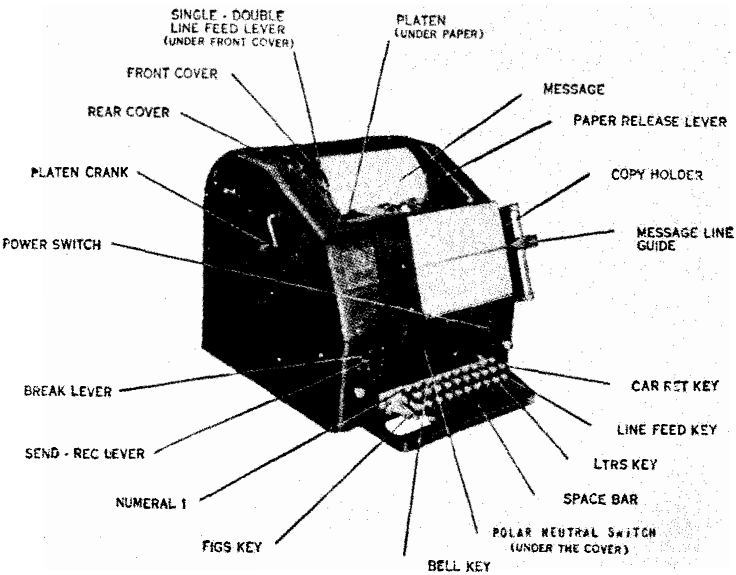


Figure 9–11.—The Model 15 page teletypewriter.

tion, as well as closeups of various parts of the printer, should be used as reference throughout the discussion.

To start or stop the machine, the power switch is placed in either the ON or OFF position. With power ON, check the SEND-REC lever at the left side of the machine to make sure it is in the SEND position. Before sending, make sure the polar-neutral switch is in the neutral or OUT position. Since almost all Navy circuits are either neutral or polarential, there is little occasion for the polar-neutral switch to be in any other position than OUT. On commercial machines, without 255–A line relay, the polar-neutral switch is called a LINE-TEST KEY, and is used in the IN position to send to the line, and in the OUT position to test the machine locally. To test a Model 15 printer, the operator removes two plugs at the front of the machine, transferring them from line jacks to a test loop. In that way, the polar-neutral key is never used for testing. With power ON, the SEND-REC lever at SEND, and the polar-neutral switch OUT, the machine is ready to accept traffic for transmission to other stations.

Transmission begins at the keyboard. With the touch system use the CAR RET key as a guide for the right hand and the A key for the left hand. The little finger of each hand is used on the guide key. It is important that you use a light, quick, even touch on the keys. Force is unnecessary because the machine is electrically operated. Teletypewriter manual operation requires accuracy, rhythm, confidence, and speed in their proper relation. Although a light touch is essential to speed, each key must be pressed in a positive manner. Otherwise you may be writing the word FOR and have FR appear on the page simply because the letter O was pressed without allowing sufficient time for printing of the letter F. To become a skillful teletypist, proficiency in the touch system of typing is, of course, a "must."

Notice that several keys represent "functional operations," or nontyping selections; that is, when pressed, they do not print anything on the page. Among these are the figures (FIGS) key, the letters (LTRS) key, space bar, carriage return (CAR RET) key, and line feed (LF) key.

To shift the machine to the upper case for typing numerals, punctuation marks, and special characters indicated on the upper part of the keys, press FIGS. To UNSHIFT the machine, press LTRS, and type the letters of the alphabet.

The SPACE BAR may be used to space between either words or characters. The machine will space as long as you hold down the space bar. On Navy printers the space bar functions the same whether upper or lower case characters are transmitted. However, some commercial and Army machines have a feature called "unshift on space," which means the printer returns to lower case after each space. On such machines, press the FIGS key when an upper case character follows the space operation.

The CAR RET key is used to return the carriage to the beginning of the line. Usually the machine is adjusted to print a line 72 characters in length. This includes the spaces between the typed words. A margin bell rings about six characters before the end of the line.

The LINE FEED key feeds the paper up, one to two lines at a time, thus preventing overlining.

Before leaving our discussion of the keyboard, there are two special uses of the FIGS key you should know. To ring a bell for signal purposes, press FIGS BELL. To type the numeral 1 (the lower case L prints as a capital letter), press FIGS Q.

Miscellaneous Features

Use the PLATEN CRANK if you wish to turn the paper up or down in your machine, without affecting the paper in the other machines on the circuits. Do not operate or attempt to hold the platen crank while the machine is in operation.

To free your paper for adjustment, push back the PAPER RELEASE LEVER, and pull it forward to hold the paper tight. Pull the LINE FEED LEVER forward for double-line spacing, or push it back for single-line spacing.

The COPYHOLDER is a metal plate just above the keyboard, on which messages are placed to be read by the operator as he types. The MESSAGE GUIDE is a horizontal bar, mounted on a vertical rod, which holds the message against the copyholder by spring tension. The message guide may be lowered with each line transmitted, furnishing a line-by-line visual guide for the operator.

CHAD AND CHADLESS TAPE

Before discussing equipments that produce and handle messages on tape, let's get squared away on the two types of tape used for messages transmitted over the NTX system. The first type is the completely perforated, or CHAD tape (fig. 9–12). On this tape the teletypewriter code is punched, and no printing appears. The other type, only

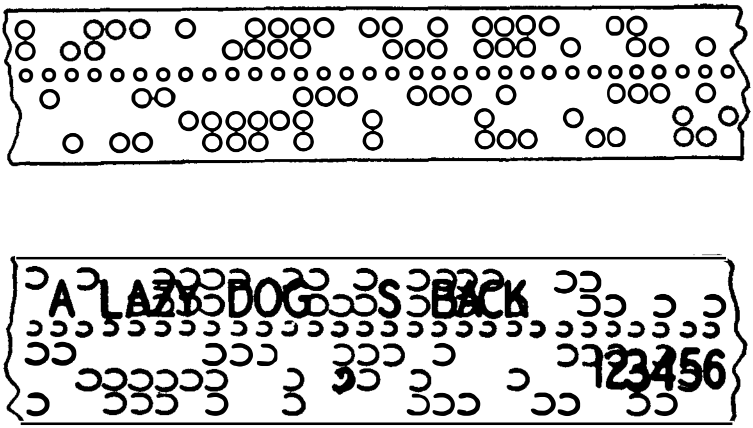


Figure 9–12.—Chad and chadless tape.

partially perforated, is called CHADLESS. The message is printed as well on this tape. (Incidentally, "chads" are those small paper disks punched from the tape to make the holes.) On chadless tape the printing lags the perforated code by six spaces. In other words, the pattern of holes representing A may be punched as the first letter of a message, and six spaces later the printed letter A will appear on the tape.

The partial perforations of chadless tape allow enough space for the printed word, which eliminates need for reading perforated code and also permits the transmitter-distributor sensing pins to rise, transmitting the message. When a tape is punched completely—as is chad tape—the remaining space is insufficient for the printed word.

You may wonder why the Navy uses chad tape at all when chadless is more convenient to read. The reason lies in the expense that would be necessary to build typing units into all perforating equipments. It is simpler for the operator to learn to read chad tape, and you must be able to do so. We will have a lesson in tape reading at the end of the chapter.

When there is need for manual tape transmission, or a combination of tape and hard copy, the MODEL 19 SET is used. The basic component of the Model 19 set is the Model 15 printer. Other units that make up the set are the perforator, transmitter-distributor, and character counter. The perforator is mounted on the left side of the printer and punches the tape as the keyboard is used. A switching arrangement permits the operator a choice of tape, hard copy, or tape and hard copy, simultaneously. Tape coming from the perforator punch block is completely perforated and bears no printing. For immediate transmission to the circuit the tape is fed into a transmitter-distributor, where five spring-operated SENSING PINS are released in proper combination by holes in the tape. These sensing pins determine the code that is transmitted over the wire.

When the perforator is not operated as a part of a Model 19 set, it has a keyboard of its own. Chad tape can be prepared for future transmission, or it may be fed directly into a transmitter-distributor. No hard copy is available with this arrangement.

Speaking of the transmitter-distributor, keep that word transmitter in mind, for the TD is the only instru-

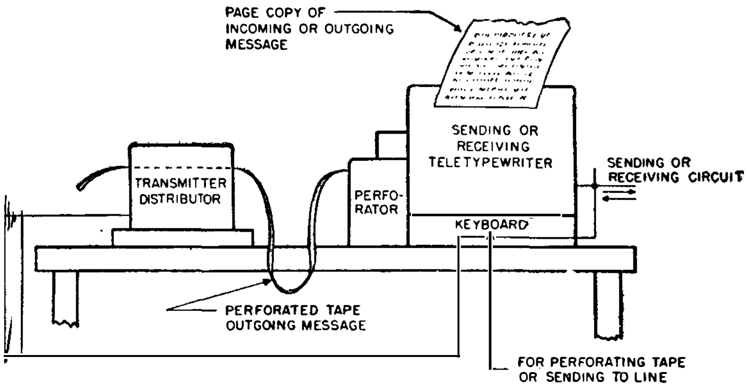


Figure 9–13.—Typical arrangement of TD, perforator, and printer.

ment used for transmitting teletypewriter messages BY TAPE over the line or (in the case of RATT) air waves.

Figure 9–13 shows a typical arrangement of a Model 19 set—printer, perforator, and TD. In this illustration the tape goes from the perforator directly to the transmitter-distributor. Regardless of how fast or slow the operator may type, the TD sends the message at the speed for which it has been set. If the operator lags, the TD "waits." This waiting takes place because the TAPE STOP lever stops the TD when the tape becomes taut. If the operator keeps up with the transmitter-distributor, the tape remains slack and operation continuous. When the tape is prepared in advance, the problem of keeping up with the TD does not arise.

When the equipment shown in figure 9–13 is set up to receive a message, the printer is not manned. Instead, the machine is actuated by the sender transmitting from the other end of the line. The message can be received as page copy, perforated tape, or both.

Operating the Model 19

The printer in the Model 19 set has a selecting feature not available in the standard Model 15 printer. To the left of the printer, and mounted just under the tabletop, is a 3-position LINE SWITCHING KEY giving the operator a choice of two circuits and a TEST position. Operation of the switch to left or right puts the machine on a circuit, while in the center position the machine is on test, and operation of the keyboard will produce hard copy or tape LOCALLY ONLY. Like the Model 15, the printer of the 19 set may also be tested by removing a pair of plugs from circuit jacks at the front of the machine and plugging them into a test loop, but in this position the TD is inoperative.

The printer may be operated in any one of the three ways by operating the KEYBOARD CONTROL OPERATING LEVER. The top position of the keyboard control operating lever, designated KEYBOARD, enables you to send manually on the circuit with a typed record being produced on your machine. This method is useful when the communication between offices does not require the automatic feature. Your speed of typing is limited to the maximum speed of the circuit, usually **60 WPM.**

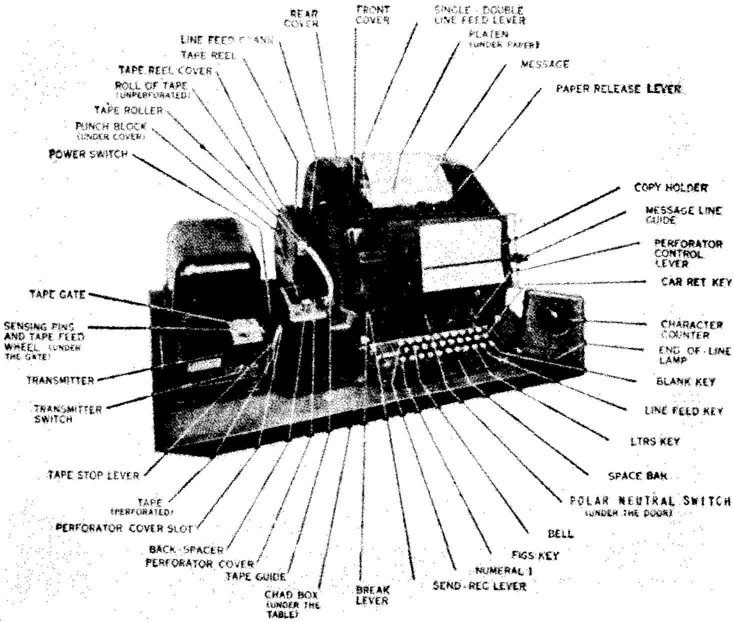


Figure 9–14.—The Model 19 set.

The middle position of the keyboard control operating lever, designated KBD & TAPE, enables you to send on the circuit while page copy and perforated tape are prepared simultaneously. This method is useful for sending messages where tape may be required for later automatic transmission. In the KBD & TAPE position it is also possible to perforate tape with page copy produced on your machine without sending on the circuit. (This is explained in the next section.)

The bottom position of the keyboard control operating lever, designated TAPE, permits you to prepare messages on perforated tape while receiving a message in hard copy from another station. You may also cut a tape while your TD is transmitting from a previously cut tape, and have the message that is clearing the TD appear as hard copy on your machine. Your speed of perforating is not limited to the speed of the circuit, for the keyboard in the tape position can be operated up to about 100 WPM. Operation of the power switch and use of the keyboard remain the same for all three methods.

To send the message directly to the line as you are typing it, operate the keyboard control operating lever to the KEYBOARD position, and the SEND-REC lever to SEND. Make sure the line switching key is either right or left, according to the channel you desire. To set the distant machine in the same position as yours, start with five spaces, two CR (carriage return), and LF (line feed), in that order; then tvpe your message.

KBD and Tape Operation

There are two possible operating arrangements with the keyboard control operating lever in the KBD & TAPE positions: with the line switching key in the left or right position, and with the line switching key in the TEST position. To send directly to the circuit, with page copy and perforated tape being prepared simultaneously, select the proper channel by operating the line switching key; operate the keyboard control operating lever to the KBD & TAPE position and the transmitter switch to the OFF position. This connects the machine to the circuit. Start with five spaces, two CR and LF; then type your message.

To cut tape for later sending and simultaneously provide hard copy, place the line switching key in the center (or TEST) position, the SEND-REC lever to the SEND position, the keyboard control operating lever to KBD & TAPE, and the transmitter-distributor switch to OFF. The machine is now disconnected from the circuit and the message will not be transmitted.

Care should be exercised in using this method on landlines since you can neither send nor receive messages during the period the machine is disconnected from the circuit. Unless you have a calling-in signal, that operates when the machine is disconnected from the circuit, be sure to notify other offices before you disconnect the machine.

Regardless of the position of the line switching key, never attempt to use the transmitter-distributor with the keyboard control operating lever in the KBD & TAPE position. In this condition, errors result when the keys are depressed.

Tape Operation

To prepare a message in tape for automatic sending while either receiving or sending other traffic automatically, place the keyboard control operating lever (fig. 9–15) in the TAPE position. You type no page copy in this position, so watch the character counter to make sure that you do not type too many characters for the length of the line. The counter registers each spacing character. Nonprinting functions such as FIGS, LTRS, LINE FEED, and CAR RET are not registered. A warning

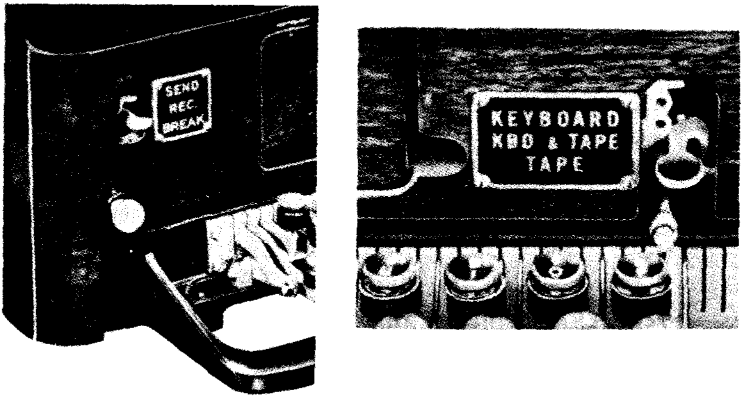


Figure 9–15.—Closeup of SEND-REC and keyboard control operating levers.

END-OF-LINE LAMP will light after about 65 characters have been perforated.

To correct an error when punching tape, use the back spacer to move the tape back, one code at a time, until the first wrong code is over the perforating pins of the punch

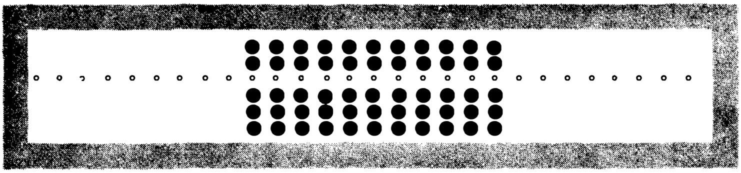


Figure 9–16.—A lettered-out tape.

block. Press LTRS key as many times as you have back-space to change the wrong code to LTRS codes. Then re-type that portion of the message. The error will not appear in the page copy when the tape is sent. However, the characters are still registered on the counter. Therefore, when the counter indicates that you have reached the end of the line, you still may type as many characters as you have LTR'd out. Figure 9–16 shows a lettered-out tape.

How To Operate the TD

To place a tape in the transmitter-distributor, perforate enough tape to reach from the punch block to the TD. Feed the tape under the TAPE STOP lever to the transmitter-distributor. Always be sure the transmitter switch is in the OFF position, before you put in the tape. Raise the tape retaining lid and place the tape over the teeth on the tape feed wheel, with the first code to be transmitted directly over the sensing pins. The code perforations must match the pins. Close the tape gate.

To transmit from the tape, make sure the line-switching key is to the right or left, not in the TEST position. Move the keyboard control operating lever to the TAPE position. Operate the transmitter switch to ON. Continue punching your message.

Look at the tape occasionally; straighten it if it becomes twisted. To prevent the tape from tearing, stop the TD by operating the transmitter switch to the OFF position. If, in spite of this, the tape tears, it must be cut again and retransmitted.

When another station interrupts your sending, the SEND-REC lever on your machine will drop to the REC position and your transmitter-distributor will stop. If the interrupting station requires an acknowledgment, raise your keyboard control operating lever to the KEYBOARD position and your SEND-REC lever to the SEND position.

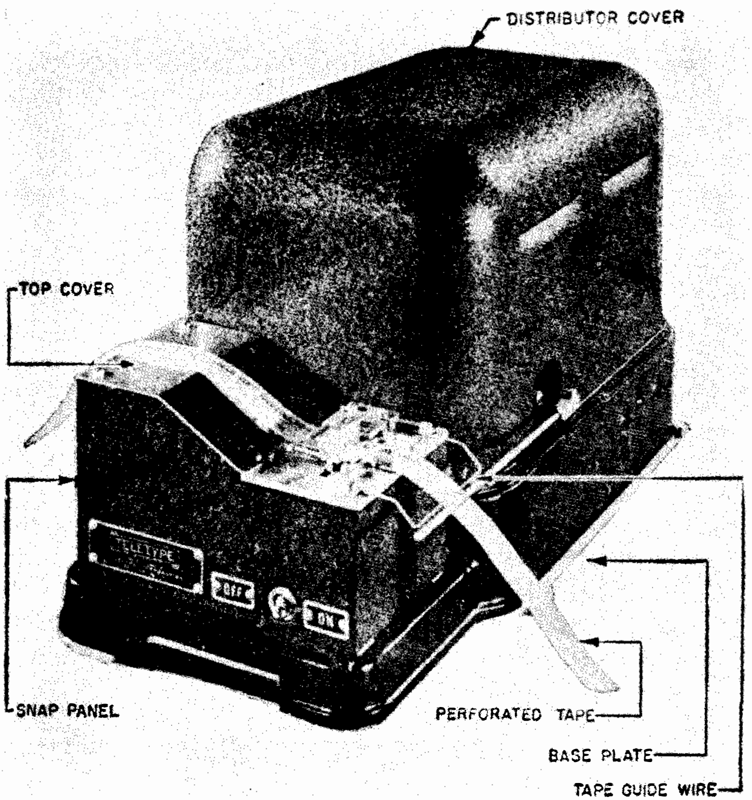


Figure 9–17.—The transmitter-distributor.

When the interrupting station wishes you to resume automatic transmission, reset the tape if necessary and operate the keyboard control operating lever to TAPE position. If no acknowledgment is required, reset the tape as necessary and restore the SEND-REC lever to the SEND position.

To receive messages on the Model 19 set make sure the machine is connected to the proper circuit. The SEND-REC lever may be in either the SEND or REC position. When the keyboard control operating lever is in the KEYBOARD or KBD & TAPE position, do not touch the keyboard while receiving, for this will cause errors. Incoming messages are typed as hard copy by the machine.

To interrupt a station which is sending, press the BREAK lever for about 3 seconds. This drops your SEND-REC lever and the one on the distant machine to the REC position, and stops its transmission. Without delay, raise your SEND-REC lever to SEND and your keyboard control operating lever to KEYBOARD, and immediately type your reason for breaking.

CHANGING PAPER

The instructions concerning changing of paper and ribbons that follow apply to the Model 15 teletypewriter and the printer of the Model 19 set.

Check the supply of paper in the machine frequently to avoid losing messages because of paper running out. The approach of the end of the roll is indicated by a colored streak along the edge of the paper. Change paper outside of service hours. However, if it is necessary to change during service hours, notify all stations on the circuit before doing so.

There are two types of paper feeds, "friction" and "sprocket." To change the paper on a friction-feed machine, turn off the power, and open front and rear covers of the machine. Observe the following steps, using figure 9–18 as your reference.

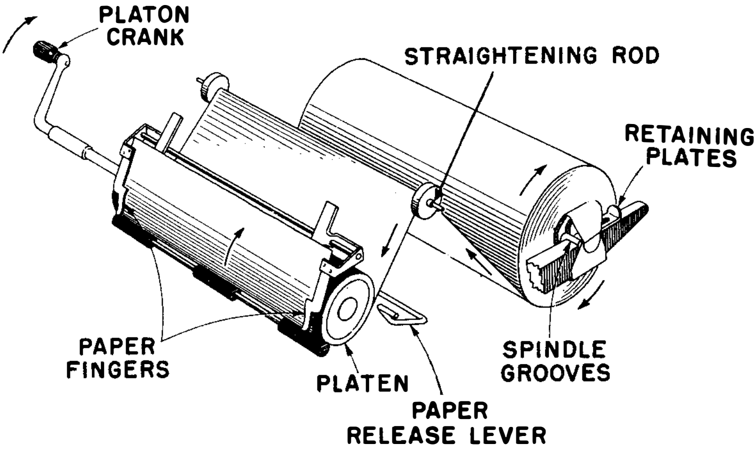


Figure 9–18.—Changing friction-feed paper.

1. Turn platen crank to roll back paper from under platen.
2. Push back retaining plates.
3. Remove roll from spindle grooves.
4. Remove spindle from used roll, and insert in new roll.
5. Place spindle first in right groove and then in left groove, with paper feeding from underneath roll.
6. Push retaining plates forward.
7. Feed paper over straightening rod and under platen, bringing it up between platen and under paper fingers by turning platen crank. Don't disturb ribbon.
8. Push back paper release lever, straighten paper as you would in an ordinary typewriter, and pull paper release lever forward.
9. Close rear cover and roll paper up over it with platen crank.
10. Close front cover.
11. Turn on power to resume operation.

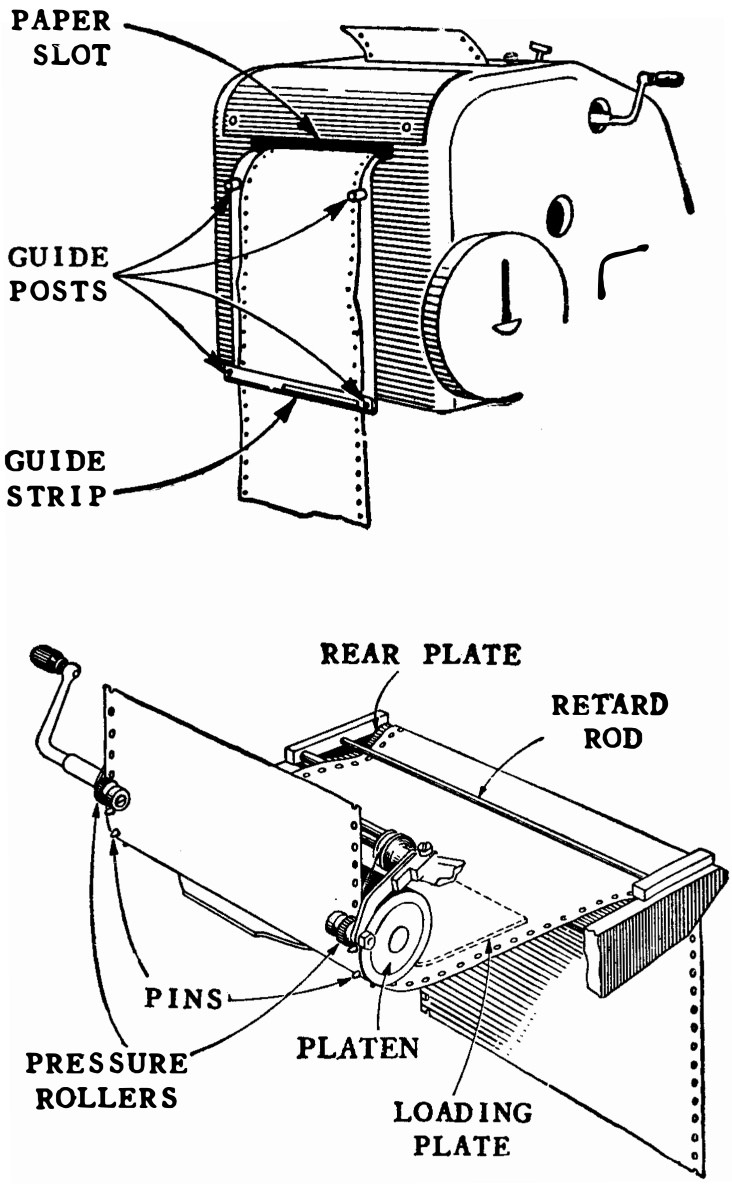


Figure 9—19.—Changing sprocket-feed paper

The second type of paper feed is called a sprocket-feed because of perforations at each side of the paper which feed across two sprocket wheels. The sprocket-feed is used when carbon copies of the traffic are required. While reading the following instructions refer frequently to figure 9–19.

1. Space carriage to center of platen, turn off power, and open front and rear covers.
2. Raise pressure rollers.
3. Feed paper under guidestrip between guideposts, into paper slot in rear of cover. Run it over rear plate, under retard rod, over loading plate, and insert the leading edge of the form under platen.
4. As with friction-feed machines, care must be taken not to disturb the ribbon. Align paper by placing perforations of paper on pins and lower pressure rollers. This operation must be continuous, otherwise paper may slide back into paper box. If a printed form is used, turn platen crank until form reaches first typing line.
5. Close rear and front covers.
6. Turn on power to resume operation.

CHANGING RIBBON

Check the condition of the ribbon frequently and replace it when it becomes worn. Otherwise, it may produce illegible copy and cause service interruptions. If necessary to make ribbon change during service hours, notify all stations on the circuit before doing so. Use a ½-inch ribbon with reversing rivets, on spools specially designed for teletypewriter use. The steps are as follows (refer to fig. 9–20) :

1. Turn off power, and open front cover of machine.
2. Lift both spools from spool shafts.
3. Disengage old ribbon from ribbon carrier hooks.
4. Reverse arms and roller guides.
5. Remove old ribbon from spool.

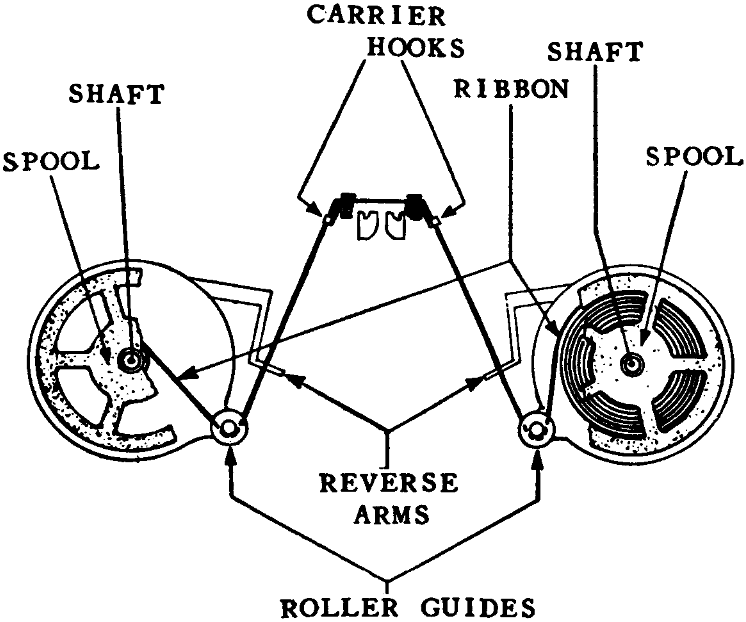


Figure 9–20.—Changing the ribbon.

6. Engage hook of new ribbon on hub of empty spool, and wind the reversing rivet on spool.
7. Pull ribbon forward around both roller guides; insert in ribbon carrier, under carrier hooks.
8. Engage ribbon in slots on both reverse arms. Do not attempt to change position of reverse arms. Take up slack in ribbon by turning free spool.
9. Close front cover.
10. Turn on power to resume operation.

CHANGING PERFORATOR TAPE

To change the ribbon or paper of a Model 19 set (friction- or sprocket-feed) use the same procedure as outlined for the Model 15 printer. Before following the steps for changing the perforator tape of a Model 19 set, study figure 9–21; or better, examine an actual perforator unit.

Check the supply of tape in the machine frequently to avoid having it run out in the middle of a message. The approach of the end of the roll is indicated by a colored streak near the end. Make the change outside service hours, if possible.

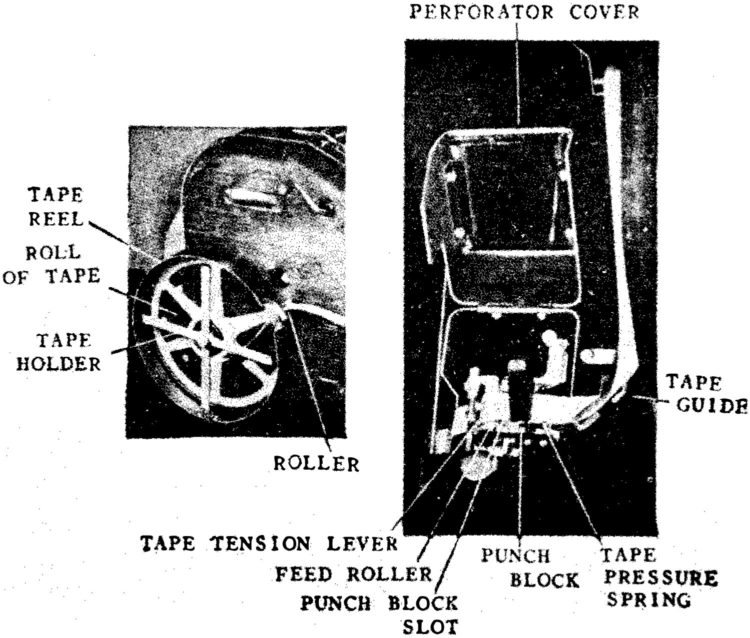


Figure 9–21.—Changing perforator tape.

1. Move keyboard control operating lever to TAPE position.
2. Lift off tape reel cover, remove tape holder, and lift out roll.
3. Place new roll of tape in tape reel, with tape feeding from underneath out over roller.
4. Replace tape holder and tape reel cover.

5. Lift perforator cover, tear tape at punch block, and remove from tape guide.
6. Feed out the piece of tape in the punch block with LTRS key. Cut or tear end of tape at an angle. Turn tape so that right edge is toward the rear. Feed tape through tape guide and past tape pressure spring, holding tape pressure spring forward. Feed tape into punch block slot. Now, hold out tape tension lever and feed tape between it and feed rollers. Release tape until it is feeding properly. Continue to operate LTRS key until tape extends beyond perforator cover. Close perforator cover.

MODEL 28 TELETYPEWRITER

The Model 28 is a recently developed keyboard-sending and page-receiving teletypewriter which is in production but will not, for some years, completely replace the models we have already discussed. It is of improved de-

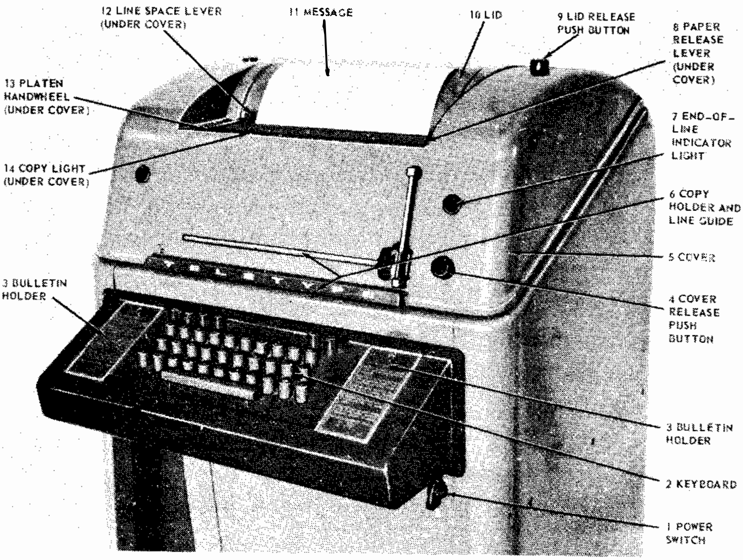


Figure 9–22.—The Model 28 teletypewriter.

sign to ensure more reliable performance in ships and aircraft. It uses the same mark-space code as the Model 15, but is mechanically different.

Let us look at some of the external features of this machine. The numbers following correspond to those shown in figure 9–22.

1. POWER SWITCH — When turned ON, this switch starts the motor in the teletypewriter, and makes the machine operative. To secure the machine, turn the power switch OFF.
2. KEYBOARD—Described in next section.
3. BULLETIN HOLDERS—There are two on the machine. Used as necessary for recording any information an operator needs to have at his fingertips.
4. COVER RELEASE PUSHBUTTON—Releases cover of machine for raising.
5. COVER—Raised for access to typing unit. It is hinged at the rear and is counterbalanced by a mechanism that aids in lifting and holding it open.
6. COPYHOLDERS and LINE GUIDE — The copyholder holds the message to be typed. The line guide helps the operator follow the lines as he types.
7. END-OF-LINE INDICATOR LIGHT—A red lamp which lights about six characters from the end of the line. The machine is adjusted to type 72 characters to the line, including spaces between words or groups.
8. PAPER RELEASE LEVER—Located under cover. When pushed back, this control frees the paper for adjustment. When pulled forward, it holds the paper tight.
9. LID RELEASE PUSHBUTTON—When pushed, releases lid of machine for raising.
10. LID—When raised, provides access to the paper, paper release lever, and line space lever.
11. MESSAGE—In the form of hard copy.

12. LINE SPACER LEVER—Located under cover. Pull forward to single space, push back to double space.
13. PLATEN HANDWHEEL—Located under cover. When depressed and turned, feeds paper in direction in which turned, up or down.
14. COPY LIGHT—A white lamp which is lit while the teletypewriter is on, illuminating the copy.

Keyboard

The keyboard arrangement is shown in figure 9–23. You will notice, from a comparison with figure 9–10, that there is a partial top row of six keys that does not appear on older equipments. These keys are red; the remainder of the keyboard is green. Red keys and their functions are discussed below.

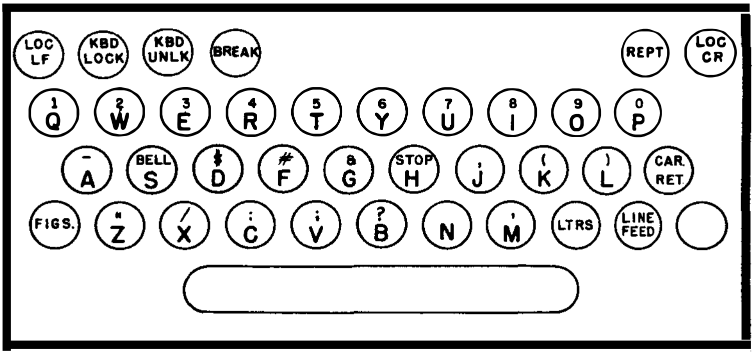


Figure 9–23.—Communication Keyboard, Model 28.

1. BREAK KEY—To stop (break) another station's sending, depress the BREAK key for about 2 seconds. This causes the KBD LOCK key to drop and lock keyboards on both sending and receiving machines. After a break it is necessary to operate the KBD UNLK key to free the keyboard for sending.

2. REPT (repeat) KEY—To repeat a character, depress the character key and the REPT key. The character will

be repeated automatically at line speed as long as both keys are held down.

The four keys described next perform their functions only on the machine on which the key is operated (referred to as "local machine"), without affecting any other machine on the line.

3. LOC LF (local line feed) KEY—To feed the paper up in the local machine, depress the LOC LF key, which will feed the paper up automatically and rapidly as long as it is held down. This key is for use in locally feeding up paper to tear off a message not fed up far enough by the transmitting station. It is also used when inserting a new supply of paper in the machine.

4. KBD LOCK (keyboard lock) KEY—To lock the keyboard on the local machine, depress the KBD LOCK key. The keyboard is now inoperative until released by the KBD UNLK (keyboard unlock) key. The KBD UNLK key also drops automatically when the control switch is turned OFF, when the BREAK key is operated, or when a break is received.

5. KBD UNLK (keyboard unlock) KEY. To unlock the keyboard on the local machine, depress the KBD UNLK key. This raises the KBD LOCK key, making the keyboard operative. Operate this key after turning on the control switch and after sending or receiving a BREAK.

6. LOC CR (local carriage return) KEY—To return the type box to the left margin on the local machine, depress the LOC CR key. This key is for use in case of omission of carriage return at the end of a transmission from another station.

Typing Unit

Printing is produced by the type box, which contains the characters and symbols shown on the keytops (fig. 9–24). Operation of keys and space bar moves the type box across the platen from left to right. On each key stroke the type box is moved into position for the printing hammer to strike the proper type pallet, printing the

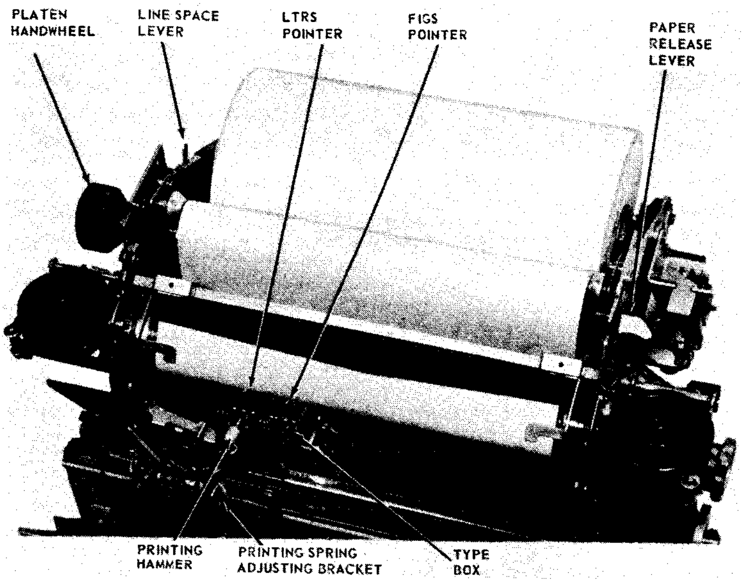


Figure 9–24.—Typing unit, Model 28.

character on the paper. Operation of the CAR RET key returns the type box to the left margin, and operation of the LINE FEED key moves the paper up to the next line.

The force of the printing blow is controlled by the printing spring adjusting bracket, which is set for the individual service requirement according to number of carbon copies required. Notch 1 is for one to three copies, and notch 2 for four or five copies. If copies are either too light or too dark, the force of the printing blow can be adjusted by moving the printing spring adjusting bracket, taking care not to make the printing blow any heavier than necessary to produce satisfactory copies.

Type pallets are arranged in four rows. The type box moves up and down in selecting the row in which each character to be printed is located. Lower case characters are in the left half of the box and upper case characters are in the right half. The type box moves left and right on shifting and unshifting operations, rather than in the familiar up-and-down motion of carriage shifting on the typewriter and older teletypewriters. This combined vertical and horizontal motion brings the character to be printed into line with the printing hammer. There are two pointers on the type box, the LTRS pointer on the left and the FIGS pointer on the right. When typing stops, the pointer at which the printing hammer is aimed indicates where the next character will be printed. If the printing hammer is aimed at the LTRS pointer, the type box is in lower case. If the printing hammer is aimed at the FIGS pointer, the type box is in upper case. An operation shifting the type box to upper or lower case moves the corresponding pointer to the typing location.

Operating Features

To raise the cover for access to the typing unit to change paper and ribbon or to clean type, press the cover release pushbutton and lift the cover. To raise the lid for access to the paper, press the lid release pushbutton and lift the lid. To turn the paper up or down, raise the

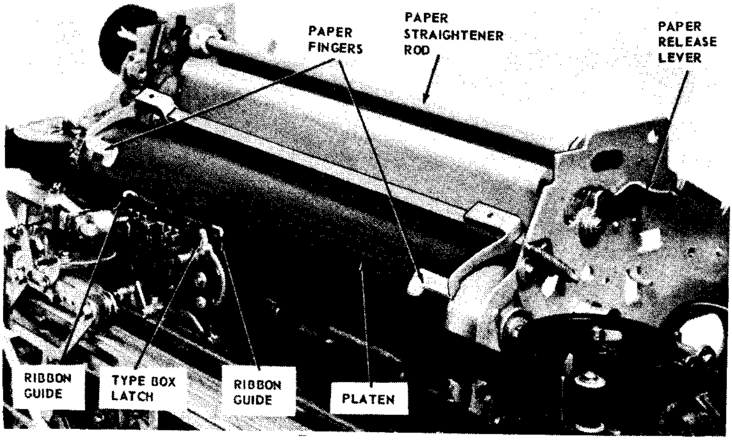


Figure 9–25.—Old roll removed.

cover, and press and hold down the platen handwheel (so that it engages the platen ratchet wheel) while turning it in the desired direction. Do not attempt to hold down or operate the platen handwheel while the teletypewriter is operating. To adjust the paper, raise the lid, push back the paper release lever to free the paper, straighten the paper, and pull the lever forward to its normal position. To set the line spacing for single or double space, raise the lid, press the line space lever to the left and pull it forward for single space or push it back for double space. To space to a desired location for typing, space the type box over until the LTRS pointer is at the desired typing location. Then if upper case is desired, operate the FIGS key.

Changing Paper

To insert a new roll of paper in the Model 28, first shut off the power. Press cover release pushbutton and lift cover. (Refer as necessary to figs. 9–25 and 9–26.) 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. Re-

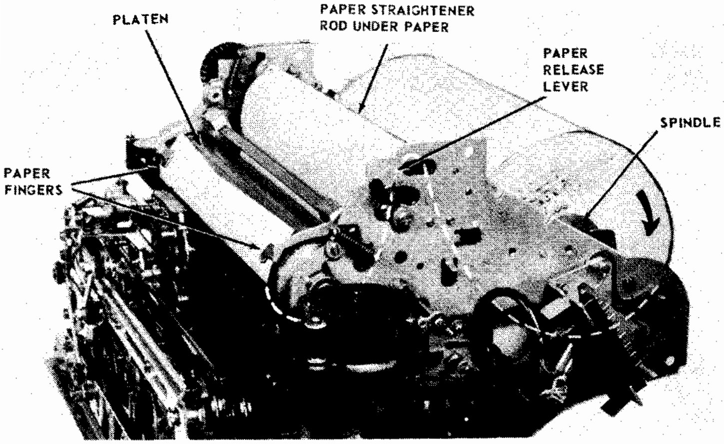


Figure 9–26.—New roll inserted.

place spindle in spindle grooves with paper feeding from underneath roll toward you. 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 you would straighten paper in a typewriter. Then lower paper fingers onto paper and pull paper release lever forward.

While inserting paper, care should be taken not to disturb the ribbon or the type box latch. After paper is in place, check to see that the ribbon is still properly threaded through the ribbon guides. Also check to make certain the type box latch has not been disengaged. It should be on 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 on top of it.

Changing Ribbon

Use a standard teletypewriter ribbon or, if hectograph reproduction is desired, a hectograph typewriter ribbon.

Press cover release pushbutton and lift cover. (Refer as necessary to figs. 9–27 and 9–28.) Lift ribbon spool locks to a vertical position, and remove both spools from ribbon spool shafts. Remove ribbon from ribbon rollers, ribbon levers, and ribbon guides. Unwind and remove old ribbon from one of the spools. Hook end of new rib-

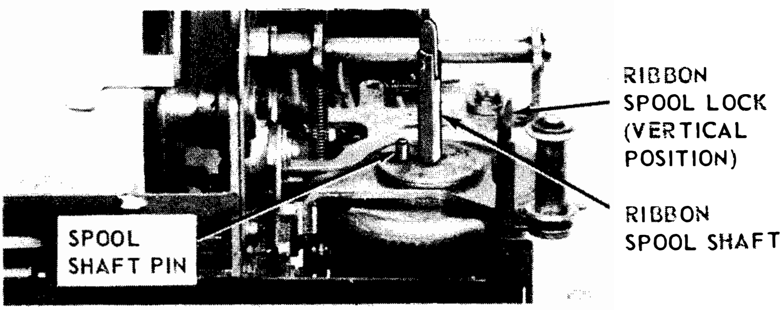


Figure 9–27.—The spool mechanism.

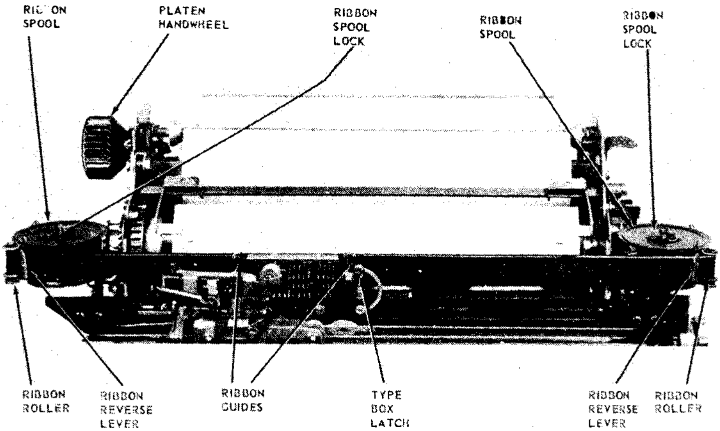


Figure 9–28.—Ribbon, inserted.

bon to hub of empty 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 which should be used to pierce the ribbon near its end.

Replace spools on ribbon spool shafts, making sure they go down on spool shaft pins, and that the ribbon feeds from the outside 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.

Cleaning Type

When printing is smudged the type should be cleaned. You must remove the type box from the machine. Open cover and unlock type box latch by moving it to the right (see fig. 9–29). Grasp handle on right side of type box, and raise that side up and to the left until the type box

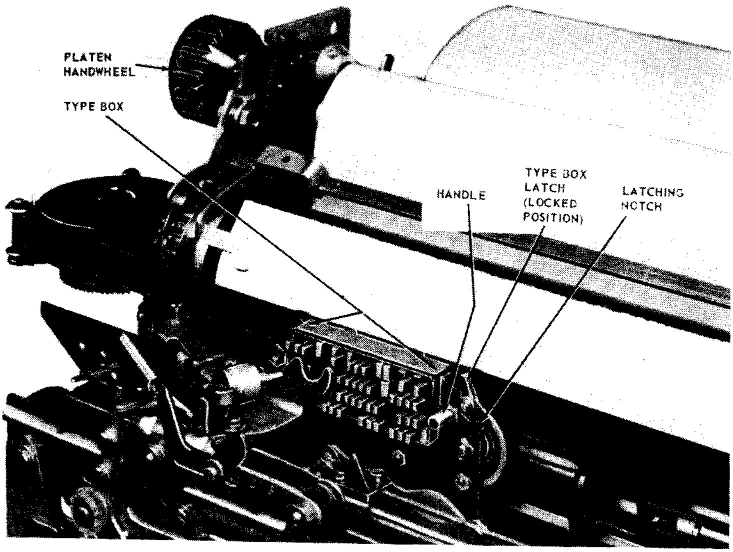


Figure 9–29.—Type box in place.

unhooks on the left side and can be freed from type box carriage. Turn type box over to side with type (fig. 9–30) and clean with a dry, hard-bristle brush. DO NOT use type cleaning solution.

To replace type box, hold it with type toward platen and the large hook on the left. Slip this hook under stud in front of left type box roller, and push smaller hook on right side down into place on stud in front of right type box roller. Hold type box latch in horizontal position and move to left over latching notch as far as it will go. Raise

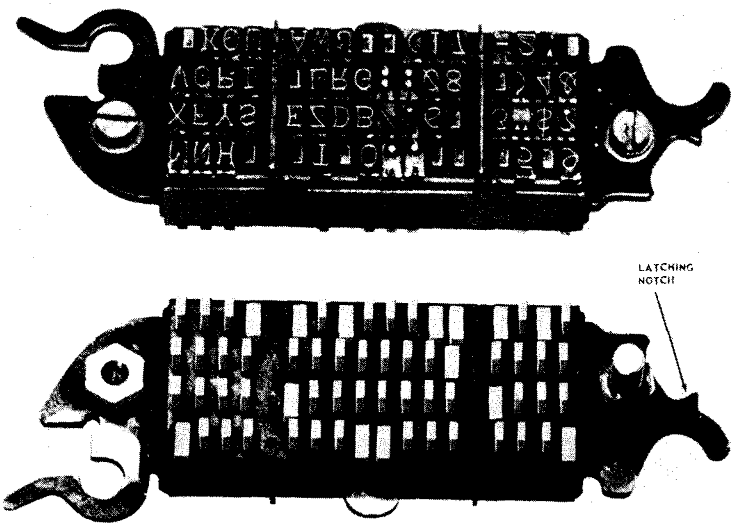


Figure 9–30.—Type box, front and back.

latch to vertical, and press to left until it locks into latching notch. Check to see that the ribbon is still properly threaded.

TELETYPEWRITER SERVICE TROUBLES

Here are some of the more common service troubles you may encounter, with a brief description of how they may be recognized, their causes, and what action the operator may take to correct them.

Model 19

MACHINE WILL NOT START. See that the plug on the power cord from the teletypewriter is pushed all the way into the outlet. Make sure the power supply has not failed. This may be indicated by failure of your lighting system.

UNABLE TO COMMUNICATE WITH OTHER OFFICES. Make sure the SEND-REC lever is in the SEND position. Be sure the line switching key is positioned correctly

IDLE PERIODS OF UNUSUAL LENGTH. Make the same check as above. If the idle period extends unreasonably, notify your supervisor.

PRINTER RUNS "OPEN." This trouble may be recognized by the machine operating continuously without either printing or spacing. The machine also appears to run faster than during normal operation. Shift the line switching key to the middle of TEST position. In a standard Model 15 printer, remove plugs from the circuit jacks, and insert them in the test loop. If this causes the machine to become idle, it is an indication that the trouble probably is in the incoming signal circuit.

PRINTING ERRORS. When printing errors occur which obviously are not typographical, some comparisons may be made to determine whether the trouble is in the machine or the circuit. If the errors occur when you are sending, operate the line switching key to the middle position (or plug in the test loop) and try the machine. If the same errors occur, the trouble probably is in the machine.

If you have a spare machine, connect it to the circuit. If errors occur on both machines, the trouble is in the circuit. If the errors occur on only one of the machines, the trouble is probably in that machine.

For errors when receiving, connect a spare machine to the circuit. As above, errors on the spare machine indicate circuit trouble, and correct copy from the spare machine indicates that the first teletypewriter is causing the trouble.

RIBBON TROUBLES. If the ribbon is feeding and the printing is faint, a new ribbon is needed. If the ribbon is not feeding, make sure it has been placed in the machine correctly.

PAPER FEED TROUBLES. This is indicated by the paper either feeding to one side, not feeding, tearing, or jamming. Make sure that the paper has been placed in the machine as previously outlined. See that too much paper has not accumulated behind the unit. The paper may not have been torn correctly. If superfold paper is used, see that the container holding the paper is properly located.

UNABLE TO SEND WITH TD. Make sure the tape has been properly placed in the transmitter-distributor. Check to see that the transmitter switch is on, and that the tape stop lever is down. See that feed holes in the tape are not mutilated.

TAPE FEED TROUBLES WHILE PERFORATING. Make sure tape is feeding freely off the roll, and that it has been placed in the machine correctly. See that the chad box is empty and the chad chute has not clogged.

Model 28

MOTOR DOES NOT START. Check for a power or fuse failure. If a fuse is open, rotate the motor by hand and check for excessive bind.

FAILURE ON LINE FEED. There may be binds in the moving parts of linkage for line feed function. Check these parts for freeness.

FAILURE TO PRINT. This may be due to binds in the printing carriage assembly. Check for freeness in moving parts, and for missing springs. Another source of this trouble may be the improper installation of the ribbon.

RIBBON FAILS TO FEED OR REVERSE. Check for binds in the moving parts of ribbon feeding or reversing mechanism.

NO SIGNALS FROM KEYBOARD. This trouble may stem from either an open or a closed signal line. The contacts should be checked to determine if they are dirty or shorted.

INTERMITTENT ERRORS. This trouble may have a variety of sources. Among them are inadequate or excessive line current, range finder set beyond range limits, or incorrect adjustments.

The troubles presented here are only a representative sample of those that may be encountered. The instruction books give a more thorough coverage and include helpful charts to aid in tracking down the trouble.

ASSOCIATED EQUIPMENTS

Typing Reperforator

The equipment which produces partially perforated, chadless tape is called the TYPING REPERFORATOR. Maintenance men and operators frequently refer to this equipment as the "reperf." Normally you will find it used for receiving only, but it can be set up for transmitting.

Figure 9–31 shows a Model 14 typing reperforator (receive only) used extensively for receiving messages from a circuit in tape form. Messages so received can, if circumstances require, be retransmitted over other circuits by automatic equipment. As its name indicates, a typing reperforator types the characters on the tape as well as perforates.

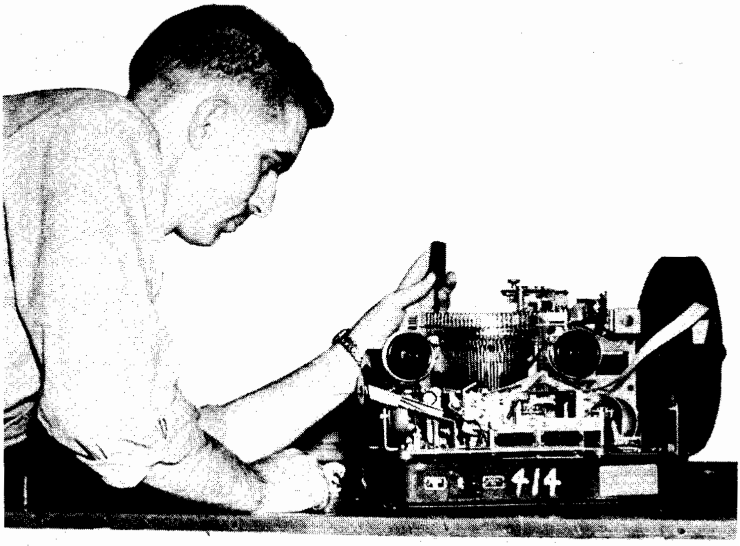


Figure 9–31.—Model 14 typing reperforator (receive only).

The traffic volume relayed by NAVCOMMSTAS, and many of the smaller shore stations has led to the development of tape relay equipment that requires a minimum of operator attention. At right in figure 9–32 is a receiving bank or console package, which houses several

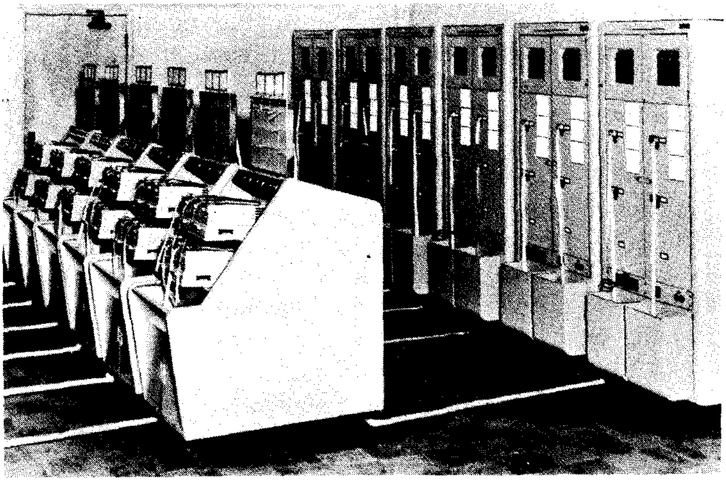


Figure 9–32.—Sending and receiving consoles.

typing reperforators for use on incoming lines in relay centers. The operator determines the proper outgoing circuit from address information on the tape. He then hand-carries each tape to the appropriate sending bank of automatic transmitter-distributors (at left) and inserts it in the designated circuit tape grid (visible at tops of sending banks). The tape grid—sometimes called a washboard owing to a certain similarity of appearance —is simply a place where tapes can remain during the period they are awaiting retransmission. They are stowed from top down in order of precedence. A second operator in attendance at the sending bank removes waiting tapes from the grid in order of precedence, and inserts them in the TD's. A numbering TD applies a sequential number to each message, thus keeping a record of traffic relayed over each channel.

If duplicate copies of relayed traffic are required for the files, monitoring equipment (not shown in fig. 9–32) is used. This is a group of typing reperforators which produces duplicates of tapes undergoing transmission on the sending bank, and winds the monitor tapes on reels suitable for stowage. The monitoring equipment also duplicates the channel number for each message, providing a means of reference should the message be needed in the future.

Tape Factory

Although only one copy of a tape message is received, routing instructions often require it to be relayed over several circuits. To avoid the delay of running a single tape through several TD's, duplicates are made by putting the tape through duplicating reperforators called a TAPE FACTORY. As many as six copies can be made at one time. If more than six are needed, the process is repeated.

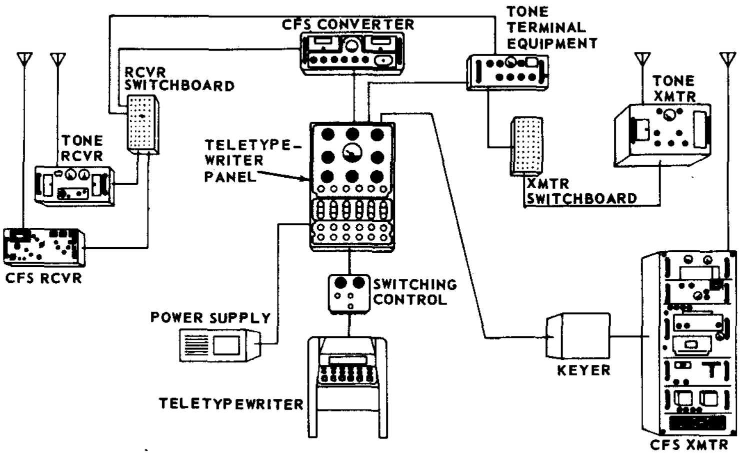


Figure 9–33.—Basic RATT transmit-receive system.

The Navy uses two RATT systems afloat. One, the TONE-MODULATED SYSTEM for short-range operation, is similar to the familiar AM radio. The other, the CARRIER-FREQUENCY SHIFT SYSTEM for long-range operations, is similar to the standard FM radio. The two systems are shown integrated in figure 9–33.

The page printer—Model 15 or 28—sends out a continuity of direct-current on-and-off pulses (timed intervals of current and no-current). These intervals are, as you know, mark and space impulses, and various combinations represent the various characters being transmitted.

When two teletypewriters are wire-connected, the exchange of intelligence between them is direct. But when the teletypewriters are not joined by wire, operation is more complex. Direct-current mark and space intervals cannot be sent through the air.

The gap between the machines must be bridged by radio. To bridge the gap, a radio transmitter and receiver are needed. The transmitter produces a radio-frequency carrier wave to carry the mark and space intelligence. Also, a device such as a KEYER is needed to change the DC pulses from the teletypewriter into corresponding mark and space modulation for the carrier wave in the transmitter. The radio receiver and a CON-

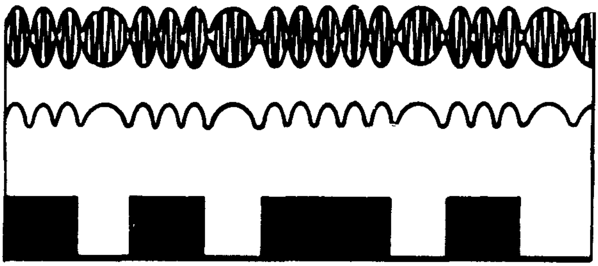


Figure 9–34.—Modulated carrier wave with corresponding audio electrical impulses with mark and space signals.

VERTER are required to change the radio-frequency signal back to DC pulses.

The differences in the Navy's two RATT systems, as well as their names, are derived from the nature of the carrier wave used. The tone-modulated carrier wave is for short-range work, and the carrier-frequency shift system is for long-range work.

Figure 9–34 shows a modulated carrier wave with audio tone impulses impressed on the radio-frequency carrier wave, with corresponding DC mark and space signals.

Figure 9–35 shows a carrier-frequency shift wave which increases and decreases to denote mark and space DC impulses.

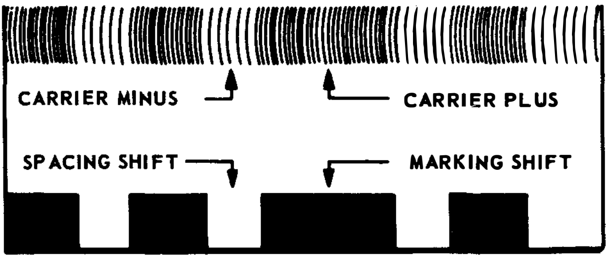


Figure 9–35.—Frequency of the carrier wave increases and decreases corresponding to mark and space signals.

In the operations shown in figures 9–34 and 9–35, the DC teletypewriter signal that can travel only by wire becomes, through the medium of a tone terminal or keyer unit, either a tone-modulated signal or a carrier-frequency shift signal for radio carrier wave transmission.

Short-Range System

To transmit messages by the short-range system, a page printer, a tone terminal, and a transmitter are used. The printer sends out a DC signal. The signal is changed to audio tones in the tone terminal. The transmitter im-

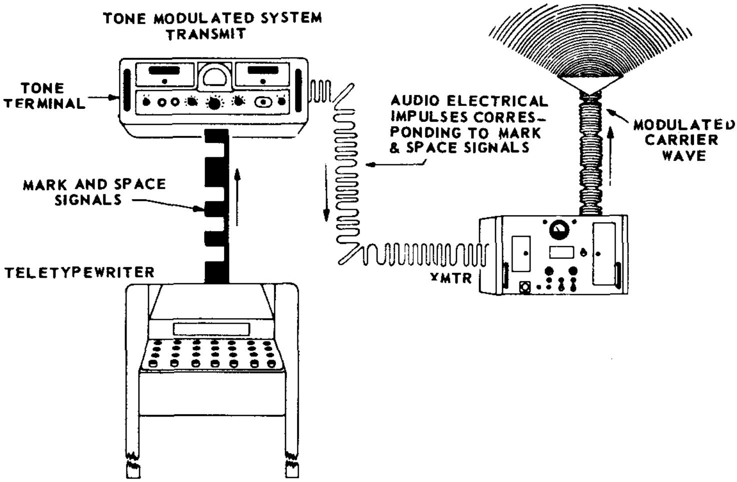


Figure 9–36.—DC mark and space signals converted to audio tones and impressed on carrier waves.

presses the audio tones on the carrier and sends out a tone-modulated carrier wave (fig. 9–36).

To receive messages with the short-range system, a radio receiver, a tone converter, and a page printer are required. The tone-modulated carrier wave enters the receiver, which extracts the signal intelligence and sends the audio tones to the tone converter. The converter changes the audio tones into DC mark and space pulses for the page printer (fig. 9–37).

In practice the same tone terminal is used for the receiving and the sending circuits since it contains both a transmit "keyer" unit and a receiver "converter" unit.

Long-Range System

At the transmitting end of the long-range system are a page printer, a transmitter, and a frequency shift keyer unit. The keyer unit is built into the newer transmitters, but in some older systems it is a separate piece of equipment. When the page printer is operated, the DC mark

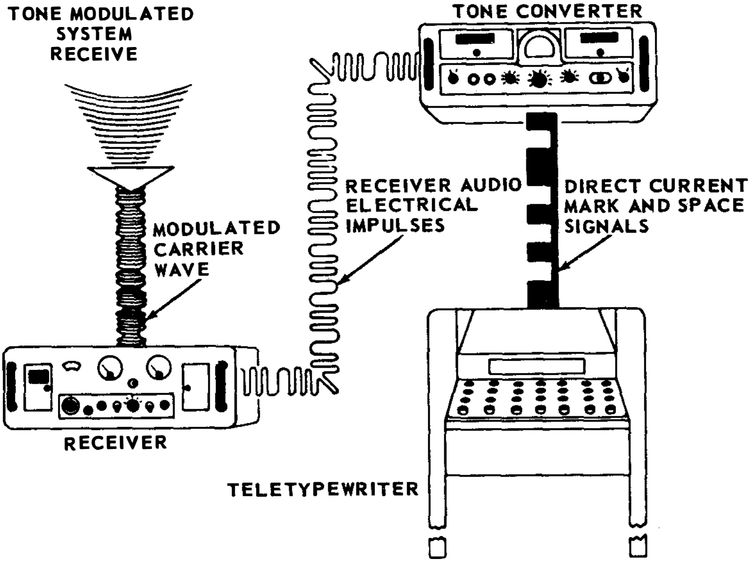


Figure 9–37.—Operation of the tone converter.

and space signals are changed by the keyer unit into frequency shift intervals. The frequency shift intervals are transmitted as carrier-frequency shift signals (fig. 9–38).

On the receiving side of the long-range system are a receiver, a frequency shift converter, and a page printer. When the carrier-frequency shift signal enters the receiver, it is detected and changed into a corresponding frequency-shifted audio signal. The audio output of the receiver is fed to the converter, which changes the frequency-shifted audio signal into DC mark and space signals (fig. 9–39).

When the carrier-frequency shift system is combined with the tone-modulated system, several more pieces of equipment are needed—a teletypewriter panel, a power supply, a switching control, a transmitter switchboard, and a receiver switchboard.

The teletypewriter panel is capable of handling six

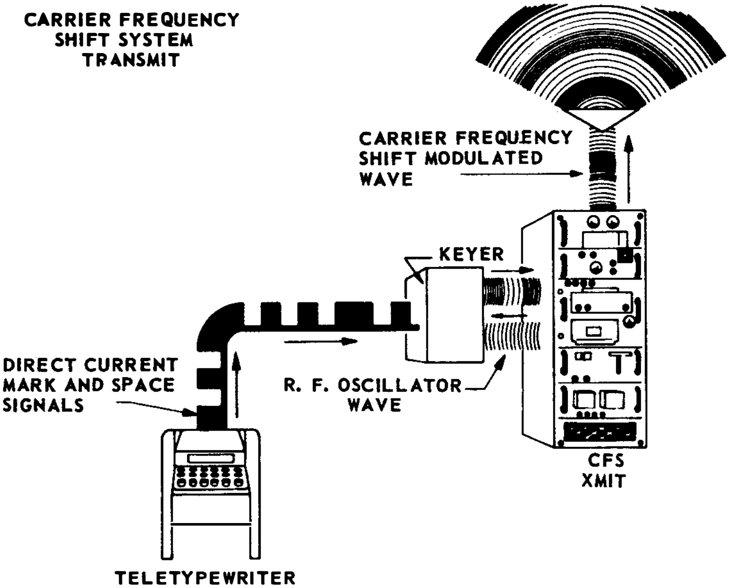


Figure 9–38.—DC mark and space signals are changed by the keyer unit into frequency shift intervals (nominal carrier plus and minus).

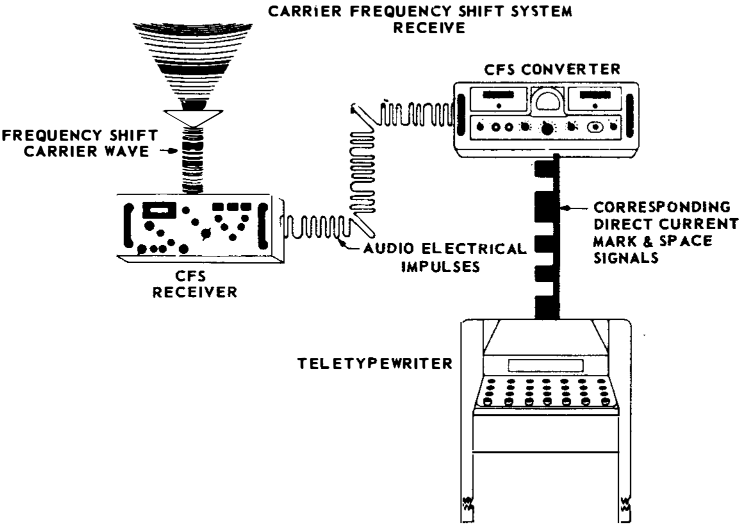


Figure 9–39.—Conversion of frequency-shifted carrier wave into mark and space signals.

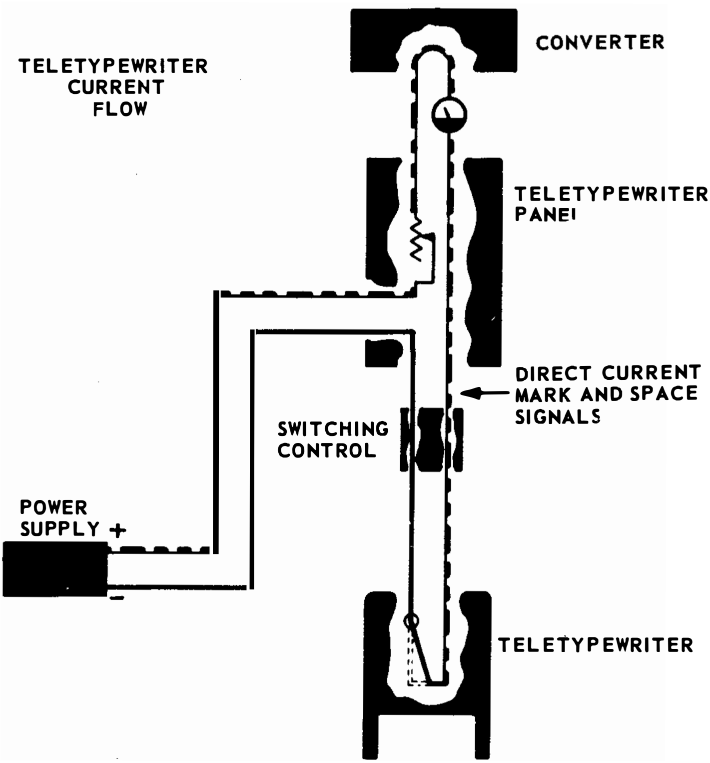


Figure 9–40.—One complete loop, with the electron flow from the negative to the positive side of the power supply.

channels, or LOOPS. The power supply furnishes the direct "looping" current for all teletypewriter DC signals. The switching control, located at the page printer, is used to select the system desired. The transmitter switchboard and the receiver switchboard are used to integrate the RATT systems with other communication systems on board ship. Integration of the various systems results in a compact and flexible installation.

The teletypewriter panel interconnects the page printer with all the different radio keyers and converters as shown in figure 9–33. The teletypewriter panel controls the direct looping current channels. Figure 9–40 is a diagram of one teletypewriter loop.

When the teletypewriter system is in operation, the electron current—which flows from negative to positive—flows from the negative side of the power supply through the teletypewriter panel, through the page printer, back through the teletypewriter panel, into a converter or keyer unit, through the teletypewriter panel a third time, and from there to the positive side of the power supply.

When the DC loop is alternately opened and closed by the page printer or one of the converters, the result is current and no-current or mark and space intervals that characterize the DC teletypewriter signal. This is what happens in all of the DC loops in both of the Navy's RATT systems.

The looping current is controlled by a rheostat in the teletypewriter panel. A common power supply is used for all teletypewriter panels in shipboard installations. In the front panel of the cabinet each of the six channels, or circuits, has a pair of looping jacks, a set jack, and an additional jack for miscellaneous teletypewriter requirements.

The numerous terminal and patching connections in the teletypewriter panel provide many different circuit possibilities. For instance, a keyer or converter circuit that terminates in channel 2 can be patched across to channel 5 to connect with teletypewriter equipment that ends there. A dummy plug is used to short out the unwanted portion of the circuit.

In both the tone-modulated system and the carrier-frequency shift system, all teletypewriter signals pass through the teletypewriter panel that controls the looping current in all the circuits. The teletypewriter panel integrates the tone-modulated and the carrier-frequency shift systems. It provides every possible RATT interconnection available on board ship. This operational flexibility gives maximum efficiency with the fewest circuits and the least amount of equipment in the Navy's compact RATT systems afloat.

TAPE READING

In order to read perforated tape, you must understand arrangement of code positions. The code is a 5-unit mark-space signaling code arranged vertically on the tape, from the No. 1 position at the top to the No. 5 position at the bottom. A hole is a mark; no hole is a space. Between the second and third positions there is a tape feed perforation (TRACK) which is smaller than the code perforation (see fig. 9–41). This smaller perforation fits over the tape feed wheel which moves the tape through the transmitter-distributor, and is NOT a part of the code. The upper side of the tape usually has a slight roughness made by the hole-punching pins. Read the tape with this side uppermost. Use the track as a visual guide. Remember, no more than two perforations will appear above the track, nor more than three below. In figure 9–41 the positions are numbered from 1 to 5. This is for study purposes; don't expect these numbers to appear on an actual tape.

The LTRS code contains perforations in all five positions. Codes other than LTRS and BLANK contain perforations in different combinations of positions; A for instance is 1–2, B is 1–4–5, and C is 2–3–4.

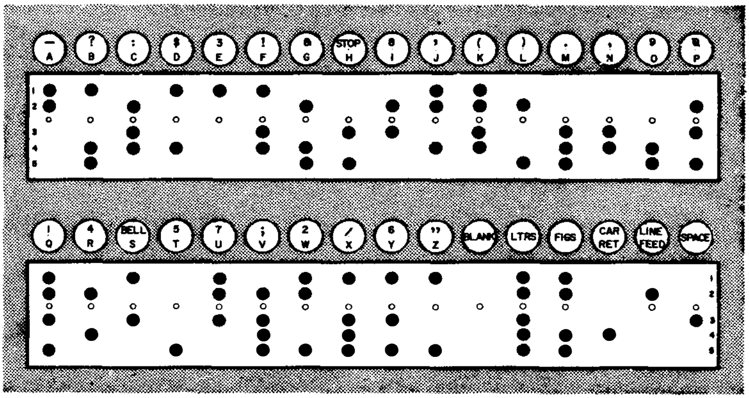


Figure 9–41.—The 5-unit teletypewriter code.

Read the perforations in lower case until a FIGS code appears. Following a FIGS code read the tape as upper case until a LTRS code appears, after which read as lower case again. On circuits on which machines unshift on spacing, read codes in lower case following the space code.

Memorize several codes at a time, learning the upper case characters for each. Perforate strips of tape and read the codes you have memorized. Association of memory and eye will help you recognize codes quickly and will build reading speed.

The discussion and illustrations following provide a study plan for learning the code. Begin by learning the 1-HOLE codes: E, LF, SPACE, CAR RET, and T. E is perforated in the No. 1 position and the remainder of the positions are blank. LINE FEED is one perforation in the No. 2 position—and so forth, down to T which is perforated in the No. 5 place. Keep this pattern in mind. Perforate these codes several times on a tape to help remember them.

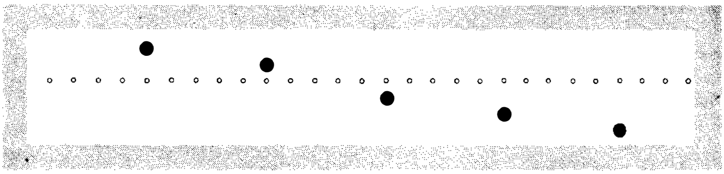


Figure 9–42.—The 1-hole codes: E, LF, SPACE, CAR RET, and T.

Your next group is of three key letters: A, O, and N. Check figure 9–43. The letter A is represented by two holes above the track. This pattern—two holes above the track—is also characteristic of U, J, and W; read DOWN to find which. In the same way (fig. 9–44) O is common to M, G, and B, but this time read UP to get the associated codes. The final letter of this series is N (fig. 9–45), which you read up for C and F.

With this much mastered, get plenty of practice before

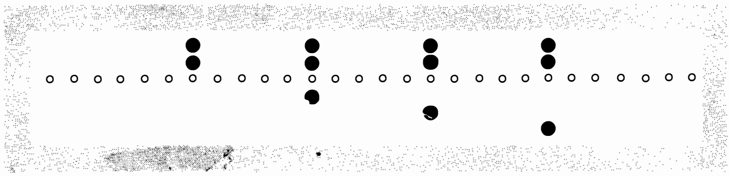


Figure 9–43.—A, U, J, and W.

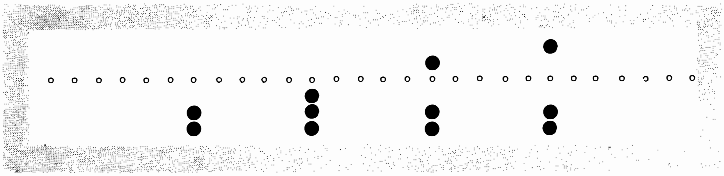


Figure 9–44.—O, M, G, and B.

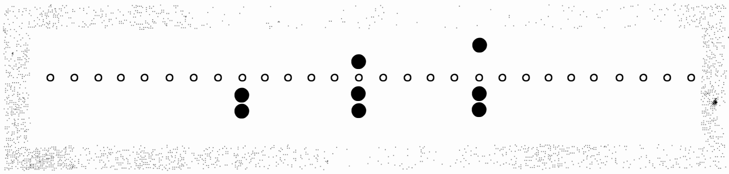


Figure 9–45.—N, C, and F.

learning more letters. Perforate the codes and, as your reading improves, mix them to make the reading more difficult. Emphasize ACCURACY, not speed. If you haven't the opportunity to work with a perforator, draw the codes on 3 x 5 cards (with answers on back) and scramble them.

You can learn three more sets of letters by using the track line for a guide. Read I (one hole above and one below the track line) and retain it as a reference point for reading D or Z (fig. 9–46). Learn R and use it to read L; learn Y and read P (fig. 9–47).

There are eight letters which you can master by remembering them as opposites: Q and X, V and K, H and S, E and T (figs. 9–48 and 9–49). E and T, remember, are also among the 1-hole codes.

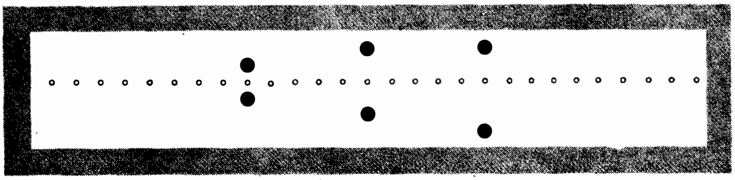


Figure 9—46.—I, D, and Z.

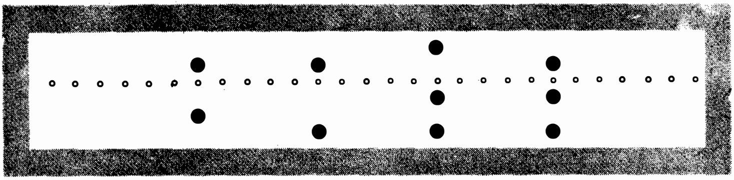


Figure 9—47.—R and L; Y and P.

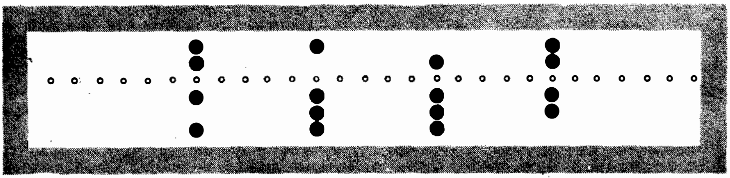


Figure 9—48.—Q and X; V and K.

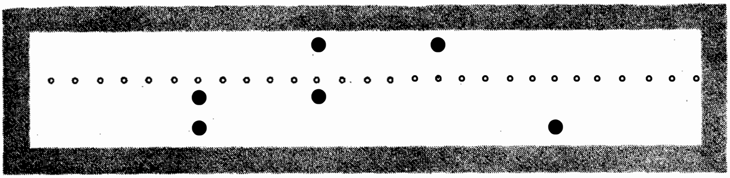


Figure 9—49.—H and S; E and T.

Two keys you will use a great deal are LTRS and FIGS, which shift your machine into lower and upper case. The LTRS code is easy to recognize for it is the only one with five perforations. The FIGS code resembles it in that there are two perforations above the track, and two below, with only the No. 3 position blank.

QUIZ

1. How many units are there in a teletypewriter signal?
2. How much transmission time does each unit in a teletypewriter signal require?
3. Basically, there are 32 combinations of the five intelligence units. A teletypewriter transmits 58 characters (or operations). How can you account for this?
4. As an operator, which component of distortion is of most interest to you?
5. What are the two types of range orientation?
6. What is the principal value of the start-stop method?
7. How much time, theoretically, is required for a transition?
8. Name the 1-hole codes in order of their positions (top to bottom) on perforated tape.
9. Which code has perforations in all five positions?
10. The code for the letter A with two holes above the track is common to what other three letters?
11. The code for the letter I may be used as a reference point for what other letters?
12. In tape reading, what eight letters can be remembered as opposites?
13. What is meant by the expression "lettering out"?
14. What action is necessary to interrupt a line teletypewriter sending station?
15. How can you tell that the paper is running out on a teletypewriter printer?
16. What are the two types of paper feeds on a Model 15 printer?
17. What is a receiving bank or console?
18. What is a "washboard"?
19. The standard tape factory is able to produce how many copies of a tape in a single run?
20. How can you tell when a printer is running open?
21. What is the term used to indicate teletypewriter messages in page form?
22. Name the two types of keyboards.
23. When you transmit from a teletypewriter keyboard, what two keys should be used as guides?
24. What is meant when you speak of a key performing a functional or nontyping operation?
25. How many characters in the standard teletypewriter line?

26. What is the difference between chad and chadless tape?
27. What is contained in the partial fourth row of keys on the Model 28?
28. What component of the Model 28 actually produces printing?
29. What should be used to clean the type in the Model 28?
30. What are the two systems used afloat to send and receive teletypewriter messages by radio?

CHAPTER 10

TELETYPEWRITER PROCEDURE

As you learned in chapter 1, the Naval Communication System includes all shore-based communication activities and the landlines and radio circuits that bind them into a worldwide network. This network is the Naval Teletypewriter and Tape Relay System—often called the NTX System. It is shown in figure 10–1.

NTX COMMUNICATION ACTIVITIES

Communication Center

A COMMUNICATION CENTER (COMMCEN) is an activity charged with responsibility for receipt, transmission, and delivery of messages in any form or by any means necessary. It is generally composed of a message center, relay station, cryptocenter, and transmitting and receiving stations as required. Although transmitting and receiving stations are often miles away from the communication center itself, positions for remote control of these facilities are usually found near the message center to facilitate traffic handling.

Message Center

A MESSAGE CENTER is responsible for the acceptance, processing, receipt, and delivery of messages. Although a message center is often found as a component part of some COMMCEN, message centers also operate independently, serving outlying areas as tributary stations.

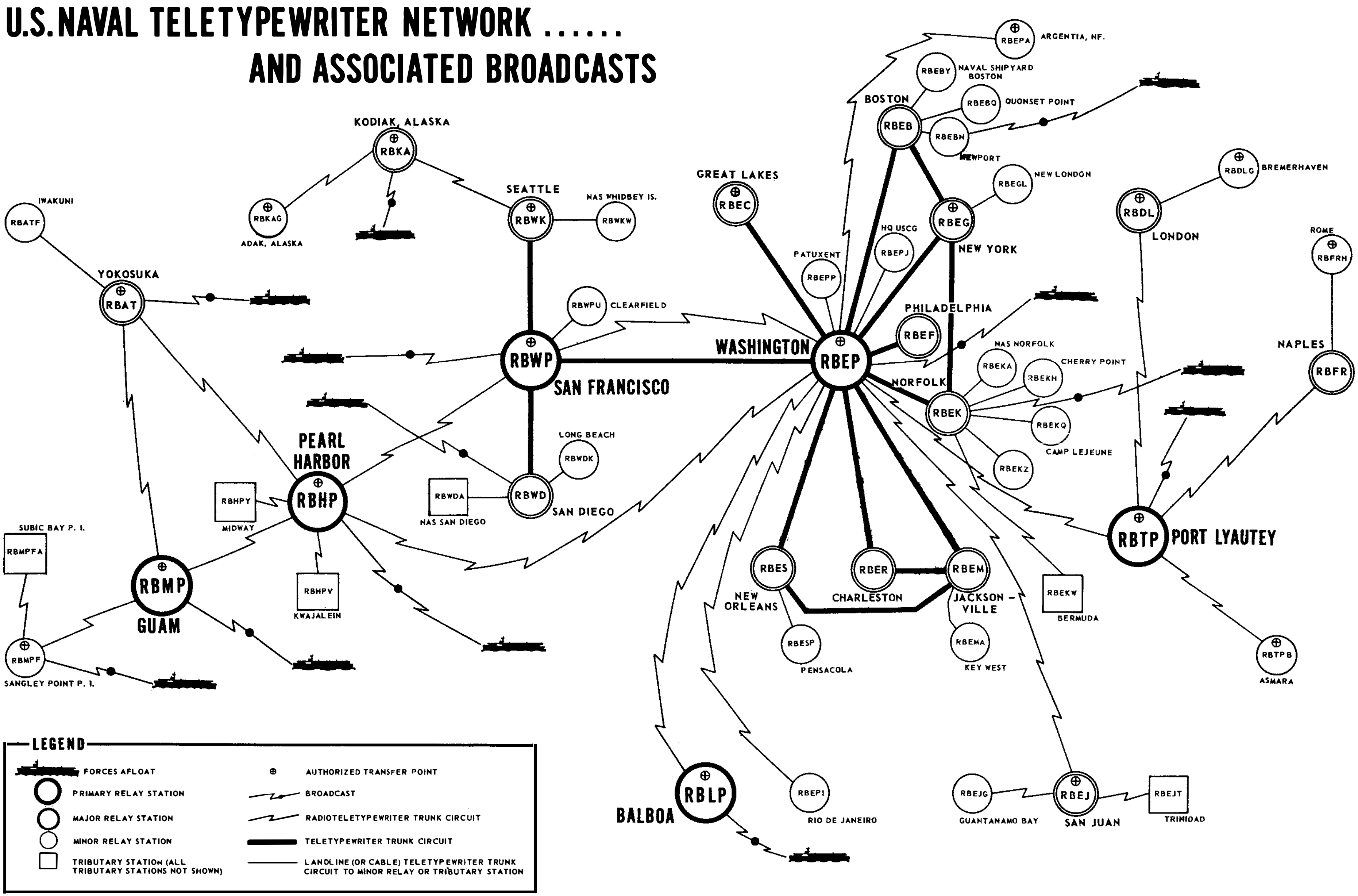


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Figure 10–1.—U.S. Naval Teletypewriter Network and associated broadcasts.

Tape Relay Station

A TAPE RELAY STATION is an activity which receives and forwards messages in tape form by means of semiautomatic and automatic relay equipment. It is always found as a component part of a COMMCEN, and never operates independently. Although relay stations are assigned routing indicators, they do not originate messages (except those relating to traffic handling) or receive them as addressees. These functions are handled by the message center which belongs to the same COMMCEN as the relay station.

Tributary Station

A TRIBUTARY STATION is an activity electrically connected to the tape relay network through some relay station. Tributaries themselves have no relay responsibilities. They receive messages in hard copy form and make final delivery to addressees, and they accept and forward messages originated locally. You may think of a tributary as an independent, outlying message center.

COMMUNICATION CENTERS

The major activities of the Naval Communication System are (1) primary communication centers, (2) major communication centers, (3) minor communication centers, and (3) tributary stations (independent message centers).

Primary COMMCENS

There are six primary COMMCENS strategically located throughout the world. Here they are, with their call signs and the routing indicator of each associated relay station:

Location	*Call sign*	*Routing indicator*
1. Washington, D. C.	NSS	RBEP
2. San Francisco, Calif.	NPG	RBWP
3. Honolulu, T.H. (Pearl Harbor)	NPM	RBHP
4. Guam, Marianas Is.	NPN	RBMP
5. Balboa, Panama Canal Zone	NBA	RBLP
6. Port Lyautey, Fr. Morocco	NHY	RBTP

These primary COMMCENS maintain all, or part, of the following communication facilities:

1. Multiplex or single sideband trunk circuits with one or more of the other Navy primary stations for the purpose of relaying tape traffic. There are also circuits with primary Army and Air Force stations in the same area.
2. Primary fleet broadcasts, for their respective areas, by RATT, radiotelegraph, or both.
3. Primary general broadcasts to the fleet and merchant marine. General broadcasts deal with such matters as time signals, weather, hydrographic warnings, notices to mariners, press, and messages for merchantmen.
4. Ship-to-shore circuits for acceptance of traffic from fleet units in the area.
5. Appropriate local harbor circuits as necessary.
6. High-power RATT duplex circuit, available upon request to fleet and force commands.
7. Continuous watch on international distress frequencies.
8. Connections with local commercial communication companies for the purpose of maintaining liaison and commercial refile facilities.

Major Communication Centers

Major communication centers, though large activities, as a rule do not handle the traffic volume of primary centers, nor do they maintain so many services. Following is a list of the major COMMCENS, their call signs, and the routing indicator of each associated relay station:

	Location	*Call sign*	*Routing indicator*
1.	Boston, Mass. (COMONE)	NAD	RBEB
2.	New York, N. Y. (COMTHREE)	NAH	RBEG
3.	Philadelphia, Pa. (COMFOUR)	NAI	RBEF
4.	Norfolk, Va. (COMFIVE)	NAM	RBEK
5.	Charleston, S. C. (COMSIX)	NAO	RBER
6.	New Orleans, La. (COMEIGHT)	NAT	RBES

7.	Great Lakes, Ill. (COMNINE)	NAJ	RBEC
8.	San Juan, P.R. (COMTEN)	NAU	RBEJ
9.	San Diego, Calif. (COMELEVEN)	NPL	RBWD
10.	Seattle, Wash. (COMTHIRTEEN)	NPC	RBWK
11.	Kodiak, Alaska (COMSEVENTEEN)	NHB	RBKA
12.	Jacksonville, Fla.	NIP	RBEM
13.	Yokosuka, Japan	NDT	RBAT
14.	London, England	NST1	RBDL
15.	Naples, Italy	NNI	RBFR

Major communication centers maintain some or all of the following service facilities, either in an active or standby status:

1. Secondary fleet broadcasts for local area coverage to relieve the load on primary broadcasts.
2. Secondary general broadcasts as necessary.
3. Ship-to-shore guard, international distress guard, and high-power duplex RATT circuits as necessary to meet fleet requirements.
4. Landline or RATT links with primary COMMCENS in the area, plus links with minor COMMCENS and tributaries in the immediate vicinity.
5. Standby equipment to assume primary fleet broadcast schedules in case of casualty to the primary COMMCEN in the area. (Maintained only by certain specified stations.)

Minor Communication Centers

Minor COMMCENS are located wherever the load of traffic warrants. In some cases they maintain fleet broadcasts for particular areas, and provide other communication facilities according to the needs of the locality. They are connected with primary or major COMMCENS by RATT or landline circuits, or both.

Tributaries

Tributaries, as we have seen, are independent message centers. They are the points from which a large part of

NTX traffic originates, and to which it eventually goes for final delivery to addressees. Tributaries may be located wherever there are Navy activities that need the services of the NTX System. Typical places are depots, receiving stations, and training centers. Even a flagship docked for long periods may temporarily become a tributary.

ROUTING INDICATORS

Construction

In order to move tape relay traffic efficiently from one point to another, each station in the U.S. and Canadian teletypewriter systems is designated by a ROUTING INDICATOR. An indicator is made up of a group of from four to eight letters, following a specific pattern, to indicate whether it is U.S. or Canadian, the service to which the station belongs, its geographic area, and the type of relay station it is.

The first letter of a routing indicator is either R or U. These letters, in that order, show whether the message will be handled by the worldwide communication network or whether it will travel over a net serving some local area. Messages with routing indicators beginning with U do not enter the worldwide system.

The second letter identifies the communication system of each nation and service. Those of the United States and Canada are as follows:

A—Canadian Army.
B—United States Navy.
C—Royal Canadian Navy.
F—Royal Canadian Air Force.
J—United States Air Force.
U—United States Army.

The third letter indicates the geographical location in which a station is located, or from which it is served. There are 14 such areas. Following is a list of the letters used to designate each.

A—Eastern Asiatic area, including Japan and Korea.

M—Southwest Pacific area, including the Philippines and Marianas.

Y—Australian-New Zealand area.

K—Alaskan-Aleutian area.

H—Central Pacific area, centered on the Hawaiian Islands.

W—Western United States and Canada; Mexico.

E—Eastern United States and Canada; Greenland.

L—South American and Caribbean areas.

D—British Islands and Iceland.

F—European area.

T—Northwest African area.

Q—East African, Arabian, Turkish, and Iranian areas.

V—South African area below equator.

S—Western Asian area, including India.

Zone boundaries are laid out according to latitude and longitude, but in spite of area boundaries a tributary must carry the same area designator as the parent relay station regardless of location. The separation line between E and W zones runs on a line between Chicago and New Orleans and thence due south, but the Naval Mission COMMCEN in Rio de Janeiro, Brazil, for instance, is assigned a routing indicator from primary relay Washington.

Fourth and subsequent letters (except for any special suffixes) designate relay and tributary stations. Primary Navy stations are always indicated by P as the fourth letter. Any OTHER letter as the fourth letter indicates a major relay station. (Although B is assigned as fourth letter to the major relay station in Boston, and some alphabetical connection can be seen in some of the other assignments, they are not assigned alphabetically.)

Following is a breakdown of the routing indicator for a primary station, RBHP, and a major station, RBAT.

R—World wide network;

B—Navy facility;

H—Central Pacific;

P—Primary relay station (Pearl Harbor).

R—World-wide network;

B—Navy facility;

A—Eastern Asia;

T—Major relay station (Yokosuka, Japan).

A routing indicator containing only four letters always indicates a primary or major relay station. There are twenty-one 4-letter routing indicators in use in the NTX System. They indicate the six primary relay stations and the 15 major relay stations. You have been given the geographic location of these stations and their indicators. LEARN THEM. These 21 routing indicators form the basis for every routing indicator in the NTX System. If you master them you will have little trouble in routing or relaying NTX messages.

Fifth and subsequent letters of a routing indicator designate a minor relay station, or a tributary of some primary or major relay station. You will have to look it up to find which. A minor relay station will always have a 5-letter routing indicator, the first four letters of which are identical to the indicator of the primary or major station into which it feeds. The minor relay station RBKAG at Adak, Alaska, for example, feeds into the major relay station RBKA, Kodiak.

Routing indicators simplify message handling because operating personnel do not need to look up locations of distant addressees to relay the message properly. Assume that the Bureau of Yards and Docks originates a message to the Construction Battalion Center, Davisville, R. I.—served by the tributary station RBEBQA. (Refer to fig. 10–1 to follow this example.) An operator at the relay station in Washington, seeing the letters RBEB, knows that the message goes to the major relay station in Boston. At RBEB the operator knows from the fifth letter, Q, that the next relay point is the minor relay station at Quonset Point, R. I. At Quonset Point, RBEBQ, the operator knows that the last letter, A, designates Davisville (too small to be shown in figure 10–1), and forwards the message to that tributary.

Special Suffixes

The letters C and X, and all 2-letter combinations CA through CZ, are reserved for suffixes to routing indicators. There is a prescribed meaning for each suffix. Suffixes aid routing of tapes for processing purposes or localized action by the relay station or any of its supplementary section or facilities. A list of suffixes follows. Those authorized for Navy use are so indicated in JANAP 117.

C—Local delivery or refile in page form is required.

CF—Section accomplishing delivery by broadcast methods.

CI—Section which coordinates routing information.

CM—Section which prepares tape copies for retransmission.

CN—Electrical conference facility or section.

CR—Cryptocenter.

CS—Section dealing with service messages.

CT—Section effecting delivery by telephone.

CU—Section using tape relay for delivery to commercial carriers.

CW—Section which relays by radiotelegraph.

CX—Section using tape relay for refile to activities served by teletypewriter exchange systems.

Following are two examples of suffixes as used with the routing indicator of the primary COMMCEN, Washington, D. C. (RBEP).

RBEPC—Primary message center, COMMCEN, Washington.

RBEPCR—Cryptocenter, COMMCEN, Washington.

PUBLICATIONS

There are three publications of principal importance to the NTX operator. Two, the effective editions of ACP 127 and DNC 5, deal with procedure—the first from a joint, and the second from the naval viewpoint.

The effective edition of JANAP 117 holds routing indicators for the United States and Canada. Following is an outline of the publication·

GENERAL INSTRUCTIONS. Construction of routing indicators; a basic outline of the publication and how to use it; general routing instructions; definitions; and a chart of the geographical zone breakdown of the world.

SECTION I (DECODE). Alphabetical listing of routing indicators, and name and location of associated communication facilities.

SECTION II (ENCODE). Activities that can be reached by United States and Canadian teletypewriter systems, listed alphabetically according to location.

UNITED STATES SUPPLEMENT. Supplementary domestic and overseas routing. Used in routing U.S.-originated messages to both military and nonmilitary activities for which routing has not been provided in Section II.

NTX MESSAGE

A message to be handled over tape circuits must be prepared in NTX message format is shown in figure 10–2. Study it and then compare it with figure 6–5, which is the radiotelegraph message format.

BASIC FORMAT FOR NTX MESSAGE

Parts	Components	Elements	Format line	Contents	Explanation
HEADING	Procedure	Handling instructions	1	Channel numbers; pilot (pilots may contain repeated precedence prosign, routing indicator(s), prosign(s), operating signal(s), and address designation(s).	Line 1—Routing Line—Contains all channel numbers and station-to-station handling instruction; i.e., specific routing pilots of the type used in handling multiple address and book messages between service networks and within networks not handling such messages in accordance with predetermined routing doctrine. NOTE.—If message is dual precedence, only one precedence is shown in this line.
		Call	2	Precedence prosign; designation of station(s) called.	Line 2—Basic Routing Line—Contains repeated precedence prosign; designation of the station(s) called. NOTE.—If message is dual precedence, only one precedence is shown in this line.

BASIC FORMAT FOR NTX MESSAGE—Continued

Parts	Components	Elements	Format line	Contents	Explanation
HEADING	Procedure—Cont'd.	Calling station's sign; calling station.	3	Prosign DE; designation of station calling; transmission identification (station serial NR).	Line 3—Contains prosign DE; designation of the calling station; transmission identification (station serial number).
		Transmission instructions.	4	Prosign T; operating signal(s); address designation(s); routing indicator(s).	Line 4—Contains transmission instructions and will be identified by appearance of prosign T; operating signal(s); routing indicator(s); address designation(s).
	Preamble	Precedence; date-time group; message instructions.	5	Precedence prosign(s); time or date and time expressed in digits, and zone suffix; operating signal(s).	Line 5—Contains precedence prosign once and in the case of dual precedence both will be shown separated by a space; originator's time group or date-time group, and message instructions in the form of operating signal(s).

HEADING	Address	a. Originator's sign; originator.	6	Prosign FM; originator's designation.	Line 6—Contains prosign FM and designation of originator which may be indicated by plain language, call sign, or address group.
		b. Action addressee sign; action addressee.	7	Prosign TO; routing indicator(s); operating signal(s); address designation(s).	Line 7—Contains prosign TO; designation of action addressee(s) in the form of plain language, address group(s), or call sign(s). It may also contain operating signal(s) indicating delivery by other means, or routing indicator(s) to indicate delivery responsibility.
		c. Information addressee sign; information addressee.	8	Prosign INFO; routing indicator(s); operating signal(s); address designation(s).	Line 8—Contains prosign INFO; designation of information addressee(s) in the form of plain language, address group(s), or call sign(s). It may also contain operating signal(s) indicating delivery by other means or routing indicator(s) to indicate delivery responsibility.
		d. Exempted addressee sign; exempted addressee.	9	Prosign XMT; address designation(s).	Line 9—Contains prosign XMT and designation of addressee(s) exempted from collective address designation, when such designation is employed in lines 7 or 8.

BASIC FORMAT FOR NTX MESSAGE—Continued

Parts	Components	Elements	Format line	Contents	Explanation
	Prefix------	Accounting information; group designation.	10-----	Accountingsymbol; group count designation; abbreviation SVC.	Line 10—Contains accounting symbol; group count prosign; abbreviation SVC. (Encrypted messages consisting of countable groups will carry a numerical group count.)
S E P A R A T I O N			11-----	Prosign BT-------------	Line 11—Separates heading from text of message.
T E X T	Text-------	Subject matter---------	12-----	Internal instructions; thought or idea as expressed by originator.	Line 12—Contains text of message which may contain message-handling instructions as well as the thought or idea as expressed by originator.
S E P A R A T I O N			13-----	Prosign BT-------------	Line 13—Separates text from ending of message.

E N D I N G	Procedure	a. Confirmation b. Time group	14	Prosign CFN; confirmatory material. Hours and minutes expressed in digits, and zone suffix.	Line 14—Contains prosign CFN and confirmed portions of message. It also contains a time group expressed in digits plus the zone suffix only when used in lieu of a time group or date-time group in line 5.
		c. Correction d. Filing time	15	Prosign(s); operating signal(s). Date separated by slant from hour and minutes expressed in digits; zone suffix; month and routing indicator.	Line 15—Contains prosign C, and other prosigns, operating signal(s), and corrections. It also contains the date and time the message was filed with the communications center. The abbreviation of the month and the routing indicator of the station preparing the tape may appear following the filing time when prescribed.

Figure 10–2.

NTX MESSAGE EXAMPLES

A PLAINDRESS MESSAGE:

Format line		
	(5 BLANKS)	
1	RBEP A92	(2CR) (LF)
2	MM RBEGC RBEBC RBEFC	(2CR) (LF)
3	DE RBEPH 48B	(2CR) (LF)
5	M Ø8Ø9Ø1Z	(2CR) (LF)
6	FM BUPERS	(2CR) (LF)
7	TO COMTHREE	(2CR) (LF)
8	INFO COMONE	(2CR) (LF)
	COMFOUR	(2CR) (LF)
11	BT	(2CR) (LF)
12	THIS IS AN NTX PLAINDRESS MSG	(2CR) (LF)
	PREPARED IN FORMAT PRESCRIBED	(2CR) (LF)
	BY ACP 127B AND DNC 5A X NOTE	(2CR) (LF)
	USE OF CNF AND C LINES	(2CR) (LF)
13	BT	(2CR) (LF)
14	CFN ACP 127B DNC 5A	(2CR) (LF)
15	C WA OF CFN	(2CR) (LF)
	Ø8/1ØØ5Z OCT RBEPH	(2CR) (8LF)
	(4Ns)	(12 LTRS)

An ABBREVIATED PLAINDRESS MESSAGE:

Format line		
	(5 BLANKS)	
2	OO RJWKC	(2CR) (LF)
3	DE RJHPAB 72A	(2CR) (LF)
5	O	(2CR) (LF)
6	FM HEAR	(2CR) (LF)
7	TO HURT	(2CR) (LF)
11	BT	(2CR) (LF)
12	THIS IS AN ABBREVIATED PLAIN-	(2CR) (LF)
	DRESS MSG X WHEN PROCEDURE	(2CR) (LF)
	COMPONENTS IDENTIFY ORIGINA-	(2CR) (LF)
	TOR AND ADEES FORMAT LINES	(2CR) (LF)
	TWO AND THREE ARE ONLY MAN-	(2CR) (LF)
	DATORY PROCEDURE ELEMENTS X	(2CR) (LF)
	OTHER LINES USED AS REQUIRED	(2CR) (LF)
13	BT	(2CR) (8LF)
	(4Ns)	(12 LTRS)

A CODRESS MESSAGE:

Format line		
	(5 BLANKS)	
2	MM RBEPCR RBWPI ____________________	(2CR) (LF)
3	DE RBHPC 38A ____________________	(2CR) (LF)
5	M 171545Z ____________________	(2CR) (LF)
10	GR21 ____________________	(2CR) (LF)
11	BT ____________________	(2CR) (LF)
12	(Twenty-one encrypted groups typed ten to	(2CR) (LF)
	the line) ____________________	(2CR) (LF)
13	BT ____________________	(2CR) (LF)
15	17/16Ø2Z MAR RBHPC ____________________	(2CR) (8LF)
		(4Ns) (12 LTRS)

EXPLANATION OF MESSAGE EXAMPLES

Machine Function Keys

You already know what machine function keys are, but you need to learn how they are used to align messages on NTX equipment. To set up page teletypewriters at all stations properly, and to facilitate manual handling of tapes, messages are preceded by five space functions (5 SPACES), two carriage returns (2CR), and a line feed (LF). But when the message is relayed, channel numbers are preceded by 5 BLANKS only. Only the punching station precedes a message with 5 SPACES, 2CR, LF. After the message is transmitted or punched it is followed by 2 CR, 8LF, 4Ns, and 12 LTRS. It is important that you always observe this procedure. It is used by every operator when punching traffic.

The carriage return function resets the machines 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. This second CR also allows time for the carriage to throw, so that the operator does not have to break his typing rhythm.

As a beginner, you should memorize these instructions. They show you exactly what keys to strike at the beginning and end of every message in NTX form. These functions are necessary because of the nature of tape relay operation. If messages are ended with too few line feeds or letters, they will run together after going through two or more relays, resulting in garbles and incomplete or lost messages.

Format Lines

LINE 1—Placed on messages by relay stations as the tape is relayed to the next station. Contains channel numbers and station-to-station handling instructions.

LINE 2—Preparation of every NTX message begins with line 2, which consists of the precedence prosign repeated, and routing indicators of stations called—that is, to which the message is routed for final delivery. Messages are routed in accordance with line 2. This is, to the tape relay operator, the most important line in the message. It must be prepared with especial care if misroutes are to be avoided.

Routing indicators are placed in the routing line according to the order in which addressees whom they serve appear in the heading. When one station serves two or more addressees, the routing indicator of that station appears only ONCE in the routing line.

LINE 3—Consists of the prosign DE, the routing indicator of the station originating the tape, and the station serial number.

LINE 4—Transmission instructions (not necessary in any of the examples). This line may contain an operating signal or the prosign T to indicate transmission responsibility, and address groups, call signs, routing indicators, or plain language as necessary. Transmission instructions are not usually employed when delivery instructions are contained in the address portion. They may be used, however, when delivery instructions will not suffice.

LINE 5—Contains the appropriate precedence prosign once, or if a dual precedence message, each precedence prosign once; the DTG; and any necessary operating signals.

LINE 6—Identified by the prosign FM, and contains designation of originator by plain language, call sign, or address group.

LINE 7—Consists of the prosign TO followed by designation of each action addressee by plain language, call sign, or address group. It may also contain operating signals indicating delivery by other means, or (in joint messages) routing indicators to indicate delivery responsibilities. A slant separates the routing indicator from the designation of the addressee for whom it is responsible.

LINE 8—Identified by the prosign INFO followed by designation of each information addressee by plain language, call sign, or address group. Like line 7, it may contain operating signals or routing indicators to indicate delivery responsibilities.

LINE 9—Identified by the prosign XMT, and contains designation of any addressee(s) exempted from the collective designation, if such a designation is used in lines 7 or 8.

LINE 10—Contains the group count prosign, the group count and, preceding, accounting symbols as required. It is not usually necessary to count the groups of messages to be handled entirely over NTX circuits because there is little chance of a group being lost in transmission. However, the counting of groups is MANDATORY when the text is encrypted.

LINE 11—Separation between heading and text. Identified by prosign BT.

LINE 12—Text: the basic thought or idea of the originator. Don't lose sight of the fact that the text is the most important part of the message, and is the reason for existence of the remainder.

LINE 13—Separation between text and ending. Identified by prosign BT.

LINE 14—Consists of the prosign CFN followed by confirmatory material. When 50 percent or LESS of the text is made up of figures, unusual letter combinations, or figure-letter combinations, you must confirm those groups. When OVER 50 percent of the text is made up of figures, or difficult combinations, it is not necessary to confirm. To confirm here would mean repeating most of the message, with consequent loss of time in transmission and checking. For the same reason, when you transmit messages in tabulated form (statistical tables, supply orders, etc.), no confirmation is necessary.

LINE 15—Consists of corrections (if any) and filing time. The correction portion consists of the prosign C followed by the correct version of any error made in the text portion. The procedure portion consists of the date and time of filing, separated by a slant sign; the current month, abbreviated; and the routing indicator of the originating station. Time of filing is the time the message was received by the COMMCEN for processing.

MESSAGE NUMBERING

Station Serial Numbers

You will recall from radiotelegraph procedure that messages are assigned serial numbers when traffic moves between ships and shore stations, and from shore station to shore station. Serial numbers for teletypewriter messages are assigned in the same way. Messages are numbered consecutively for each channel or perforating position, beginning at 0001Z and continuing for 24 hours. The station serial number is put on the message by the punching station. That number then becomes a permanent means of message identification, and remains the same regardless of whether the message is destined for one or for many addressees. It provides a reference for addressees who may, by quoting it and the DTG, subsequently refer the originator back to the message. It also serves for circuit accountability between punching station and first relay station.

When more than one outgoing position or transmitting channel is used, a separate set of serial numbers is used on each channel, and a channel letter designator is added to each station serial number to identify the channel over which transmitted. The letter appears following the station serial number. The first channel is normally assigned the letter A. The next channel is usually designated B, the next C, and so on. Example: RBEPH 148B.

Channel Numbers

Channel numbers are assigned by relay stations as they send each message on to the next station. As the tape is relayed through the system, each relay station adds its channel number to the head of the tape so that upon arrival at the final station it carries a record of every station through which it has passed.

Unlike station serial numbers, the channel letter designator appears in channel numbers PRECEDING numerals. This is because the number is put on by an automatic device set to stop automatically on the letters shift. An example of a channel number: BEP B148. NOTE: The letter R of the routing indicator is not used with U.S. Navy channel numbers, but is used with station serial numbers.

Channel numbers provide a constant check on all traffic between stations, and ensure that no message is lost or unaccounted for. This check on traffic is known as "protecting the continuity of service." Understand: A message carries the same serial number all the way, but will receive a new channel number at each relaying station.

Channel numbers are assigned on a 24-hour basis, beginning at 0001Z. From tributary stations to relay stations, station serial numbers may serve as channel numbers.

PAGING MESSAGES

Messages containing more than 12 lines or 125 groups of encrypted text are divided into pages for transmission. The first page contains the heading and first ten lines of text. Second and succeeding pages each contain 20 lines of text, with the exception of the last page, which may contain fewer. No more than five pages may be sent in any one transmission.

Second and succeeding pages carry a page identification line above the first line of text giving the page number (spelled out) and the station serial number of the message. Confirmation and correction lines, if necessary, follow the last line of text on each page. Succeeding pages are separated from each other by 8LF functions.

The example following shows how to page a message properly.

```
(5 SPACES) (2CR) (LF)
RR RBWPI RBHPB ----------------------------(2CR) (LF)
DE RBEPW 43B ------------------------------(2CR) (LF)
R Ø8Ø91ØZ ---------------------------------(2CR) (LF)
FM CNO ------------------------------------(2CR) (LF)
TO COMWESTSEAFRON -------------------------(2CR) (LF)
CINCPACFLT --------------------------------(2CR) (LF)
BT ----------------------------------------(2CR) (LF)
(Ten lines plain language text on page one)(2CR) (LF)
CFN (if necessary) ------------------------(2CR) (LF)
C   (if necessary) ------------------------(2CR) (8LF)

PAGE TWO RBEPW 43B ------------------------(2CR) (LF)
(Twenty lines of text on page two) --------(2CR) (LF)
CFN (if necessary) ------------------------(2CR) (LF)
C   (if necessary) ------------------------(2CR) (8LF)

PAGE THREE RBEPW 43B ----------------------(2CR) (LF)
(Remainder of text) -----------------------(2CR) (LF)
BT ----------------------------------------(2CR) (LF)
CFN (if necessary) ------------------------(2CR) (LF)
C   (if necessary) ------------------------(2CR) (LF)
Ø8/Ø94ØZ FEB RBEPW ------------------------(2CR) (8LF)
                                    (4Ns) (12 LTRS)
```

LONG MESSAGES

In order to prevent prolonged circuit tieups by long messages, those over 900 groups, 90 lines, or 5 teletypewriter pages, are prepared for transmission in sections. When a long message tape starts through the TD, other traffic backs up waiting for the circuit to clear. But a long message sent in short sections keeps the line relatively free for more important traffic. For example, a tributary station has a DEFERRED message to be sent in three sections. Normally, the three sections would be transmitted to the relay station in succession. Assume this is the case. At the relay station the first section receives further transmission immediately. While waiting for this section to clear the transmitter, the relay station receives two messages from other circuits—one a PRIORITY, the other ROUTINE. These messages are relayed immediately after section one of the DEFERRED message clears, and before section two begins. The delay to the PRIORITY and ROUTINE, which would have occurred if the entire DEFERRED message had been sent in one part, is thus avoided. For efficiency, NTX tries to hold transmission time of a section to 15 minutes.

For purposes of dividing a message into sections, each encrypted group or complete word is counted as a group. Lines are identified according to textual lines that appear on the original message form submitted to the communication office for transmission. When counting pages, compute 10 textual lines for the first page and 20 for each succeeding page. Of course, the last page may have fewer.

Each transmission section of a long message will have exactly the same heading except that station serial numbers will change with succeeding transmissions. A group count, if used, applies only to the section it accompanies. The filing time is the same on all sections of the message.

Each section is identified in the first line of the text as SECTION ---- OF ----, except for the last section, which is identified as FINAL SECTION OF ----. The first part of a 3-section message would thus be identified as SECTION ONE OF THREE, the second as SECTION TWO OF THREE, and the third as FINAL SECTION OF THREE. Each section is paged as necessary.

Here is a message handled in three transmission sections:

```
(5 SPACES) (2CR) (LF)
RR RBHPB RBWPI RBMPB ----------------(2CR) (LF)
DE RBEPW 1Ø5A ----------------------(2CR) (LF)
R 181922Z --------------------------(2CR) (LF)
FM CNO -----------------------------(2CR) (LF)
TO CINCPACFLT ----------------------(2CR) (LF)
INFO COMWESTSEAFRON ----------------(2CR) (LF)
COMARIANAS -------------------------(2CR) (LF)
BT ---------------------------------(2CR) (LF)
SECTION ONE OF THREE X PLAIN LAN-   (2CR) (LF)
GUAGE TEXT INCLUDES 9Ø TELETYPE-    (2CR) (LF)
WRITER LINES IN THIS SECTION X PAGED (2CR) (LF)
AS REQUIRED ------------------------(2CR) (LF)
BT ---------------------------------(2CR) (LF)
CFN 9Ø -----------------------------(2CR) (LF)
18/2Ø3ØZ FEB RBEPW -----------------(2CR) (8LF)
                             (4Ns) (12 LTRS)
(5 SPACES) (2CR) (LF)
RR RBHPB RBWPI RBMPB ----------------(2CR) (LF)
DE RBEPW 1Ø6A ----------------------(2CR) (LF)
R 181922Z --------------------------(2CR) (LF)
FM CNO -----------------------------(2CR) (LF)
TO CINCPACFLT ----------------------(2CR) (LF)
INFO COMWESTSEAFRON ----------------(2CR) (LF)
COMARIANAS -------------------------(2CR) (LF)
BT ---------------------------------(2CR) (LF)
SECTION TWO OF THREE X PLAIN LAN-   (2CR) (LF)
GUAGE TEXT CONTINUES FROM WHERE IT  (2CR) (LF)
LEFT OFF IN SECTION ONE TO INCLUDE  (2CR) (LF)
9Ø TELETYPEWRITER LINES X PAGED AS  (2CR) (LF)
REQUIRED ---------------------------(2CR) (LF)
BT ---------------------------------(2CR) (LF)
CFN 9Ø -----------------------------(2CR) (LF)
18/2Ø3ØZ FEB RBEPW -----------------(2CR) (8LF)
                             (4Ns) (12 LTRS)

(5 SPACES) (2CR) (LF)
RR RBHPB RBWPI RBMPB ----------------(2CR) (LF)
DE RBEPW 1Ø7A ----------------------(2CR) (LF)
R 181922Z --------------------------(2CR) (LF)
FM CNO -----------------------------(2CR) (LF)
TO CINCPACFLT ----------------------(2CR) (LF)
INFO COMWESTSEAFRON ----------------(2CR) (LF)
COMARIANAS -------------------------(2CR) (LF)
BT ---------------------------------(2CR) (LF)
```

```
FINAL SECTION OF THREE X TEXT CON-  (2CR) (LF)
TINUES FROM WHERE IT LEFT OFF IN    (2CR) (LF)
SECTION TWO TO END X PAGED AS RE-   (2CR) (LF)
QUIRED ---------------------------- (2CR) (LF)
BT -------------------------------- (2CR) (LF)
18/2Ø3ØZ FEB RBEPW ---------------- (2CR) (8LF)
                             (4Ns) (12 LTRS)
```

HIGH-PRECEDENCE TAPES

Messages of FLASH or EMERGENCY precedence are given special handling over NTX circuits. When the tape is prepared by the first station, the repeated precedence prosign in line 2 is preceded by five bells so that the next station has audible warning that a high-precedence message is coming in. EXAMPLE:

```
(5 bells)     ZZ RBHPB RBWPI
              DE RBATC 58A
              Z Ø8Ø91ØZ
              (Etc.)
```

Notice that the precedence prosign appears in lines 2 and 5 just as in any other message.

In relay stations high-precedence tapes receive hand-to-hand processing. The receiving operator immediately notifies the supervisor when a high-precedence tape is received. The supervisor sees that the tape is immediately put through the tape factory (if necessary) and taken to the proper outgoing circuit and sent out. A receipt must be given to the station from which the message was received, and a receipt received from every station to which the message is relayed.

Procedure and Service Messages

PROCEDURE MESSAGES and SERVICE MESSAGES are short, concise messages used to expedite traffic handling. Either may be used by communication personnel when the subject concerns traffic handling, but only service messages are used for matters relating to communication facilities or circuit conditions. All questions concerning a message which contains more than one error are incorporated into one service or procedure message.

A procedure message is one in which the text contains only prosigns, operating signals, address designations, identification of messages, parts of messages, and amplifying data as required. It always has a precedence prosign, transmission identification, and filing time.

Service messages are prepared and transmitted in plaindress, abbreviated plaindress, or codress. They generally concern messages originated at, destined to, or refiled by, the station originating the service message. They normally are assigned a precedence equal to that of the message to which they refer.

CORRECTION OF ERRORS

Even the best operators sometimes make mistakes. There is a definite procedure used for correcting mistakes, depending on whether they occur in tape preparation or while you are sending direct from a keyboard. You learned in the last chapter how to "erase," or letter out errors by using the backspacer and striking the LTRS key as many times as necessary. This holds for all errors in tape preparation with the exception of those made in the routing line. When you make a mistake in the routing line, there is only one thing to do: Throw the tape away, and prepare a new one.

When you are transmitting from a keyboard and make an error, use the same prosign (E E E E E E E E) and the same procedure as in radiotelegraphy. Assume you are transmitting the words IN ACCORDANCE WITH PREVIOUS INSTRUCTIONS and make a mistake 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. Transmission resumes with the last word or group correctly sent.

Errors made in the message heading may not be corrected in the above manner. The incorrect transmission is canceled by transmitting the prosign E E E E E E E E AR, 2 carriage returns, 4 N's, and 12 letters.

If you have transmitted the text before discovering an error in it, use the prosign C and make the correction immediately following. Previous message examples have shown the use of the prosign C. Errors in a multiple-page message, which have not been corrected by 8 or more E's, are corrected at the bottom of each page by use of C.

MISSENT AND MISROUTED

Occasionally you will receive a message which was delivered to your office through error. The thing to remember here is that every NTX office is responsible for delivery of EVERY message received, even though it was transmitted through error.

Messages transmitted through error are classed in two groups: MISSENT and MISROUTED. A missent message has the correct routing indicator, but the relay station has transmitted it over the wrong circuit. The message may have carried New York's indicator (RBEG) but was transmitted over the RBEF circuit to Philadelphia.

Misrouted messages carry the wrong indicators, either through error when assigned by the punching station, from mechanical trouble in the system, or from the tape-cutter's typing mistake.

If you should receive two copies of a multiple-address message, and the second is not marked SUSPECTED DUPLICATE, you must assume that one of the other addressees has not received his copy. You will then notify the relay station from which you received the duplicate message, explaining the situation. The relay station will check its monitor rolls to make sure that all addressees received a copy of the message in question.

PILOT TAPES

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. Here are four important types of NTX 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 mutilated tape of ROUTINE or lower precedence, the tape is not usually 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 ROUTINE, 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 has been received garbled at the primary relay station in Honolulu, and is shown forwarded SUBCOR.

(5 SPACES) (2CR) (LF)
OO RBEPW ------------------------------------(2CR) (LF)
ZDG RBHP ------------------------------------(2CR) (LF)
RBMP C19Ø ------------------------------------(2CR) (LF)
RBAT A1Ø5 ------------------------------------(2CR) (LF)
OO RBEPW ------------------------------------(2CR) (LF)
DE RBATC 93 ---------------------------------(2CR) (LF)
O 18191ØZ ------------------------------------(2CR) (LF)
FM COMNAVFE ------------------------------(2CR) (LF)
TO CNO ---------------------------------------(2CR) (LF)
BT ---(2CR) (LF)
(Garbled text) --------------------------------(2CR) (LF)
(Etc.) ---(Etc.)

CORCY Pilot

When a relay station has forwarded a SUBCOR message, it is that station's responsibility to obtain a good tape and forward it to the station to which the SUBCOR went. The next example shows the corrected copy sent for the message above.

```
(5 SPACES) (2CR) (LF)
OO RBEPW ---------------------------------(2CR) (LF)
ZEL RBHP ---------------------------------(2CR) (LF)
RBMP C19Ø --------------------------------(2CR) (LF)
RBAT A1Ø5 --------------------------------(2CR) (LF)
OO RBEPW ---------------------------------(2CR) (LF)
DE RBATC 93 ------------------------------(2CR) (LF)
O 18191ØZ --------------------------------(2CR) (LF)
FM COMNAVFE ------------------------------(2CR) (LF)
TO CNO -----------------------------------(2CR) (LF)
BT ---------------------------------------(2CR) (LF)
(Good text) ------------------------------(2CR) (LF)
(Etc.) -----------------------------------(Etc.)
```

SUSDUPE Pilot

When a station has no conclusive evidence that a tape has been transmitted, but suspects that it has been, the message is forwarded as a suspected duplicate. This action may be taken whenever necessary by either tributary or relay stations. The station called is responsible for preventing duplicate deliveries to the addressee.

EXAMPLE:

```
(5 SPACES) (2CR) (LF)
PP RBESMC --------------------------------(2CR) (LF)
ZFD RBES ---------------------------------(2CR) (LF)
PP RBECS RBEMC RBESMC --------------------(2CR) (LF)
DE RBEPH 48A -----------------------------(2CR) (LF)
P 111213Z --------------------------------(2CR) (LF)
(Etc.) -----------------------------------(Etc.)
```

In cases where a tributary is forwarding a message as a suspected duplicate, a station serial number is used.

EXAMPLE:

```
(5 SPACES) (2CR) (LF)
RR RBWPI ------------------------------------(2CR) (LF)
ZFD RBEPW 128C ------------------------------(2CR) (LF)
RR RBHPB RBWPI RBEPD ------------------------(2CR) (LF)
DE RBEPW 98A --------------------------------(2CR) (LF)
R 221221Z -----------------------------------(2CR) (LF)
(Etc.) --------------------------------------(Etc.)
```

In the above example the originating station is retransmitting a message as a suspected duplicate. This is done mostly by tributaries initiating tracer proceedings.

Reroute Pilot

The station which catches a misroute (in some cases a relay station, in others the message center to which it was misrouted) is responsible for preparing a reroute pilot and sending the message to the proper station. Also, a copy of the message with reroute pilot is made, the incorrect routing indicator in line 2 marked, and the copy mailed to the station responsible for the misroute—that is, the punching station.

Assume that RBEP, an intermediate station, discovers a misroute on a message sent to it for further relay. The station prepares a pilot tape (not changing the original tape as received), prefixes it, and relays the message. RBEPH, not RBEPD, is guard for BUPERS.

```
(5 SPACES) (2CR) (LF)
RR RBEPH ------------------------------------(2CR) (LF)
ZOV RBEP ------------------------------------(2CR) (LF)
RBHP C123 RBAT A98 --------------------------(2CR) (LF)
RR RBHPB RBWDA RBEPD ------------------------(2CR) (LF)
DE RBATAB 43 --------------------------------(2CR) (LF)
R Ø8Ø92ØZ -----------------------------------(2CR) (LF)
FM NAS ATUSGI -------------------------------(2CR) (LF)
TO COMSERVPAC -------------------------------(2CR) (LF)
INFO COMAIRPAC ------------------------------(2CR) (LF)
BUPERS --------------------------------------(2CR) (LF)
BT ------------------------------------------(2CR) (LF)
(Etc.) --------------------------------------(Etc.)
```

RBEP mails a copy of the message to NAS Atsugi, Japan. The message is not routed to RBEPD, for that station is not concerned.

READDRESSING

On occasion, an originator or addressee may, without rewriting a message, wish to readdress it to one or more other addressees not included in the original address. The following rules apply.

1. A supplementary heading is inserted in front of the original heading. All procedure lines preceding line 5 of the original heading are deleted, and the original placed three LF's before it.
2. The precedence indicated in the supplementary heading applies to the supplementary address only.
3. Originator's designation appearing in the supplementary heading identifies the activity originating the message.
4. The DTG of the original message is used for purposes of reference, reply, and filing. Readdressed messages are also cross-filed.
5. A message cannot be readdressed if any change is made from line 5 on.

Assume that on receipt of this message COMFIVE wishes to readdress it for INFO to NTC Bainbridge, Md.

```
(5 SPACES) (2CR) (LF)
RR RBEPW RBEKC RBWPI ----------------(2CR) (LF)
DE RBHPB 123C -----------------------(2CR) (LF)
R Ø8Ø91ØZ ---------------------------(2CR) (LF)
FM CINCPACFLT -----------------------(2CR) (LF)
TO CNO ------------------------------(2CR) (LF)
COMFIVE -----------------------------(2CR) (LF)
COMWESTSEAFRON ----------------------(2CR) (LF)
BT ----------------------------------(2CR) (LF)
(Plain language text) ---------------(2CR) (LF)
BT ----------------------------------(2CR) (LF)
Ø8/Ø93ØZ MAY RBHPB ------------------(2CR) (8LF)
                            (4Ns) (12 LTRS)
```

Here is the message as readdressed. Note that COMFIVE has changed the precedence in the supplementary heading. Selected of precedence and decision as to whether the message is to be readdressed for action or information are responsibilities of the readdressing activity. The message has not been changed past line 4.

```
(5 SPACES) (2CR) (LF)
MM RBEPRB ______________________________(2CR) (LF)
DE RBEKC 34 ____________________________(2CR) (LF)
M Ø81253Z ______________________________(2CR) (LF)
FM COMFIVE _____________________________(2CR) (LF)
INFO NTC BAIN __________________________(2CR) (3LF)
R Ø8Ø91ØZ ______________________________(2CR) (LF)
FM CINCPACFLT __________________________(2CR) (LF)
TO CNO _________________________________(2CR) (LF)
COMFIVE ________________________________(2CR) (LF)
COMWESTSEAFRON _________________________(2CR) (LF)
BT _____________________________________(2CR) (LF)
(Plain language text) __________________(2CR) (LF)
BT _____________________________________(2CR) (LF)
Ø8/Ø93ØZ MAY RBHPB _____________________(2CR) (8LF)
                                 (4Ns) (12 LTRS)
```

NUMBER COMPARISONS

Tape relay procedure has established the responsibilities of the various stations for number comparisons. Each primary relay station compares with each other primary relay station (with which it is in direct contact) hourly on the hour over each wire and radio circuit. Each primary relay station initiates a SENT number comparison to each major station with which it is in direct contact EACH EVEN hour GMT. In turn, each major station initiates a comparison to its primary station each ODD HOUR, GMT. Primary and major stations usually arrange their own schedule of number comparisons with minor and tributary stations. Even so, the schedule must call for comparisons not more than 1 hour apart.

Stations maintaining 24-hour service have a final number comparison at midnight GMT. Closing number comparisons for those offices where 24-hour circuit operation is not maintained are made on what is called the return tape basis. The office preparing to close will start the closeout comparison:

RBEPH 78A
RBEP SUPVR RBEPH ALFA CLOSE OUT 2ØØØ

Counting the comparison notice above, RBEPH (closing out) has transmitted to RBEP 78 messages over channel ALFA. RBEP verifies receipt of all messages up to 78A, and sends a closeout notice which indicates total number of messages sent from RBEP to RBEPH for the day. In the example below, A88 is the number of messages from RBEP to RBEPH, and 78A verifies the number received from RBEPH. NOTE: Relay stations, and those only, drop the R in front of routing indicators when channel numbering.

BEP A88
RBEPH 78A
RBEP SUPVR RBEPH ALFA CLOSE OUT 2ØØØ

The office closing (RBEPH) verifies receipt of all numbers up to the channel number (A88) on the return closeout tape. RBEPH then transmits to the primary station a final tape with the time of closing:

RBEPH 79A
RBEP SUPVR RBEPH ALFA CLOSED 2Ø1Ø

All sending positions (if monitor equipment is not used) and all receiving positions in a station receive new number sheets not later than 2345Z each day. At midnight GMT, the supervisor records the last number sent on each channel on a form called a number tabulation sheet, provided for this purpose. Traffic is immediately resumed under new numbers beginning with 1. This procedure is continued until all channels have been changed. The received number sheet is then inspected for open numbers (omits). If none are found and the distant station has started a new number sequence, the last old number will be entered on the number tabulation sheet. This procedure is performed with all receiving channels.

If inspection of received number sheets reveals numbers not crossed off, reruns (or appropriate transmission cancellation notices) are requested immediately.

The number tabulation sheet and the received number sheets should be retained at the supervisor's position until the final number comparison is received from the distant station. The correctness of the number comparison notice is verified by comparing the number of the number tabulation sheet against those included in the received number comparison notice.

If the received comparison notice does not agree with the number tabulation sheet, appropriate supervisory messages are exchanged until they are in agreement.

TRACER PROCEEDINGS

While naval communications prides itself on reliability, no communication system is absolutely perfect. For this reason there must be some provision for tracing messages which are lost or which 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 nothing more than checking from station to station to find where the failure occurred. Proceedings are usually handled by speedletter. They start with the originator of the message, either on his own initiative or at the request of an addressee who believes he did not get the message. Inasmuch as a message sent to several addressees will usually be referenced later in a message sent to some or all of the former addresses, it is not difficult to see how a nondelivery will come to light within a few days.

When an originator becomes aware of a nondelivery he takes the following steps:

1. Refiles the original message SUSDUPE to addressee(s) who did not get it.
2. Originates a speedletter (or in urgent cases, a tracer message) to the first message center handling the message. The speedletter or message will say who claims nondelivery, and what activity did not get the message. For the missing message it gives complete routing line, originating station and station serial number, DTG, and time given to the station.

This information is relayed along the path of the message until the nondelivery is found. Each station checks its relay station monitor rolls to see that the message in question was received and sent out.

The following message was not delivered to RBFRC.

```
(5 SPACES) (2CR) (LF)
RR RBFRC RBFRS RBEKT ---------------(2CR) (LF)
DE RBEKL 1Ø8B --------------------------(2CR) (LF)
R Ø3Ø2Ø5Z --------------------------------(2CR) (LF)
FM COMSECONDFLT ---------------------(2CR) (LF)
TO NAVSTA NAPLES -------------------(2CR) (LF)
INFO COMSIXTHFLT ADMIN REP TRIPOLI (2CR) (LF)
COMSERVLANT --------------------------(2CR) (LF)
BT --------------------------------------(2CR) (LF)
(Text) -----------------------------------(2CR) (LF)
BT --------------------------------------(2CR) (LF)
Ø3/Ø3ØØZ MAY RBEKL -------------------(2CR) (8LF)
                              (4Ns) (12 LTRS)
```

The nondelivery has come to the attention of the originator, COMSECONDFLT. COMSECONDFLT sends the message again SUSDUPE. Next, RBEKL sends a speedletter to RBEKC containing the following information:

FROM: COMSECONDFLT
TO: NAVCOMMSTA NORVA
RBEKL CLAIMS NONDLY TO RBFRC MSG RR RBFRC RBFRS RBEKT X RBEKL 108B/COMSECONDFLT 030205Z SENT RBEK AT 03/0331Z X TRACE TO DESTN AND ADVISE

On receipt of the tracer from RBEKL message center, RBEK checks the logs on the incoming circuit from RBEKL, then the monitor for the outgoing circuit to RBEP. On finding the message was properly handled through that station, RBEKC originates the following speedletter to RBEP:

FROM: NAVCOMMSTA NORVA
TO: NAVCOMMSTA WASHDC
RBEKL CLAIMS NONDLY TO RBFRC MSG RR RBFRC RBFRS RBEKT X RBEKL 108B/COMSECONDFLT 030205Z SENT RBEP AS RBEK B248 AT 03/0401Z X TRACE TO DESTN AND ADVISE

On receipt of the foregoing speedletter, RBEP checks through the relay station monitors and finds that the message was not sent out to RBFP relay as it should have been. The following speedletter is sent back to the originator of the tracer.

FROM: NAVCOMMSTA WASHDC
TO: COMSECONDFLT
THIS STA ASSUMES RESPONSIBILITY FOR NONDELIVERY RBEKL 108B/COMSECONDFLT 030205Z X CORRECTIVE ACTION TAKEN THIS STA

To facilitate tracer proceedings, relay stations keep monitor rolls and log sheets of transmitted tapes for a 60-day period. Incoming message tapes need be retained only 24 hours.

DELIVERED COPIES

Such terms as "mailed," "by messenger," or " by guard mail" have no place in the NTX message format. The operating signal ZEN means "This message has been delivered by other means or by a separate transmission to addressees immediately following this signal." It is used in joint and combined messages only. No indication is made of delivery by other means in headings of messages to Navy routing indicators only.

In the next example a joint message has been delivered by messenger to one of the addressees—NAVSTA Sangley Point—who is served by the same message center as the originator.

NOTE.—In joint multiple-address messages the routing indicators responsible for delivery are placed before address designators in lines 7 and 8.

```
(5 SPACES) (2CR) (LF)
PP RBATC RBMPFA RBMPB RUEPC -------(2CR) (LF)
DE RBMPFC 48 -----------------------------(2CR) (LF)
P 14ø834Z ---------------------------------(2CR) (LF)
FM COMNAVPHIL ------------------------(2CR) (LF)
TO RBATC/COMNAVFE -------------------(2CR) (LF)
ZEN/NAVSTA SANGLEYPT ---------------(2CR) (LF)
INFO RBMPFA/SUBICBAY ---------------(2CR) (LF)
RBMPB/COMARIANAS --------------------(2CR) (LF)
RUEPC/DEPT OF THE ARMY -------------(2CR) (LF)
NAVY GRNC ------------------------------(2CR) (LF)
BT -----------------------------------------(2CR) (LF)
(Etc.) -------------------------------------(Etc.)
```

BOOK MESSAGE

A BOOK MESSAGE is a message which is destined for two or more addressees, and is of such a nature that the originator considers that no one addressee need know who the others are. Book messages are drafted in the same manner as multiple-address messages. The operating signal ZEX appears in line 5 following the DTG. ZEX means "This is a book message and may be delivered as a single address message to the addressees for whom you are responsible."

Book messages are prepared for transmission as follows:

1. Addressees are divided into groups according to the relay station which serves them.
2. For each group a separate message tape is prepared and transmitted.

Each such message is exactly the same, except that the station serial numbers will vary, and a different group of addressees will be in the heading. Originator, DTG, text, and ending will be the same for all transmissions. Following is an example of a message originated by the Bureau of Aeronautics (served by tributary RBEPE) for preparation as a book message.

Originator ________BUAER

DTG ______________091225Z

Precedence ________DEFERRED

Action to _________BUAER representatives at Essington, Pa.; Morton, Pa.; Windsor Locks, Conn.; East Hartford, Conn.; Bethpage, N. Y.; Buffalo, N. Y.; Palo Alto, Calif.; El Segundo, Calif.; and at Convair Corp., San Diego, Calif.

BUAER maintenance representative, Western Dist., San Diego, Calif.

BUAER general representative, Eastern Dist., New York, N. Y.

Naval Aircraft Factory, Philadelphia, Pa.

Naval Air Devices Center, Johnstown, Pa.

RBEPC divides the addresses into three groups and prepares three separate messages to be placed on circuits to RBWD, RBEG, and RBEF. Here are the messages.

Transmission as made to stations in RBWD area:

```
(5 SPACES) (2CR) (LF)
MM RBWDKM RBWDCX RBWDAC __________(2CR) (LF)
DE RBEPC 17B ______________________(2CR) (LF)
M Ø91225Z ZEX _____________________(2CR) (LF)
FM BUAER __________________________(2CR) (LF)
TO BAR ELSEGUNDO __________________(2CR) (LF)
BAR PALOALTO ______________________(2CR) (LF)
BAMR WESTDIST _____________________(2CR) (LF)
BAR CONVAIR CORP SDIEGO ___________(2CR) (LF)
BT ________________________________(2CR) (LF)
BUAER INST VOL 6 ART 75Ø1 X REVISE (2CR) (LF)
```

```
RQRS MFRS CLASSIFICATION RE-
STRICTIONS PER EFFECTIVE DI-
RECTIVES ------------------------------(2CR) (LF)
BT ------------------------------------(2CR) (LF)
CFN 6 75Ø1 ----------------------------(2CR) (LF)
Ø9/1311Z SEP RBEPC --------------------(2CR) (8LF)
                                   (4Ns) (12 LTRS)
```

As made to stations in RBEG area:

```
(5 SPACES) (2CR) (LF)
MM RBEGLCX RBEGV RBEGCX RBEGN ---(2CR) (LF)
DE RBEPC 19A --------------------(2CR) (LF)
M Ø91225Z ZEX -------------------(2CR) (LF)
FM BUAER ------------------------(2CR) (LF)
TO BAR WINDSORLOCKS -------------(2CR) (LF)
BAR EASTHARTFORD ----------------(2CR) (LF)
BAR BETHPAGE --------------------(2CR) (LF)
BAR BFLO ------------------------(2CR) (LF)
BAGR EASTDIST -------------------(2CR) (LF)
BT ------------------------------(2CR) (LF)
(Etc.) --------------------------(Etc.)
```

As made to stations in RBEF area:

```
(5 SPACES) (2CR) (LF)
MM RBEFCX RBEFF RBEFV RBEFM -----(2CR) (LF)
DE RBEPC 2ØA --------------------(2CR) (LF)
M Ø91225Z ZEX -------------------(2CR) (LF)
FM BUAER ------------------------(2CR) (LF)
TO BAR ESSINGTON ----------------(2CR) (LF)
BAR MORTON ----------------------(2CR) (LF)
NAVAIRCRAFT FACTORY PHILA -------(2CR) (LF)
NADEVCEN JOHNSTOWN --------------(2CR) (LF)
BT ------------------------------(2CR) (LF)
(Etc.) --------------------------(Etc.)
```

COMMERCIAL MESSAGES VIA NTX

Official messages to commercial activities are sent over NTX circuits to the message center nearest the addressee. If the message center is near enough, delivery may be made by telephone or by other appropriate means. Otherwise, it must be given to a commercial communication company for final delivery.

```
(5 SPACES) (2CR) (LF)
MM RBEGC RBEBC ------------------------(2CR) (LF)
DE RBEPD 43A --------------------------(2CR) (LF)
M 261235Z -----------------------------(2CR) (LF)
FM BUSHIPS ----------------------------(2CR) (LF)
TO SPERRY GYRO CORP 113 CHURCH ST       (2CR) (LF)
REMINGTON TYPEWRITER CORP 999           (2CR) (LF)
TREMONT ST BSN ------------------------(2CR) (LF)
NAVY GRNC -----------------------------(2CR) (LF)
BT ------------------------------------(2CR) (LF)
THIS IS AN EXAMPLE OF A MULTIPLE        (2CR) (LF)
ADDRESS MSG FOR COMMERCIAL              (2CR) (LF)
ADEES ONLY X ROUTED TO AUTHOR-          (2CR) (LF)
IZED REFILE POINTS NEAREST ADEES ------(2CR) (LF)
BT ------------------------------------(2CR) (LF)
26/124ØZ MAY RBEPD --------------------(2CR) (8LF)
                                 (4Ns) (12 LTRS)

(5 SPACES) (2CR) (LF)
MM RBEBA RBEBC ------------------------(2CR) (LF)
DE RBEPD 88A --------------------------(2CR) (LF)
M 27233ØZ -----------------------------(2CR) (LF)
FM BUSHIPS ----------------------------(2CR) (LF)
TO INSMAT BSN -------------------------(2CR) (LF)
ATLAS CORP 17 SOUTH ST BSN ------------(2CR) (LF)
NAVY GRNC -----------------------------(2CR) (LF)
BT ------------------------------------(2CR) (LF)
THIS IS AN EXAMPLE OF A MULTIPLE        (2CR) (LF)
ADDRESS MSG FOR A NAVAL AND A           (2CR) (LF)
COMMERCIAL ADEE X ROUTED NORM-          (2CR) (LF)
ALLY OVER NTX SYSTEM FOR DE-            (2CR) (LF)
LIVERY TO NAVAL ADEE AND TO             (2CR) (LF)
NEAREST POINT OF COMMERCIAL RE-         (2CR) (LF)
FILE FOR DELIVERY TO COMMERCIAL         (2CR) (LF)
ADEE ----------------------------------(2CR) (LF)
BT ------------------------------------(2CR) (LF)
26/2335Z JUN RBEPD --------------------(2CR) (8LF)
                                 (4Ns) (12 LTRS)
```

TWX

TWX is a commercial teletypewriter system owned and operated by the 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 Navy uses TWX as an extension of the NTX system. TWX serves outlying stations which do not send or receive enough traffic to warrant the cost of circuits and equipment that would make them a part of NTX.

A message to an activity served by TWX is forwarded over NTX to the station nearest its destination and there refiled into the TWX network. The routing indicator given in JANAP 117 for any activity served by TWX is a relay station routing indicator with CX added. For instance, the routing indicator for NAS Lincoln, Nebr., is listed as RBECLCX, which indicates that the message would be sent to RBECL in Olathe, Kans., and there refiled by TWX for delivery to Lincoln. Keep in mind that any time you have a message to an activity whose routing indicator ends in CX, there will be commercial charges for final delivery.

When a message is received by a relay station for refile by TWX, the operator first checks the address to see if the TWX number is given. If not, he looks it up in his TWX number book. When he has the number he calls the local TWX operator and gives her the number he wants, and then stands by until she gives him a GA (go ahead) to send his message.

Assume that RBECL has received a message for refile to NAS Lincoln. This is the way it came in:

```
BEC 78 BEP B58
RR RBECLCX
DE RBEPC 34B
R Ø8Ø91ØZ
FM BUAER
TO NAS LINCOLN L193
BT
BUAER SPARE RH-43-98Ø2Ø SHIPPED THIS DATE FOR
PB4Y2 BUNO 48536
BT
CFN RH-43-98Ø2Ø PB4Y2 48536
Ø8/Ø925Z SEP RBEPC
```

This is the procedure for delivery:

Transmission	*Explanation*
OPR OLATHE KANS 4Ø	RBECL operator calls TWX operator.
GA PLS	TWX operator answers "Go ahead, please."
L193	RBECL operator gives number he wants.
MIN PLS	TWX operator says stand by a "minute please."
L193	TWX operator calls NAS Lincoln.
GA PLS	NAS Lincoln answers.
OLATHE KANS 4Ø CALLING	TWX operator tells Lincoln who is calling.
GA	Lincoln tells Olathe to go ahead. (At this point switchboard operator drops off line, and RBECL transmits message to Lincoln.)

CLASS E NTX MESSAGES

The class E privilege is extended to personnel at most overseas naval stations. Such messages are handled as plaindress, single address messages to points of refile in the continental United States. The three authorized refile points for class E messages are Washington, San Francisco, and Seattle. Following is an example of a class E message in NTX form:

```
(5 SPACES) (2CR) (LF)
MM RBEPC ------------------------------(2CR) (LF)
DE RBEJC 213 --------------------------(2CR) (LF)
M 152347Z -----------------------------(2CR) (LF)
FM NAVCOMMCEN SANJUAN -----------------(2CR) (LF)
TO NAVCOMMCEN WASHDC ------------------(2CR) (LF)
BT ------------------------------------(2CR) (LF)
MSG CK16 NL COMLE MR RICHARD ROE       (2CR) (LF)
ATTY 127 SOUTHSIDE DR CHARLOTTES-      (2CR) (LF)
```

```
VILLE VA DROP SUIT IF TENANT WILL  (2CR) (LF)
SETTLE OUT OF COURT FOR 75 PER-    (2CR) (LF)
CENT ESTIMATED DAMAGE FRANK        (2CR) (LF)
HOUSEWHEEL NAVCOMMSTA PR ----------(2CR) (LF)
BT --------------------------------(2CR) (LF)
CFN CK16 127 75 -------------------(2CR) (LF)
16/Ø2Ø6Z JUN RBEJC ----------------(2CR) (8LF)
                             (4Ns) (12 LTRS)
```

Class E messages originated from ships operating in the area are also accepted by overseas stations of relay to the United States. These are sent by radiotelegraph from ship to station and are handled to point of refile in radiotelegraph form. Following is an example of a message received by a shore station from a ship and forwarded for refile by NTX.

```
(5 SPACES) (2CR) (LF)
MM RBWPC --------------------------(2CR) (LF)
DE RBMPC 92 -----------------------(2CR) (LF)
M 23Ø816Z -------------------------(2CR) (LF)
FM NGFV ---------------------------(2CR) (LF)
TO NPG ----------------------------(2CR) (LF)
GR4Ø ------------------------------(2CR) (LF)
BT --------------------------------(2CR) (LF)
MSG CK27 NL COMLE MRS WILLIAM      (2CR) (LF)
THATCH 48Ø7 MAPLE ST SANDIEGO      (2CR) (LF)
CALIF RECEIVED ORDERS TO DUTY      (2CR) (LF)
GREATLAKES PACK AND MEET ME        (2CR) (LF)
HOTEL MARK HOPKINS SANFRANCISCO    (2CR) (LF)
WILL CALL YOU THERE MY ARRIVAL     (2CR) (LF)
MOFFETT FIELD ABOUT 29 JAN LOVE    (2CR) (LF)
BILL USS ROCHESTER ----------------(2CR) (LF)
BT --------------------------------(2CR) (LF)
CFN CK27 48Ø7 29 ------------------(2CR) (LF)
23/1Ø25Z JAN RBMPC ----------------(2CR) (8LF)
                             (4Ns) (12 LTRS)
```

GARBLE TABLE

As you know, impulses carried over a teletypewriter circuit are governed by the action of five tiny sensing pins in the transmitter-distributor. Operation of those pins through perforations in tape momentarily opens or closes a circuit which determines the impulse to be transmitted. When any of these pins are not functioning properly, garbled copy results. This may be caused by a bent or stuck pin which refuses to operate. Or the opposite may be true. A pin that is broken or operated by a spring that is too strong may transmit a pulse even when there is no hole in the tape.

When you are getting garbled copy you may analyze it by using the garble table. This shows you what is likely to be wrong. For instance, when the letter A appears in place of E in the test tape, you can assume that the second pulse was transmitted without being on the tape. Teletypewriter repairmen describe this by saying: "Second pulse is gaining." Likewise, where the letter E appears when it is known that the letter should be A, it may be assumed that the second pulse has been lost.

As you become familiar with test tapes, you'll have no trouble determining which character isn't printing correctly, or why the message is garbling. Proper use of the garble table will help you make intelligent reports and greatly assist in making repairs. It's always easier to make repairs when the exact cause of the trouble is known.

TEST TAPES

Test tapes are transmitted on a circuit or channel which has just been opened and prior to transmission of traffic. Here is an example of the use of the standard test tape. The interrogatory meaning of the operating signal ZHN is "How do you receive my automatic transmissions?" The reply ZHN1, ZHN2, or ZHN3 indicates, as the case may be, that the transmissions are good, fair, or unreadable.

(5 SPACES) (2CR) (LF)
RR RBWP ----------------------------------(2CR) (LF)
DE RBWD ----------------------------------(2CR) (LF)
TEST THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG

```
1234567890Ø (2CR) (LF)
RYRYRYRYRYRYRYRYRYRYRYRYRYRYRYRYRYRYRYRYRY
INT ZHN K (2CR) (LF) (4Ns) (12 LTRS)
```

When RBWP determines that operation is satisfactory for the reception of traffic, it makes the following transmission:

```
(5 SPACES) (2CR) (LF)
RR RBWP ___________________________________(2CR) (LF)
DE RBWP ___________________________________(2CR) (LF)
ZHN1 K _______________(2CR) (8LF) (4Ns) (12 LTRS)
```

TABULATED MESSAGES

The ability to handle information in tabulated form is one of the many advantages of automatic equipment. If a message is received for transmission in tabulated form, normally it should be transmitted in that form. In some instances the headings of the columns will require more space than the data in the column. When this is the case, use more than one line for the headings. (Compare the form of the headings in the incorrect and correct methods shown below.) Another point: Keep your columns as close to the left margin as possible, for this reduces the total transmission time.

In the first example each dash represents the transmission of a blank or space which requires as much circuit time as the transmission of a character. In the second example (the correct way) the same information is transmitted at a saving of 5 minutes of circuit time, or 300 words.

EXAMPLE (incorrect method):

```
            STOCK REPORT AND REQUIREMENTS
                    QUANTITY
ITEM    CAT NO      ON HAND      ARTICLE        REQUIRE
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
```

ETC. TO ITEM
5Ø ------ 43256------- 42-------- CARBURETORS -- 5Ø

EXAMPLE (correct method):

STOCK REPORT AND REQUIREMENTS

ITEM	CAT NO	QNTY ON HAND	ARTICLE	REQUIRE
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
5Ø	43264	42	CARBURETORS	5Ø

When it is necessary to handle tabulated reports over NTX periodically, your communication officer will arrange a form with the originator that will require the least circuit time for transmission.

MANUAL TELETYPEWRITER PROCEDURE

Manual teletypewriter procedure—that is, the procedure used in sending messages by typing directly on the keyboard—presents little difficulty for the operator versed in radiotelegraph procedure. The two are closely allied, but there are a few differences. Manual teletypewriter omits radiotelegraph separative signs. Message format line 1 is used in manual teletypewriter only when working with tape relay nets. If used, it is the same as format line 1 of the tape relay message format. Lines 14, 15, and 16 of the manual teletypewriter format (all after the second BT) are individual, though sharing many contents with both radiotelegraph and tape relay formats. These three lines are shown in figure 10–3.

MANUAL TELETYPEWRITER MESSAGE EXAMPLES

SINGLE ADDRESS, PLAINDRESS MESSAGE:

(5 SPACES) (2CR) (LF)
(Line 2) --------NSS ---------------------------(2CR) (LF)
(Line 3) --------DE YTLP NR114 ---------------(2CR) (LF)

LINES 14, 15, AND 16, MANUAL TELETYPEWRITER FORMAT

Parts	Components	Elements	Format line	Contents	Explanation
ENDING	Procedure	a. Time group	14	Hours and minutes expressed in digits and zone suffix.	May contain a time group expressed in digits plus the zone suffix.
		b. Confirmation (as required).		Prosign CFN; confirmatory material.	May contain prosign CFN and confirmed portions of message as necessary.
		c. Corrections; final instructions.	15	Prosigns; operating signals; necessary corrections.	Contains final instructions. Identified by appearance of prosign C, operating signals, and corrections, as required.
		d. Ending sign; filing time.	16	Prosign; date-separated by slant from hour and minutes expressed in digits; plus zone suffix.	May contain date and time message was filed with communication center. Date is separated from hours and minutes by a slant. Also contains prosigns K or AR. (The date and time of filing will not be used in ship-ship, ship-shore, or naval radioteletypewriter broadcast circuits.)

Figure 10–3.

(Line 4) --------T ----------------------------(2CR) (LF)
(Line 5) --------R 151412Z --------------------(2CR) (LF)
(Line 6) --------FM CINCLANTFLT ----------(2CR) (LF)
(Line 7) --------TO CNO ----------------------(2CR) (LF)
(Line 10) -------GRNC ------------------------(2CR) (LF)
(Line 11) -------BT ----------------------------(2CR) (LF)
(Line 12) -------A PLAINDRESS SINGLE AD- (2CR) (LF)
DRESS MESSAGE IS TRANS- (2CR) (LF)
MITTED BY MANUAL TELE- (2CR) (LF)
TYPEWRITER AT THIS FORM (2CR) (LF)
(Line 13) -------BT ----------------------------(2CR) (LF)
(Line 15) -------C WA TELETYPEWRITER IN (2CR) (LF)
(Line 16) -------K ----------------------------(2CR) (8LF)

This is a ROUTINE single address message originated by CINCLANTFLT and addressed to the Chief of Naval Operations. In this, as in all message examples throughout this text, format lines not needed for the message are left out.

Line 2—NSS is the call sign for the station called. This station is responsible for delivery to the addressee.

Line 3—YTLP designates the calling station. NR114 is the station serial number.

Line 4—Prosign T.

Line 5—Precedence prosign R ; DTG.

Line 6—Prosign FM; CINCLANTFLT is the originator.

Line 7—Prosign TO; CNO is action addressee.

Line 10—Prosign GRNC.

Line 11—Prosign BT.

Line 12—Text.

Line 13—Prosign BT.

Line 15—Corrects a typing mistake in the text. "At" should be "in."

Line 16—Prosign K.

SINGLE ADDRESS, ABBREVIATED PLAINDRESS MESSAGE:

(5 SPACES) (2CR) (LF)
(Lines 2 and 3) -----NTSS DE DTAK NR35 ----(2CR) (LF)
(Line 5) ------------P ------------------------(2CR) (LF)

(Line 11) ------------BT ------------------------(2CR) (LF)

(Line 12) ------------THIS IS AN ABBREVI- (2CR) (LF)
ATED PLAINDRESS (2CR) (LF)
MESSAGE X DTG AND (2CR) (LF)
GROUP COUNT ARE (2CR) (LF)
OMITTED AND THE (2CR) (LF)
CALL SERVES FOR AN (2CR) (LF)
ADDRESS ----------------(2CR) (LF)

(Line 13) ------------BT ------------------------(2CR) (LF)

(Line 16) ------------K -------------------------(2CR) (LF)

Lines 2 and 3—NTSS is the ship called (a destroyer in DESDIV 172); prosign DE; DTAK is the address group of COMDESDIV 172, calling; NR 35 is the station serial number.

Line 5—Precedence prosign P.

Line 11—Prosign BT.

Line 12—Text.

Line 13—Prosign BT.

Line 16—Prosign K.

CODRESS MESSAGE:

(5 SPACES) (2CR) (LF)

(Lines 2 and 3) -----NBA DE NA NR2∅ ---------(2CR) (LF)

(Line 5) ------------P 2718∅5Z -----------------(2CR) (LF)

(Line 10) ------------GR18 ---------------------(2CR) (LF)

(Line 11) ------------BT ------------------------(2CR) (LF)

(Line 12) ------------(18 encrypted groups) -----(2CR) (LF)

(Line 13) ------------BT ------------------------(2CR) (LF)

(Line 16) ------------K -------------------------(2CR) (LF)

This is a ship-shore radioteletypewriter message prepared in codress form. Radio Balboa, the station accepting the message, must decrypt and pass it to certain local activities named in the encrypted text.

Lines 2 and 3—NBA is the call sign of the accepting station, Radio Balboa.

NA is an indefinite ship's call, used to conceal the identity of the sender.

Line 5—Precedence prosign P; DTG.

Line 10—Group count prosign and figures showing the number of groups in the text of the message.

Line 11—Prosign BT.

Line 12—Encrypted text.

Line 13—Prosign BT.

Line 16—Prosign K.

QUIZ

1. What are the usual component parts of a communication center?
2. An independent message center may serve outlying areas as a ______.
3. Where are the six primary COMMCENS located?
4. Give the significance of the first three letters of a United States routing indicator.
5. A routing indicator containing only four letters always indicates what?
6. What publication holds routing indicators for the United States and Canada?
7. After a message has been punched or transmitted, it is followed by what letters and/or machine functions?
8. What is the "50-percent rule" for confirmations?
9. What are two types of NTX message serial numbers?
10. Plain language NTX messages longer than ____ groups, ____ lines, or ____ teletypewriter pages are prepared for transmission in parts.
11. How is an operator warned that he is receiving a FLASH or EMERGENCY message?
12. If, when cutting a message tape, you make a mistake in the routing line, what must you do?
13. What is a missent message? A misrouted message?
14. If you should receive two copies of a multiple-address message, and the second is not marked SUSDUPE, what can you assume?
15. A message cannot be readdressed if any change is made past what format line?
16. Tracer messages answer three questions. What are they?
17. Tracer proceedings are usually handled by what communication medium?
18. What is meant by the operating signal ZEN in a joint message?
19. For what does the Navy use TWX?
20. What letter is added to the routing indicator to indicate that an activity is served by TWX?
21. How can you identify a book message?

CHAPTER 11

RADIOTELEPHONE

Most of what you learned about radiotelegraph nets is equally applicable to radiotelephone. Just as in radiotelegraph, a net is an organization of two or more stations in direct communication on a common channel. One station in the net, the NET CONTROL STATION, is in charge. Radiotelephone nets may be either free or directed.

The lessons you learned about operation and circuit discipline are also just as important in radiotelephone. Abide by the instructions of the net control station, keep a good log, and stand a taut watch.

DO'S AND DONT'S OF MICROPHONE TECHNIQUE

DO—

1. DO LISTEN BEFORE TRANSMITTING. Unauthorized break-in is lubberly and causes confusion. Often neither transmission gets through.
2. DO SPEAK CLEARLY AND DISTINCTLY. Slurred syllables and clipped speech are both hard to understand. A widespread error among untrained operators is failure to emphasize vowels sufficiently.
3. DO SPEAK SLOWLY. Unless the action officer is listening he will have to rely on the copy being typed or written at the other end. Give the recorder a chance to get it all the first time. You will save time and repetitions that way.

4. Do AVOID EXTREMES OF PITCH. A high voice cuts best through interference, but is shrill and unpleasant if too high. A lower pitch is easier on the ear, but is hard to understand through background noises if too low.
5. Do BE NATURAL. Maintain a normal speaking rhythm. Group words in a natural manner. Send your message phrase by phrase rather than word by word.
6. Do USE STANDARD PRONUNCIATION. Speech with sectional peculiarities is difficult for persons from other parts of the country. Talkers using the almost standard pronunciation of a broadcast network announcer are easiest to understand.
7. Do SPEAK IN A MODERATELY STRONG VOICE. This will override unavoidable background noises and prevent drop-outs.
8. Do KEEP CORRECT DISTANCE BETWEEN LIPS AND MICROPHONE. If the distance is too great, speech is inaudible and background noises creep in; if too small, blaring and blasting result.
9. Do SHIELD YOUR MICROPHONE. Turn your head away from noise generating sources while transmitting.
10. Do KEEP THE VOLUME OF A HAND SET EARPHONE LOW.
11. Do KEEP SPEAKER VOLUMES TO A MODERATE LEVEL.
12. Do GIVE AN ACCURATE EVALUATION IN RESPONSE TO A REQUEST FOR A RADIO CHECK. A transmission with feedback and/or a high level of background noise is not loud and clear even though the message can be understood.
13. Do PAUSE MOMENTARILY, WHEN POSSIBLE, AND INTERRUPT YOUR CARRIER. This allows any other station with higher precedence traffic to break in.
14. Do ADHERE STRICTLY TO PRESCRIBED PROCEDURES. Up-to-date radiotelephone procedure is found in the effective edition of ACP 125.

15. DO TRANSACT YOUR BUSINESS AND GET OFF THE AIR. Preliminary calls only waste time when communication is good and the message short. It is NOT necessary to blow into a microphone to test it, nor to repeat portions of messages when no repetition has been requested.

DON'T—

1. DON'T 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. DON'T HOLD THE MICROPHONE BUTTON IN THE PUSH-TO-TALK POSITION UNTIL ABSOLUTELY READY TO TRANSMIT. Your carrier will block communications on the net.
3. DON'T HOLD A HAND SET IN SUCH A POSITION WHILE SPEAKING THAT THERE IS A POSSIBILITY OF HAVING FEEDBACK FROM THE EARPHONE ADDED TO OTHER EXTRANEOUS NOISES.
4. DON'T HOLD A HAND SET LOOSELY. A firm pressure on the microphone button prevents unintentional release and consequent signal drop-out.
5. DON'T SEND TEST SIGNALS FOR LONGER THAN 10 SECONDS.

PRONOUNCING NUMERALS

Care must be taken to distinguish numerals from similarly pronounced words. Pronounce numerals as follows:

Numeral	*Spoken as*	*Numeral*	*Spoken as*
Ø	Zero	5	Fi-yiv
1	Wun	6	Six
2	Too	7	Seven
3	Thuh-ree	8	Ate
4	Fo-wer	9	Niner

Numerals are transmitted digit by digit except that exact multiples of hundreds and thousands may be spoken as such. EXAMPLES:

Number	
44	Fo-wer fo-wer
90	Niner zero
136	Wun thuh-ree six
500	Fi-yiv hun-dred
1478	Wun fo-wer seven ate
7000	Seven thow-zand
16000	Wun six thow-zand
16400	Wun six fo-wer hun-dred
812681	Ate wun two six ate wun

PHONETIC ALPHABET

Any letter of the alphabet that occurs in radiotelephone is identified by using the standard phonetic alphabet equivalent. The accent for pronunciation is shown here in capital letters.

Alphabet letter	*Phonetic equivalent*	*Pronunciation*
A	ALFA	AL fåh
B	BRAVO	BRÄH VŌH
C	CHARLIE	CHÄR LĒĒ
D	DELTA	DĔLL tåh
E	ECHO	ĔCK ōh
F	FOXTROT	FŎKS trŏt
G	GOLF	GŎLF
H	HOTEL	hōh TĔLL
I	INDIA	ĬN dēē åh
J	JULIETT	JEW lēē ĔTT
K	KILO	KĒY lōh
L	LIMA	LĒĒ måh
M	MIKE	MĪKE
N	NOVEMBER	nō VĔM bē.
O	OSCAR	ŎSS cåh
P	PAPA	påh PÄH
Q	QUEBEC	kēh BĔCK
R	ROMEO	ROW mē ōh
S	SIERRA	sēē ÄIRråh
T	TANGO	TĂNG gō
U	UNIFORM	YOU nēē fôrm
V	VICTOR	VĬK tåh
W	WHISKEY	WĬSS kēy
X	XRAY	ĔCKS rāy
Y	YANKEE	YĂNG KĒY
Z	ZULU	ZŌŌ lōō

PROWORDS

Prowords are words and phrases used to speed the handling of radiotelephone messages. They perform the same functions and are used in the same manner as prosigns are used in the other procedures. Many prosigns and prowords are exactly equivalent in meaning.

Following is a complete list of prowords (except for precedence prowords) together with an explanation of each and the corresponding prosign, if one exists. Learn them now.

Proword	*Meaning*	*Corresponds to*
UNKNOWN STATION	Unknown station	$\overline{\text{AA}}$
ALL AFTER	All after	AA
ALL BEFORE	All before	AB
OUT	End of transmission; no reply expected.	$\overline{\text{AR}}$
WAIT	I must pause a few seconds.	$\overline{\text{AS}}$
WAIT OUT	I must pause longer than a few seconds.	$\overline{\text{AS}}$ $\overline{\text{AR}}$
BREAK	Long break	$\overline{\text{BT}}$
THAT IS CORRECT	Correct	C
THIS IS	From	DE
TIME	That which follows is the time or date-time group of this message.	_____
CORRECTION	Error	EEEEEEEE
DISREGARD THIS TRANSMISSION	This transmission is in error. Disregard it.	EEEEEEEE $\overline{\text{AR}}$
DO NOT ANSWER	Do not answer	F
FROM	Originator's sign	FM
READ BACK	Repeat this entire transmission back to me exactly as received.	G
I READ BACK	The following is my response to your instructions to read back.	_____
GROUPS	Group count	GR

Proword	*Meaning*	*Corresponds to*
GROUP NO COUNT	The groups in this message have not been counted.	GRNC
SILENCE	Emergency silence sign	$\overline{\text{HM}}$ $\overline{\text{HM}}$ $\overline{\text{HM}}$
SILENCE LIFTED	Resume normal transmissions.	_____
SPEAK SLOWER	Your transmission is at too fast a speed. Reduce speed of transmission.	_____
SAY AGAIN	Repeat	$\overline{\text{IMI}}$
I SAY AGAIN	I am repeating transmission or portions indicated.	_____
I SPELL	I shall spell the next word phonetically.	_____
WORDS TWICE	Communication is difficult. Transmitting each phrase twice. (Can be used as an order or request.)	_____
INFO	The addressee designations immediately following are addressed for information.	INFO
EXECUTE TO FOLLOW and IMMEDIATE EXECUTE	Action on the message or signal which follows is to be carried out upon receipt of EXECUTE. EXECUTE TO FOLLOW is used with the normal and delayed executive methods; IMMEDIATE EXECUTE is used with the immediate executive method.	$\overline{\text{IX}}$

Proword	*Meaning*	*Corresponds to*
EXECUTE	Carry out the meaning of the message or signal to which this applies.	$\overline{IX}$ (5-second dash)
VERIFY	Verify with originator and repeat.	J
I VERIFY	I have verified with originator and am repeating.	C
OVER	Invitation to transmit	K
MESSAGE FOLLOWS	A message which requires recording is about to follow.	____
NUMBER	Station serial number	NR
FIGURES	Numerals or numbers follow.	____
ROGER	I have received your last transmission satisfactorily.	R
RELAY (TO)	Transmit this message to all addressees or to the addressee designations immediately following.	T
TO	Action addressee	TO
WILCO	I have received your message, understand it, and will comply.	____
WORD AFTER	Word after	WA
WORD BEFORE	Word before	WB
WRONG	Your last transmission was incorrect. The correct version is ____.	____
EXEMPT	Exempt	XMT
SERVICE	The message that follows is a service message.	SVC

Proword	*Meaning*	*Corresponds to*
SIGNALS FOLLOW	Groups which follow are taken from a signal book. (This proword need not be used on nets primarily employed for conveying signals. It is intended for use when tactical signals are passed on nontactical nets.)	____

RADIOTELEPHONE MESSAGES

Radiotelephone uses a 16-line message format that is closely comparable to the formats used in radiotelegraph and in teletypewriter communications. It also uses the same three military message forms: PLAINDRESS, ABBREVIATED PLAINDRESS, and CODRESS. By far the most common message form in radiotelephone traffic is the abbreviated. In fact, it is sometimes so abbreviated that its resemblance to the basic message format is barely detectable. But the three major message parts are still there: heading, text, and ending. Each of these, as in teletypewriter, can be reduced to parts, components, elements, and contents.

Figure 11–1 is a table showing the correct arrangement of a radiotelephone message. Not all parts, components, elements, or contents are necessarily included in any one message, but when one of them is used it must be placed in the message in the order shown in the table.

Heading

The heading of a radiotelephone message may include any or all of the first 10 procedural lines shown in figure 11–1. More often than not it will include only the call, preceding the text. One explanation for such general use of the abbreviated form is that radiotelephone communication is nearly always conducted with station originating and station addressed in direct communication.

Text

The text of the 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.

Ending

Every radiotelephone message ends with one of the prowords, OVER or OUT. With the use of 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 use of OUT, the sender tells the receiver, "This is the end of my transmission to you and no response is required." There is never a need for using OVER and OUT 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; they are also the names of the signal flags. Flag A is ALFA, flag B is BRAVO, and so on. Signal flags are combined into code groups which have meanings of their own: ECHO KILO TWO, for example, means "anchor is dragging." The meaning of such code groups may be found in appropriate signal publications.

It may sound strange to you that flag signals are sent by radiotelephone, but it is done, and done often. You must be able to recognize whether you are hearing a flag signal or a word or group spelled phonetically. Here is how you will know: If the phonetic alphabet is used, the word I SPELL precedes it, and each phonetic letter is to be recorded as a letter. If you hear I SPELL followed by DELTA OSCAR, you would write it as DO. Without that proword, you can assume the alphabet flags are intended, and record the transmission as DELTA OSCAR.

There is no need for the Radioman to be an expert in visual signaling, but you should be acquainted with the names of flags and pennants. Flag signaling employs the alphabet flags we have already mentioned, numeral flags, numeral pennants, and a set of additional flags and pennants with special meanings. The alphabet flags are used as letters, and numeral pennants as numbers. Numeral PENNANTS are used only in calls. The SPECIALS are used in tactical maneuvers to direct changes in speed, position, formation, and course; to indicate units; to identify units; and for other specialized purposes. The specials are—

Flag or Pennant	*Spoken*	*Written*
CODE or ANSWER	CODE or ANSWER	CODE or ANS
BLACK PENNANT	BLACK PENNANT	BLACK
CORPEN	CORPEN	CORPEN
DESIGNATION	DESIG	DESIG
DIVISION	DIV	DIV
EMERGENCY	EMERGENCY	EMERG
FLOTILLA	FLOT	FLOT
FORMATION	FORMATION	FORM
INTERROGATIVE	INTERROGATIVE	INT
NEGATIVE	NEGAT	NEGAT
PREPARATIVE	PREP	PREP
PORT	PORT	PORT
SPEED	SPEED	SPEED
SQUADRON	SQUAD	SQUAD
STARBOARD	STARBOARD	STBD
STATION	STATION	STATION
SUBDIVISION	SUBDIV	SUBDIV
TURN	TURN	TURN

Radiotelephone Message Format

Parts	Components	Elements	Format line	Contents
H	Procedure	a. Call		Station(s) called (proword EXEMPT, exempted calls). Proword THIS IS and station calling.
		b. Message follows	2 and 3	Proword MESSAGE FOLLOWS.
		c. Transmission identification		Proword NUMBER and station serial number.
E		d. Transmission instructions	4	Prowords RELAY TO; READ BACK; DO NOT ANSWER. Operating signals; call signs; address groups; address indicating groups; plain language.
A	Preamble	a. Precedence; date-time group; message instructions.	5	Precedence designation. Proword TIME; date and time expressed in digits and zone suffix, operating signals.
D	Address	a. Originator's sign; originator	6	Proword FROM; originator's designation as address group(s), call sign, or plain language.
I		b. Action addressee sign; action addressee.	7	Proword TO; action addressee designation as address group(s), call sign, or plain language.
N		c. Information addressee sign; information addressee.	8	Proword INFO; information addressee designation(s) as address group(s), call sign(s), or plain language.

G		d. Exempted addressee sign; exempted addressee.	9	Proword EXEMPT; exempted addressee designation(s) as address group(s), call sign(s), or plain language.
	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; station designation.
		c. Ending sign	16	Prowords OVER; OUT.

Figure 11-1.—Parts, components, elements, and contents of a radiotelephone message.

There are, in addition, the 1st, 2nd, 3rd, and 4th SUBSTITUTES, but these are used only for flag communication and are of no concern to the radiotelephone operator.

Separations in flag signals are indicated by the TACKLINE. This is spoken and written TACK.

The PREPARATIVE, INTERROGATIVE, and NEGATIVE pennants are known as the GOVERNING pennants. In flag signaling they are hoisted either above or below a signal, while in radiotelephone operation they are transmitted as the first or last part of a signal. Their meanings in either case are as follows:

Preceding the signal	*Pennant*	*Following the signal*
Prepare to——.	PREPARATIVE	My present intention is to____.
Questions or inquiries.	INTERROGATIVE	Request permission to____.
Cease, do not——.	NEGATIVE	Action is not being carried out.

RADIOTELEPHONE PROCEDURE

Before you continue your study of radiotelephone, you should be warned that there is no "final" word on any communication procedure. This chapter will help you, but you can keep up with changes only by continued study of current communication instructions.

Radiotelephone transmissions used for illustrative purposes are assumed to pass over the net shown in figure 11–2. Prowords are placed in italics to help you recognize them and see how they are used. Dashes indicate natural pauses.

Calling and Answering

Radiotelephone communication is established by a preliminary call, which will always take one of the following forms:

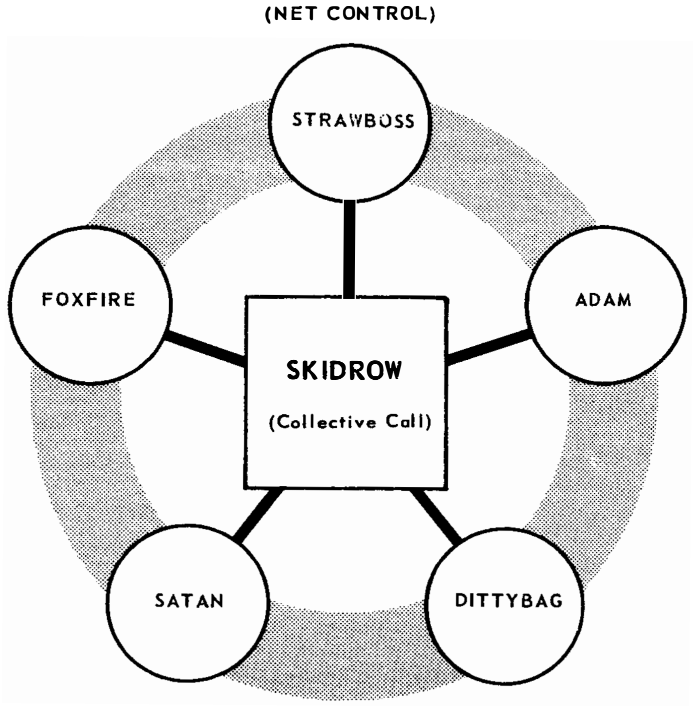

Figure 11–2.—Radiotelephone net.

FULL CALL:

FOXFIRE—	Call sign of receiving station.
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 case a single station has been called; if two or more 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.

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 up 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 will result.

THIS IS ADAM—*OVER*

Clearing Traffic

With communication established, stations commence clearing traffic, as follows:

	Transmission	*Meaning*
Heading	FOXFIRE— SATAN—	Call signs of receiving stations.
	THIS IS	From.
	STRAWBOSS—	Call sign of sending station.
	MESSAGE FOLLOWS—	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 addresses.
	INFO—	Information addressee is——
	FOXFIRE—	Call sign of information addressee.
	GROUPS SEVEN	Group count.

Separation	*BREAK—*	..........Long break.
Text	GO ALONGSIDE FOXFIRE AND EFFECT PERSONNEL TRANSFER—	....Thought or idea conveyed by message.
Separation	*BREAK—*	....Long break.
Ending	*OVER–*	....Go ahead; transmit.

On hearing the proword OVER, receiving stations check the message to see that it has been received fully and correctly. If so, they receipt by use of the proword ROGER, which means "I have received your last transmission satisfactorily."

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 (alone or with ALL BEFORE, ALL AFTER WORD BEFORE, WORD AFTER and ______ to ______), is used for this purpose. In complying with such requests, the transmitting station identifies that portion to be repeated. EXAMPLES: DITTYBAG has sent a message to SATAN. SATAN has missed the word following "ship." SATAN transmits:

DITTYBAG—*THIS IS* SATAN—*SAY AGAIN—WORD AFTER* SHIP—*OVER*

DITTYBAG transmits:

SATAN—*THIS IS* DITTYBAG—*I SAY AGAIN—WORD AFTER* SHIP—SIGHTED—*OVER*

Having received the doubtful portion, DITTYBAG receipts for the entire message with ROGER.

You may give repetitions in plain language messages by natural phrases or by individual words. In encoded or encrypted messages, make them by individual characters.

Correcting an Error

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 1:

> ADAM—*THIS IS* STRAWBOSS—*TIME* ONE ZERO ONE TWO ZULU—*BREAK*—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 2:

> ADAM—*THIS IS* STRAWBOSS—*TIME* ZERO SIX THREE ZERO ZULU—*BREAK*—ARE YOU RIGGED FOR HEAVY WEATHER—*CORRECTION*—*TIME* ZERO SIX FOUR ZERO ZULU—*OVER*

Canceling a Message During Transmission

During the transmission of a message and prior to the transmission of the ending proword OVER or OUT, the message may be canceled by use of the proword DISREGARD THIS TRANSMISSION. (A message which has been completely transmitted can be canceled only by another message.) EXAMPLE: During the transmission of a message STRAWBOSS discovers he is giving it to the wrong station:

> FOXFIRE—*THIS IS* STRAWBOSS—*ROUTINE*—*TIME* ZERO SIX ZERO TWO ZULU—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 following the call. The complete transmission is sent twice. EXAMPLE:

> SKIDROW—*THIS IS* STRAWBOSS—*DO NOT ANSWER* — *OPERATIONAL IMMEDIATE* — *TIME* ONE SIX THREE ZERO ZULU—*BREAK* — NOVEMBER YANKEE DELTA PAPA — *I SAY AGAIN*—*SKIDROW*—*THIS IS* STRAWBOSS—*DO NOT ANSWER*—*OPERATIONAL IMMEDIATE*—*TIME* ONE SIX THREE ZERO ZULU—*BREAK*—NOVEMBER YANKEE DELTA PAPA—*OUT*

Verifications

When verification has been requested on a message, the originating station will verify with the originating person, check the cryptography (if the message is encrypted), and send the correct version.
EXAMPLE 1:

> STRAWBOSS—*THIS IS* ADAM—*VERIFY* MESSAGE—*TIME* ONE ZERO ZERO EIGHT ZERO ONE ZULU—*ALL BEFORE* TEXT—*OVER*

STRAWBOSS transmits:

> *THIS IS* STRAWBOSS—*ROGER*—*OUT*

STRAWBOSS, after checking with the originating officer, finds the heading correct as previously transmitted. STRAWBOSS sends:

> ADAM—*THIS IS* STRAWBOSS—*I VERIFY*—MESSAGE—*TIME* ONE ZERO ZERO EIGHT ZERO ONE ZULU—*ALL BEFORE* TEXT—ADAM *THIS IS* STRAWBOSS—*PRIORITY*—*TIME* ONE ZERO ZERO EIGHT ZERO ONE ZULU—*FROM*—STRAWBOSS—*TO*—ADAM—*INFO*—DITTYBAG—*GROUPS* ONE SEVEN—*BREAK*—*OVER*

ADAM transmits:

THIS IS ADAM—*ROGER—OUT*

EXAMPLE 2:

STRAWBOSS—*THIS IS* SATAN—*VERIFY* MESSAGE—*TIME* ZERO EIGHT FOUR FIVE ZULU —*WORD AFTER* PROCEED—*OVER*

STRAWBOSS transmits:

THIS IS STRAWBOSS—*ROGER—OUT*

STRAWBOSS, after checking with the originating officer, finds that he means HONG KONG instead of SHANGHAI as word after PROCEED. STRAWBOSS transmits:

SATAN—*THIS IS* STRAWBOSS—*CORRECTION* — MESSAGE — *TIME* ZERO EIGHT FOUR FIVE ZULU — *WORD AFTER* PROCEED — HONG KONG—*OVER*

SATAN transmits:

THIS IS SATAN—*ROGER—OUT*

Read Back and Words Twice

Further checks on transmission accuracy can be had by using the prowords READ BACK and WORDS TWICE. You use READ BACK when you want your own message (or a portion of it) repeated back to you as received. Remember to identify the message or portion you want read back. Transmit the READ BACK proword immediately after the call. EXAMPLE:

ADAM—*THIS IS* STRAWBOSS—*READ BACK* TEXT—*TIME* ONE SIX THREE ZERO ZULU —*BREAK*—CONVOY DELAYED ONE TWO HOURS—*OVER*

ADAM replies:

THIS IS ADAM—*I READ BACK* TEXT—CONVOY DELAYED ONE TWO HOURS—*OVER*

STRAWBOSS then sends:

> *THIS IS* STRAWBOSS—*THAT IS CORRECT—OUT*

If a message is repeated back incorrectly, it may be corrected by use of the proword WRONG, followed by the corrected version. In the example above, let us assume that ADAM made a mistake when he read the message back:

> *THIS IS* ADAM—*I READ BACK* TEXT—CONVOY DELAYED TWO ONE HOURS—*OVER*

STRAWBOSS corrects ADAM:

> *THIS IS* STRAWBOSS—*WRONG*—CONVOY DELAYED ONE TWO HOURS—*OVER*

ADAM reads back again:

> *THIS IS* ADAM—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 your intention by transmitting WORDS TWICE after the call. Do not repeat the proword THIS IS.

EXAMPLE:

> FOXFIRE—FOXFIRE—*THIS IS* STRAWBOSS—STRAWBOSS—*OVER—OVER*

FOXFIRE replies:

> STRAWBOSS — STRAWBOSS — *THIS IS* FOXFIRE—FOXFIRE—*OVER—OVER*

STRAWBOSS sends his message:

FOXFIRE—FOXFIRE—*THIS IS* STRAWBOSS—STRAWBOSS—*WORDS TWICE—WORDS TWICE—ROUTINE—ROUTINE—TIME* ONE SIX THREE ZERO ZULU—*TIME* ONE SIX THREE ZERO ZULU—*BREAK—BREAK*—MAIL FOR YOU—MAIL FOR YOU—RECEIVE AT FIRST LIGHT—RECEIVE AT FIRST LIGHT—*OVER—OVER*

FOXFIRE receipts:

STRAWBOSS—STRAWBOSS—*THIS IS* FOXFIRE—FOXFIRE—*ROGER—ROGER—OUT—OUT*

Executive Method

The executive method is used to execute tactical signals so that two or more units can take action at the same time. The abbreviated form is generally used for such messages. Executive messages contain the proword EXECUTE TO FOLLOW or IMMEDIATE EXECUTE, as the case may be, immediately following the call. The signal to carry out the purport of the message is the proword EXECUTE. It may be sent shortly after transmission of the message (NORMAL EXECUTIVE METHOD), later (DELAYED EXECUTIVE METHOD), or in case of urgency, as a part of the final instructions of the message itself (IMMEDIATE EXECUTIVE METHOD). In any case a warning STANDBY precedes the proword EXECUTE. In our first example the OTC sends a message to the task group by the normal executive method.

SKIDROW—*THIS IS* STRAWBOSS—*SIGNALS FOLLOW—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. In order 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*

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 STANDBY—EXECUTE is given. 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 have elapsed. 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, the two texts separated by I SAY AGAIN. The warning proword IMMEDIATE EXECUTE is used in the message instructions instead of EXECUTE TO FOLLOW. The executive signal itself follows in the final instructions of the message. Notice that because only one transmission is made, the immediate executive method message does not allow stations to obtain verifications, repetitions, acknowledgements, and cancellations before the message is executed. EXAMPLE:

SKIDROW—*THIS IS* STRAWBOSS—*SIGNALS FOLLOW—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 has received a certain message, understands it, and can comply with it. Only the commanding officer, or his authorized representative, can authorize an acknowledgment.

The request for an acknowledgment is the word ACKNOWLEDGE (which is 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, since the meaning of ROGER is contained in WILCO. If the acknowledgment cannot be returned at the moment, 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 use these prowords together.

In the following example the OTC sends a tactical signal. He desires acknowledgment from two ships.

SKIDROW—*THIS IS* STRAWBOSS—*SIGNALS FOLLOW—EXECUTE TO FOLLOW—BREAK*—TANGO BRAVO—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, understood 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*

or,

STRAWBOSS—*THIS IS* FOXFIRE—*WILCO*—YOUR *EXECUTE TO FOLLOW*—*BREAK*—TANGO BRAVO—TACK—ONE FIVE—TACK—ZERO ZERO ZERO—TACK—ONE TWO—*OUT*

When ready to execute, the OTC transmits:

SKIDROW—THIS IS STRAWBOSS—STANDBY—*EXECUTE*—ADAM—*OVER*

ADAM receipts as directed:

THIS IS ADAM—*ROGER*—*OUT*

Signal Strength and Readability

A station is understood to have good readability unless otherwise notified. Strength of signals and readability are not exchanged unless there is good reason for it.

The response to the question "How do you hear me?" is a short concise report of actual reception, such as "Weak, but readable," "Strong, but distorted," "Loud and clear," and so on. Reports such as "Five by five," "Four by four," etc., must never be used to indicate quality and strength of reception. EXAMPLES:

Ship (FOXFIRE) and plane (CATFISH ONE) establish communication:

FOXFIRE—*THIS IS* CATFISH ONE—HOW DO YOU HEAR ME—*OVER*

THIS IS FOXFIRE—LOUD AND CLEAR—*OVER*

Had FOXFIRE not received CATFISH ONE strongly, the following transmission might be sent:

THIS IS FOXFIRE—YOU ARE WEAK AND BARELY READABLE—*OVER*

THIS IS CATFISH ONE—*ROGER*—*OUT*

Later, further communication is desired. Conditions are good, so no exchange of strength and readability is needed.

FOXFIRE—*THIS IS* CATFISH ONE—*OVER*
THIS IS FOXFIRE—*OVER*
THIS IS CATFISH ONE—SECOND LEG COMPLETED—*OVER*
THIS IS FOXFIRE—*ROGER*—*OUT*

Relay

The proword RELAY used alone 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*—REPORT NUMBER ROUNDS EXPENDED LAST RUN—*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*—REPORT NUMBER ROUNDS EXPENDED LAST RUN—*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—SATAN—*RELAY TO* FOXFIRE—*MESSAGE FOLLOWS*—*ROUTINE*—*TIME* ZERO ONE TWO TWO ZULU—*FROM*—STRAWBOSS—*TO*—FOXFIRE—*INFO*—DITTYBAG—SATAN—*BREAK*—PROCEED ON MISSION ASSIGNED—*OVER*

SATAN receipts and relays as instructed:

FOXFIRE—*THIS IS* SATAN—*MESSAGE FOLLOWS—ROUTINE—TIME* ZERO ONE TWO TWO ZULU—*FROM*—STRAWBOSS—*TO*—FOXFIRE—*INFO*—DITTYBAG—SATAN—*BREAK*—PROCEED ON MISSION ASSIGNED—*OVER*

Occasionally it is necessary to relay by radiotelephone a message which is received by some other means of communication. In our final example NOLT (FOXFIRE) has received a radiotelegraph message from NAAT (STRAWBOSS) for relay to NRTK (DITTYBAG):

NOLT DE NAAT–T–P–241632Z–FM NAAT–TO NRTK GR3 $\overline{\text{BT}}$ RETURN TO BASE $\overline{\text{BT}}$ K

FOXFIRE places the message in radiotelephone form and relays:

DITTYBAG—*THIS IS* FOXFIRE—*MESSAGE FOLLOWS—RELAY—PRIORITY—TIME* TWO FOUR ONE SIX THREE TWO ZULU—*FROM*—STRAWBOSS—*TO*—NOVEMBER ROMEO TANGO KILO—*GROUPS* THREE—*BREAK*—RETURN TO BASE—*OVER*

Setting Up a Net

FREE NET. The procedures described here are for use either when opening a net for the first time or when reopening a net that has been temporarily secured. In the next example STRAWBOSS opens a FREE net.

SKIDROW—*THIS IS* STRAWBOSS—*OVER*

SKIDROW 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 have been heard:

SKIDROW—*THIS IS* STRAWBOSS—*OUT* (or proceeds with message)

If some station does not reply to a collective call within 5 seconds, the next station goes ahead and answers. The delinquent station then answers last, if able to do so. If the station is having some difficulty that makes it impossible to answer the call at all, the operator reports in to the net when he can. In the example above, 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 answers up, each station indicating the traffic on hand:

STRAWBOSS—*THIS IS* ADAM—I HAVE ONE *OPERATIONAL 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*

STRAWBOSS informs all stations that their transmissions have been heard, and commences to clear traffic in order of precedence:

SKIDROW—*THIS IS* STRAWBOSS—*ROGER*——ADAM—SEND YOUR *OPERATIONAL IMMEDIATE—OVER*

When ADAM has sent and obtained 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 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 FOLLOWS*—(etc.)

When STRAWBOSS hears the proword OUT that ends the exchange between DITTYBAG and FOXFIRE, he directs ADAM to send the ROUTINE that is still outstanding.

As operators are handed messages to be sent out, they call net control and request permission to transmit. SATAN, for example, has a DEFERRED for ADAM:

STRAWBOSS—*THIS IS* SATAN—I HAVE ONE *DEFERRED* FOR ADAM—*OVER*

STRAWBOSS replies (assuming no other station wishes to send a message of higher precedence):

THIS IS STRAWBOSS—SEND YOUR MESSAGE —*OUT*

Whereupon SATAN sends his message. If, however, higher precedence traffic awaited transmission, STRAWBOSS would send:

THIS IS STRAWBOSS—*WAIT—OUT*

When traffic conditions permit, STRAWBOSS would call SATAN and give him permission to transmit:

> SATAN—*THIS IS* STRAWBOSS—SEND YOUR *DEFERRED—OUT*

ADAM answers up to save a preliminary call, and SATAN clears his message.

AUTHENTICATION

A radiotelephone message must be authenticated if there is any chance it might be of enemy origin. Be alert and be quick to be suspicious. You can sometimes (but not always) spot an enemy deceptive message by the operator's mistakes in procedure or in English grammar or pronunciation. One of the best informal authenticators is to be able to recognize the other operator's voice.

QUIZ

1. Why should you listen before transmitting?
2. In what publication can you find up-to-date radiotelephone procedure?
3. What are prowords? What do they correspond to in other procedures?
4. What will happen if you hold a microphone too far from your lips? Too close to your lips?
5. How can you tell whether you are hearing a flag signal or a word phonetically spelled?
6. Name the governing pennants.
7. What proword would you use to cancel a message prior to sending the ending proword OVER or OUT?
8. What is the purpose of the executive method?
9. What is an acknowledgment? Who can authorize sending an acknowledgment?
10. In what order do stations reply to a collective call?
11. If some station does not reply to a collective call, what should the next station do?
12. What is the response to the question, "How do you hear me?"
13. What proword is used to correct transmission errors?
14. When is the proword WORDS TWICE used?
15. How should you NOT test a microphone?

CHAPTER 12

MAINTENANCE

Maintenance includes both measures to prevent malfunction of equipment (PREVENTIVE MAINTENANCE) and measures taken to correct existing malfunction of equipment (CORRECTIVE MAINTENANCE).

Preventive maintenance detects conditions before they cause trouble, and corrects them before they have a chance to affect operation. Well-done preventive work reduces chances for equipment failure and need for more extensive overhaul. In preventive maintenance it's the little things that count. It's a matter of cleanliness and lubrication, of tube testing, and of tightening connections and knobs which have loosened from vibration and normal wear and tear. It is also a matter of routine inspections and tests to be conducted at appropriate intervals, depending upon the nature and extent of operation and type of gear. Preventive maintenance keeps the equipment cared for and its condition under continual appraisal.

Procedures for routine preventive maintenance are found in manufacturers' instruction books, maintenance checkoff books, locally prepared maintenance logs, the volumes of the *Electronics Maintenance Bulletin* (NAVSHIPS 900,000), and in such additional instructions as may be issued.

Corrective maintenance is the task of finding and eliminating troubles after they have started to affect operation of the gear. These troubles are generally reported by operators of the equipment, but also include those discovered by the ship's maintenance force.

MANUFACTURER'S INSTRUCTION BOOK

Two copies of the manufacturer's instruction book normally are supplied with each new equipment in accordance with contractual requirements. A typical instruction book contains a general description of the equipment, the theory of operation, directions for installation and operation, procedures for preventive and corrective maintenance, and possible troubles and probable causes. There will be circuit diagrams and there may be parts lists. As can be seen, the instruction book is an important source of information to maintenance personnel.

MAINTENANCE CHECKOFF BOOK

The maintenance checkoff book is prepared by the manufacturer to provide a means of specifying and recording the necessary preventive maintenance for an equipment over a period of 1 year. The book contains sheets for daily, weekly, monthly, quarterly, semiannual, and annual checks. Operating personnel are called upon to assist the technician by performing certain periodic checks (indicated by appropriate markings in the book).

Procedures for performing the checks are given in a series of charts. (See right-hand page of fig. 12–1). At the top of the first chart page for each period (daily, weekly, etc.) is a list of the test equipment (if any) for the checks in that period. There is also a list of operating conditions and control settings. These apply to all steps on the page unless other subsequent changes in conditions and settings are given elsewhere on the page.

Step numbers of procedures are enclosed in circles, for easy association with the corresponding left-hand illustrative page. The illustrative page facing each chart page

Quarterly NAVSHIPS 92121.41 AN/SRT-14, -15, -16

Steps thru

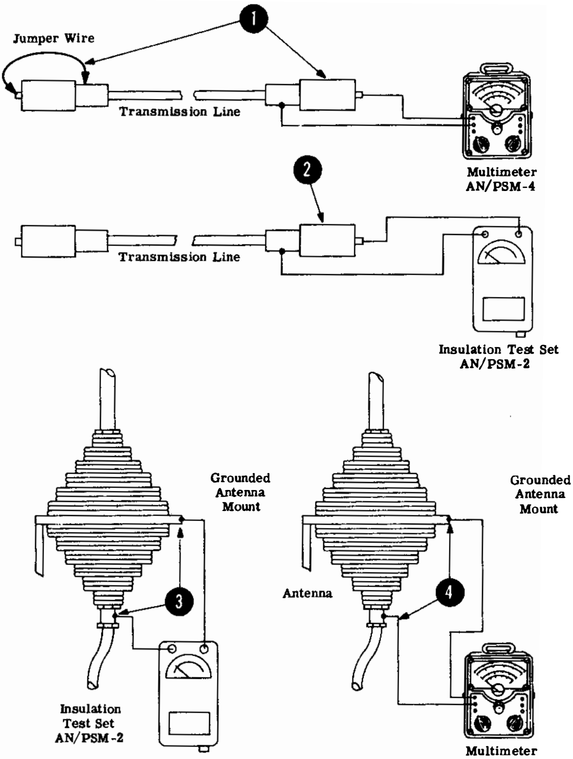

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Figure 12-1.—Opposing pages from a maintenance checkoff book.

Steps 1 thru 4

Operating Conditions and Control Settings:

All transmitter Primary Power switches set to OFF position; Antenna and transmission lines disconnected.

Test Equipment Required:

Multimeter AN/PSM-4
Insulation Test Set AN/PSM-2

STEP NO.	STEP ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	PERF. STD.
1	Record transmission line resistance.	Connect Multimeter AN/PSM-4, using R x 1 ohmmeter scale, from inner conductor to output conductor of transmission line. Connect jumper wire from inner to outer conductor at opposite end of transmission line. Record resistance (a) of line from transmitter to Antenna Coupler, and (b) from Antenna Coupler to Radio Frequency Tuner.	Multimeter AN/ PSM-4	(a)____ ohm (b)____ ohm (See page ii.)
2	Record transmission-line insulation resistance.	Connect Insulation Test Set AN/PSM-2 from inner to outer conductor of (a) transmission line from transmitter to Antenna Coupler, and (b) transmission line from Antenna Coupler to Radio Frequency Tuner.	Insulation Test Set AN/PSM-2	(a)____ meg (b)____ meg (50 or over)
2	Record antenna insulation resistance.	Reconnect all transmission lines. Set BYPASS switch (S402) to TUNER IN, ANTENNA COUPLER LOADING switch (S404) to A, and TRANSFORMER switch (S403) to DIRECT. Connect Insulation Test Set AN/PSM-2 as shown on opposite page, and record insulation resistance.	Insulation Test Set AN/PSM-2	____ meg (50 or over)
4	Record antenna cable resistance.	With all antenna cables connected, set BYPASS switch (S402) to TUNER IN, ANTENNA COUPLER LOADING switch (S404) to DIRECT, and TRANSFORMER switch (S403) to DIRECT. Connect Multimeter AN/PSM-4, using R x 1 ohmmeter scale, as shown on opposite page.	Multimeter AN/PSM-4	____ ohm (See page ii.)

Time Schedule: Record and initial. Approx Time Reqd for Quarterly Steps — 3 hr

Quarter		1st Quarter 19__	2nd Quarter 19__	3rd Quarter 19__	4th Quarter 19__
Step 1	a				
	b				
Step 2	a				
	b				
Step 3					
Step 4					
Initial					

Figure 12-1.—Continued.

shows equipment setup for each procedural step on that chart page, and each setup carries a step number (circled) corresponding to the step of the chart to which it applies. Arrows leading from this step number present graphically certain basic information given in the associated step of the chart, as follows: the point where the test equipment is to be connected; the setting of the pertinent control or switch; and the indicator from which the test reading is to be taken.

LOCAL MAINTENANCE LOGS

In addition to maintenance publications provided by manufacturers, individual ships and stations may have locally prepared logs to record and ensure performance of minor routine maintenance. Here is a sample section from such a log for a receiver:

DAILY

1. Operate equipment for at least 10 minutes.
2. Check operation of all controls. Look for binding, excessive play, loose knobs, etc.
3. Inspect equipment and associated antennas for general cleanliness.
4. Check pilot and dial lights.
5. While operating equipment, watch for deterioration of reception characteristics, such as receiver gain falling off, or noise level increasing.

WEEKLY

1. Check operation of interlocks and other safety devices.
2. Clean equipment thoroughly, inside and out. Use a soft, dry cloth or brush and, if available, a vacuum cleaner.
3. Check tubes for proper seating in sockets and proper action of tube clamps.

MONTHLY

1. Check for loose plugs, fittings, ground straps, terminals, bolts, etc.
2. Check for evidence of overheating and other abnormal conditions.
3. Clean and lubricate sliding mechanical contacts.
4. Clean and burnish fuses and relay contacts as required.

The form is provided with a place for the date and the initials of the man making the checks.

FAILURE REPORTS

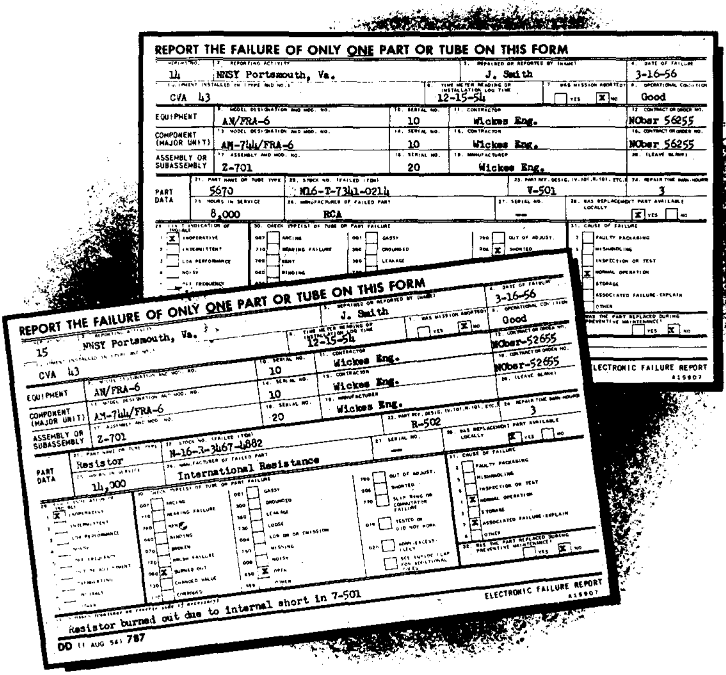
It is of major importance that the Bureau of Ships be informed promptly of ALL failures of electronic equipment parts, and if special instructions are issued for the equipment, of electron tubes. Accurate failure reports provide the basis for modifications to existing equipments, as well as guidance for design and manufacture of new gear. It is particularly important to report actual operation circumstances under which failures occur.

Failures of and reports on all items or parts of electronic equipments, either electrical or mechanical, are classified in two categories:

1. Electron tubes and piezo-electric quartz crystals.
2. All other items or parts contained in or supplied as components, parts, or maintenance parts for use in or with electronic equipment.

The Department of Defense Electronics Failure Report, DD–787 (which supersedes NAVGEN 1025 and the earlier NAVSHIPS 383 report card), is the form on which failures are to be reported. (See fig. 12–2.) The form must be filled out in conformity with interleaved instructions included with pads of forms.

All failures must be reported and a separate form filled out for each failure. Reports should be mailed promptly to the Bureau of Ships. No covering letter is necessary, unless required to explain circumstances surrounding the


REPORT THE FAILURE OF ONLY ONE PART OR TUBE ON THIS FORM

14 | NNSY Portsmouth, Va. | J. Smith | 3-16-56
CVA 43 | 12-15-54 | NO | Good
EQUIPMENT AN/FRA-6 | 10 | Wickes Eng. | NObsr 56255
COMPONENT (MAJOR UNIT) AM-744/FRA-6 | 10 | Wickes Eng. | NObsr 56255
ASSEMBLY OR SUBASSEMBLY Z-701 | 20 | Wickes Eng.
PART DATA 5670 | N16-T-73441-0214 | V-501 | 3
8,000 | RCA | YES

ELECTRONIC FAILURE REPORT

REPORT THE FAILURE OF ONLY ONE PART OR TUBE ON THIS FORM

15 | NNSY Portsmouth, Va. | J. Smith | 3-16-56
CVA 43 | 12-15-54 | NO | Good
EQUIPMENT AN/FRA-6 | 10 | Wickes Eng. | NObsr-52655
COMPONENT (MAJOR UNIT) AM-744/FRA-6 | 10 | Wickes Eng. | NObsr-52655
ASSEMBLY OR SUBASSEMBLY Z-701 | 20 | Wickes Eng.
PART DATA Resistor | N-16-R-3467-4882 | R-502
14,300 | International Resistance

Resistor burned out due to internal short in 7-501

DD 1 AUG 54 787

ELECTRONIC FAILURE REPORT

Figure 12–2.—Form DD–787, with sample entries.

failure, or to make recommendations for correcting the deficiency. Ordinarily the remarks portion of the report form is adequate for explanatory comments.

HANDLING AND TESTING ELECTRON TUBES

All electron tubes received by a ship, station, or other using activity must be examined immediately for signs of breakage, defective packing, and rough handling. Electrical tests also must be conducted where feasible. Large or expensive tubes must be checked for filament continuity, shorted elements, and presence of gas. If a suitable gas detector is available, tubes (other than mercury or gas-filled rectifier tubes) must be tested for gas. Where possible, tubes should be checked by operation in an equipment socket under rated operating conditions. New tubes received from supply activities and found upon test to be unfit for use are returned to the supply activity in accordance with established instructions.

Tubes should not be allowed to remain inactive or indefinitely in storage if use is possible. Little-used tubes, including those in emergency equipment, should be advanced into active equipment as replacements are required. The oldest tubes, as indicated by the dates of acceptance by the inspector of naval material, should be placed in active service before tubes with subsequent dates of acceptance.

TROUBLESHOOTING RADIO EQUIPMENT

To locate faults or defects quickly, certain basic electrical tests can be made. As a general rule, begin by testing the power supply to see that current in the proper amount is reaching the equipment. Following this, examine the cordage for defects, and inspect the fuses. (Except in emergency, blown fuses are never replaced until the cause of failure has been located and cleared.) When you have determined that current is flowing normally, your test of the power supply is completed.

Use common sense when working on equipment. For instance, if the equipment—say a receiver—is energized, and line power is available, you know the trouble is located within the set. Bypass the power tests and search for the trouble source within the equipment.

Once you have determined the gear is getting ample power, test the tubes one by one. Tubes with an open filament or heater can be detected with a tube tester or, if not available, with an ohmmeter. Burned-out tubes should not be replaced until possible set or circuit troubles have been located. It is always wise to run a voltmeter and resistance test on the set before putting in new tubes, since the trouble may be caused by improper voltage. Sockets should be inspected for loose connections and foreign matter. If the set still fails, section-by-section and circuit-by-circuit tests must be made.

Circuit-by-circuit tests include voltage, current, resistance, and dynamic (signal tracing) tests. With exception of resistance tests, all are conducted with tubes in operation and with normal power applied. Resistance tests, alone, are conducted with power off.

The instruction book or equipment checkoff list will indicate exact points at which to take measurements. Readings that differ materially from the maintenance data in your references generally indicate defects.

When working with receivers, a current test will normally be used only after other tests have failed to disclose the trouble. On the other hand, the current test increases in importance when you are working on transmitters, since transmitters deal with greater voltages.

When testing most equipments, it is advisable to make resistance tests first. Here's why: You know that the equipment is not operating as it should. If the trouble can be located through a resistance test, you can remedy the defect without turning on the power and possibly endangering other parts of the equipment.

It is not easy to generalize and recommend a definite procedure to follow in searching for troubles. There are too many possible sources. Attempt, by logic, to isolate the trouble to a particular circuit of the equipment. As an example, if the B-band of a receiver is all right, but the C-band is dead, reasoning will tell you that the loudspeaker, power supply, or audio circuits are not to blame. By this process of elimination you can concentrate on circuits in the band at fault.

To make certain the job has been done right—that soldering is good, and the assembly is correct—a thorough inspection should be made after you replace parts or make repairs. Conduct a final test run and make it long enough to assure that repairs are adequate. Only then is it ready for operation.

Whatever type of test you conduct, always observe the safety precautions.

CLEANING RADIO EQUIPMENT

All radio equipment should be cleaned, not just for appearance, but to assure good performance. Transmitters and receivers should be cleaned at least once a week. To clean the inside of receivers, a hand bellows or any form of dry air pressure is convenient for blowing out dust particles. Where it is necessary to wipe out a receiver, use a soft rag. Receiving antenna insulators deserve special attention, for a collection of dirt, salt spray, and paint will impair reception.

During routine transmitter cleaning periods the contacts of rotating inductors and capacitors should be checked, as well as the surface of these parts. Poor operation of these contacts causes the plate current meter to jump slightly as the circuit is tuned through resonance. The contacts and the surface of the inductors must be clean and smooth. If necessary to prevent scoring the copper surface, a tiny amount of vaseline may be applied. Couplings between dials and rotating inductors or variable capacitors should be inspected carefully. Set screws in these couplings may become loose, causing the dials to have considerable backlash. Backlash produces errors in the settings.

Never allow transmitter insulators to become coated with dust, dirt, or paint, for this increases the danger of arcovers. Once an RF insulator arcs it usually has to be replaced, as the RF burn cannot be reinsulated or cleaned.

TELETYPEWRITERS

The most important factor in maintenance of teletypewriter equipment is proper lubrication and cleaning of the machines. Lubrication does not mean drenching the teletypewriter with oil or swabbing it with grease. Too much lubricant will, in a short time, collect dust and grit and oil-soak the wiring. A machine in this condition will be subjected to excessive wear and deterioration of insulation. Such machines are a fire hazard as well as a source of constant trouble.

It is important that you understand your cleaning and lubrication responsibilities. On most shore stations the operators are not required to clean or lubricate equipment. These duties are assigned to the station's maintenance branch. However, on small stations or on some ships, it may be necessary for the operator to clean and lubricate. You should not attempt the job alone until you have done it several times under supervision of an experienced hand. Even so, be sure to consult references which give exact lubrication specifications. The instructions that follow are general.

To do the job properly, have the following material on hand:

1. A cleaning stick, also called orangestick, type KS-6320.
2. Clean cheesecloth.
3. Lubricants called for by the manufacturer's instruction book.

Before beginning to clean or lubricate there is one thing to remember: ALWAYS TURN THE POWER OFF.

When cleaner is used on metal parts, be sure that any unit on which you use it is not allowed to stand more than 1 hour before grease or oil is applied to the cleaned surfaces. A good cleaning mixture is kerosene and SAE-10 oil. This mixture leaves a rust-preventing residue of light oil on the metal. NEVER use a paraffin base oil, for it will leave the parts gummy, resulting in sluggish action of moving parts.

Before cleaning or relubricating, wipe old grease and oil off the machine. Old grease and dirt should be removed with an orangestick or a piece of fabric. Avoid wiping grease or dirt into wearing surfaces; this makes it difficult or impossible for fresh lubricant to work in. Avoid disturbing springs or adjustments. TROUBLES FREQUENTLY DEVELOP AS A RESULT OF CARELESS CLEANING OR INSPECTION.

A clean, dry piece of cheesecloth may be wrapped around a screwdriver or orangestick to reach points not readily accessible. Finish cleaning the machine before starting lubrication.

CLEANING TYPE. Insert a doubled piece of cheesecloth between the type bars and backstops to catch dirt and excess cleaning fluid. Clean the type thoroughly with a piece of cheesecloth moistened with Varsol or patented type cleaner. Use the cleaning fluid sparingly to avoid getting it on other parts of the machine. Then brush the type with a dry typewriter brush.

CLEANING KEY CAPS. Clean key caps with a cloth slightly moistened with water. Do not use carbon tetrachloride on rubber caps.

CLEANING SELECTING MECHANISM. The code bar bearings, T-lever pivots, and the sword and selector lever assembly between the separator blades should be cleaned without disassembling. Pour over each assembly about a teaspoonful of approved cleaner. Hold a rag underneath the mechanism during the cleaning process to catch drippings.

Transmitting contacts should not be cleaned unless there is evidence of keyboard trouble. When necessary, they can be cleaned with clear carbon tetrachloride and wiped bright with a lint-free cloth.

After a thorough cleaning, the equipment is ready for lubrication. The different kinds of teletypewriter lubricants are used as follows:

1. Oil, for small moving parts.
2. Grease, for heavy moving parts.
3. Oil-grease-oil, for ball bearings.

An oil can with a spout at least 3 inches long and with the tip curved is useful for applying oil. Grease should be applied with a No. 88975 (KS–3819) grease gun or, if not available, with a toothpick, screwdriver blade, or similar instrument.

Springs require a small dab of grease where the spring hooks into a retaining hole or grommet. Bushing-type bearings have a small oil cup (with wick) which should be kept filled. All fiber and metal gears require a small amount of oil. Friction washers on the selector unit and the main shaft in the transmitter-distributor are lubricated by forcing the point of a screwdriver beneath the felt washers.

When lubricating most parts, apply a single drop of oil. Two or three should be sufficient at any point. Oil cups should be filled completely but not to the point of overflow. New felt washers and wicks must be thoroughly saturated in oil, then squeezed by hand to remove any excess.

If a teletypewriter is used 8 hours a day, the machine should be cleaned and lubricated every 250 hours. When a machine is in continuous service, it should be cleaned and lubricated every 200 hours. The schedule may be adjusted according to operation of the equipment. It's a good idea to lubricate at least once in 2 weeks and clean at least once a month. A record must be kept of each machine in use, showing hours of operation and dates of cleaning and lubrication, as well as dates of major and minor overhaul.

MOTORS AND GENERATORS

Keep interior and exterior of motors and generators free from metal dust, dirt, oil, or water. Take particular care to prevent metal dust from collecting inside the end windings of the armature—that means both the coupling and commutator ends. Dirt, aside from restricting the air flow, is a heat insulator. An excessive accumulation will eventually ground the coils and burn them out.

Compressed air, if dry, is the most effective means of cleaning interior parts of motors and generators. The hand bellows is preferred to a pressure hose for there is less chance that small metal particles will be driven into the insulation. When cleaning a machine, take care not to crowd dirt into the air ducts or into narrow spaces between conducting parts. Carefully wipe and clean brush holders, studs, and leads to remove all traces of metal dust worn from the commutator. Also guard against carbon dust from the brushes.

The Commutator

The commutator should be kept clean by wiping with light canvas, cheesecloth, or woolen cloth, but don't allow any threads to lodge on the brushes or between the segments. If oil or carbon dust collect on the commutator, they will make trouble.

If you use sandpaper on the commutator, keep your touch light. Never apply emery cloth, for this is a metallic conductor, particles of which will lodge between the segments and short-circuit them. If it becomes necessary to use sandpaper to smooth the commutator, fit it on a wooden block shaped to the curve of the armature. Hold it firmly against the surface and draw in the direction the armature normally rotates.

Brushes

Brushes should move freely in the holders and make proper contact with the commutator. They should be staggered in pairs of studs, allowing a positive brush to follow the same path as a negative brush to offset the electrolytic effect (fig. 12–3).

Sparking and its Remedies

When a motor or generator sparks, it is an indication of a condition which should be remedied promptly to prevent serious trouble. There are a number of things which will produce sparking; often the type of sparks thrown will give you a clue to the underlying trouble. But there are no hard-and-fast rules in this matter. The types of sparks simply tell you what is LIKELY to be wrong with the machine.

Poor brush contacts may cause continuous heavy sparking or heat the brushes until they glow. Improper brush contact may be caused by three things: high spots on the

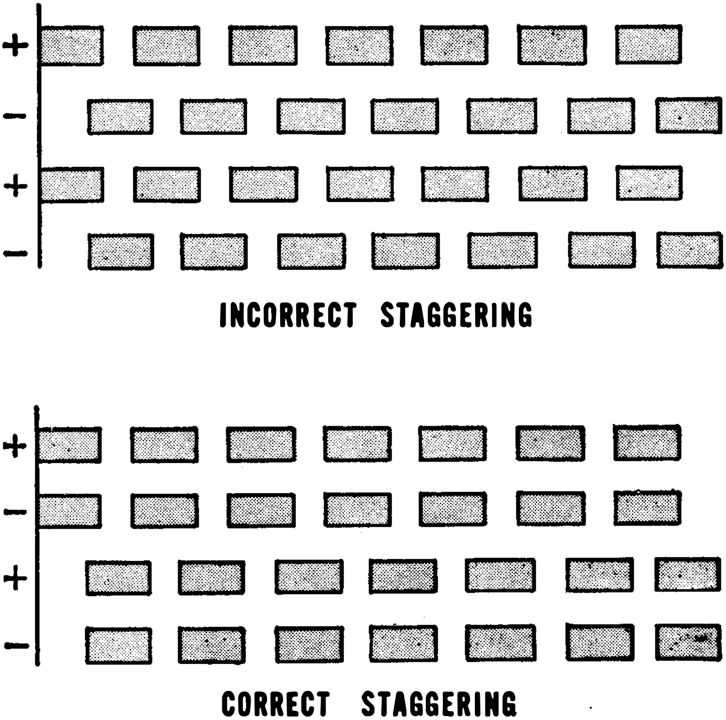


Figure 12–3.—Correct and incorrect stagger of brushes.

brushes, binding of brushes in their holders, and varying spring tension among different brushes. In any case, here is what happens: Effective brush area is reduced, causing the small area of actual contact to carry an excessive current load.

You can eliminate high spots on brushes by placing a piece of sandpaper face-up on the commutator, then revolving the commutator with the brushes held in firm contact. Grind the face of the brushes down to an even bearing. After running a short time, the appearance of the brush faces will indicate whether they will soon wear to a proper fit over the entire surface. Any brush showing a fit over only a small area should be sandpapered again.

If the trouble is a result of brushes binding, clean the holder and make sure the brush is free to move in the holder. Finally, check the spring tension.

Brushes should be adjusted to an equal tension of 1½ to 2 pounds per square inch each on the commutator, and about 4 pounds per square inch each on collector ring brushes. Brush holder studs should be checked for alignment with the armature shaft and to see that they are rigidly secured to the rocker. Holders in turn should be securely clamped to the studs. Brushes must fit in holders snugly, but not so snugly as to bind. Check each pigtail to make sure it is not loose, for such looseness often causes abnormal brush heating, and consequent loss of spring tension.

Continuous light sparking may be caused by wrongly spaced brushes, or it may be an indication that the mica between the segments of the commutator has not worn down as rapidly as the copper, thus causing the brushes to vibrate. Wrongly spaced brushes can be caused by a blow to the brush holder or the rocker ring, bending one or the other out of alignment. Wrong spacing may also be caused by a poor setting when the brush holder stud is tightened.

A large percentage of commutator troubles can be eliminated by undercutting the mica insulation with a sharp tool. Undercutting is the surest way of eliminating high mica trouble, but the job must be done carefully. When cleaning the slot of a properly undercut commutator, use a thin wooden wedge instead of a steel instrument.

Coil Trouble

Occasionally, defective coils will give difficulty. But there is no simple "sparking clue" to give a hint of the trouble. A faulty coil may produce blue, snappy sparks, a ring of fire, or continuous heavy sparking. If the coil is OPEN-CIRCUITED, the trouble is usually a loose connection between the armature coil and the commutator bar. This condition is indicated by a blue, snappy spark, occurring just as the bar leading to the defective coil passes under a brush. If the contact is definitely broken, the spark will hold between the bars, producing a ring of fire around the commutator and burning the mica between the segments. The connection may at times be broken, and at other times give sufficient contact to carry the current without trouble. This will give rise to intermittent sparking.

To locate accurately an open-circuited coil, if inspection does not disclose it, remove all brushes from the commutator except one pair. Across these brushes connect leads from the lighting circuit with a lamp in series, or use two dry cells to furnish a low-voltage supply. With a low-reading voltmeter take readings from bar to bar around the commutator, rotating the commutator slowly so that the bars will be successively under the brushes. If readings are the same all around, no trouble is indicated. If the reading across one coil is equal to voltage across the brushes, and all other readings are low and of equal voltage, the open circuit is found. An aggravated condition will often be indicated by local high temperature, and sometimes by an actual burning of the commutator bar attached to the defective coil.

When sparking is caused by a SHORT-CIRCUITED coil, there is a simple test which will help uncover the trouble. Hold a piece of iron (screwdriver or other tool) a few inches from the end windings. The iron will throb each time the short-circuited coil passes. To locate the defective coil accurately, test with a low-reading voltmeter as you did for open-circuited coils. In this case a zero reading, or a reading materially less than the other readings, will indicate the trouble. This condition is also accompanied by local high temperature and often by burning of the commutator segment.

Sparking may be caused by a GROUNDED coil. In this case, the trouble can be located by using a megger and reading the armature resistance to ground. At least 0.5

megohm is required for proper operating condition, and the initial insulation resistance to ground is 1 megohm. If a ground is indicated by this general test, use the low-voltage test, connecting one voltmeter lead to the shaft and the other to each segment in turn. Should readings be the same, the armature is not grounded. If grounded, readings will vary, and there will be two segments with practically zero readings. One of these is the real ground; the other, a phantom. Mark both with chalk, rotate the armature a few degrees, and again make the test. The real ground will read on the same bar as before, while the phantom will shift to another bar.

Baking will often remove moisture grounds, and a jury oven may be rigged by using a box or even a tarpaulin for the cover—anything big enough to cover the armature, or even the whole machine. By using a lamp bank, maintain a temperature of from 135° to 150° F. and take megger reading to ground until the insulation resistance reads 0.5 megohm or better. This may take several days. If the field coils have moisture grounds, the armature may be disconnected and a properly regulated current applied to the field for drying out. A thermometer can be placed in the windings to determine the rise in temperature. The rise, with properly adjusted current, should be at a slow and uniform rate.

If the trouble cannot be remedied readily, the armature should be replaced by a spare, and the old armature repaired promptly. When a spare is lacking, a jury rig may be made by disconnecting the broken coil from its segments. The segments then can be connected by bridging them with a piece of strip copper of sufficient size to carry the current. Solder the copper at the segments to secure a good connection.

When your machine produces continuous heavy sparks, it is usually a sign of overload or defective coils. Look for overload first. If the sparking starts suddenly and without apparent reason, the controlling ammeter should be checked. While all Navy equipment is designed to allow for an overload, running in this condition for any length of time will break down insulation. When an enclosed motor is found running hot, it may be opened to cool it, but care should be taken to see that it is not left open where dust and moisture may collect. If overheating occurs too often, the trouble should be located and corrected.

The importance of checking the speed and ampere load after each overhaul cannot be overstressed. It is good for the equipment, and it provides excellent training in use of test instruments.

You are already familiar with steps to be taken if continuous heavy sparking is produced by faulty coils.

A bright spark appearing under one brush and gradually grooving the commutator is due to a particle of copper embedded in a brush. At the point indicated by the spark, the local contact resistance is reduced, causing an abnormal current to pass. Remove the copper by scraping the brush face with a knife and sandpapering the brush to a fit.

A single bar, which has raised above or dropped below the cylindrical surface of the commutator will cause periodic sparking. As soon as possible, stop the machine and tap any raised bars back into place with a block of wood and a mallet. A low bar is seldom found. It usually indicates a slackening of the commutator and bolts, making a readjustment of all bars necessary. If the commutator bars are loose, the nuts on the end should be tightened and the entire commutator given a light cut.

Sparking, which appears as a "ring of fire," is sometimes seen when an improperly cared-for motor is put in operation. Dirt, collected between the segments, is usually the cause. It forms crosses, which are burned out as the voltage increases, endangering the insulation.

Lubrication

Motors and generators, like other machines, need oil and grease. See that oil wells or grease cups are filled with a good quality lubricant. Under average conditions and normal running periods, the lubricant should be drained or cleaned every 60 days and replaced with fresh, clean lubricant. When filling containers for oiling motor bearings, be sure that the oil level is not high enough to leak along the armature shaft. Overfilling these containers will cause a flow into the brush rigging and lower field coils. This condition will also cause oil to creep into the interior of the spider and thence to the commutator windings. Serious troubles result when that happens.

Motor-Starting Panels

The very fact that a motor-starting panel or controller is automatic usually leads to its neglect. To function properly, this equipment needs the same care and rigid inspection required for transmitters, generators, motors, etc.

Controllers of the panel type should be cleaned with a painter's duster, a brush having soft bristles and no metallic binding. If it is necessary to remove anything other than dust, use a soft flannel rag or a chamois skin. Cotton waste or rags will leave lint.

When you inspect a panel, be sure connections are tight —soldered or brazed, if practicable. Don't overlook the wires behind the board. The tendency of the ship's structure to weave will sometimes cause enough movement of the wires to bring about abrasion and, in time, breakdown. Speaking of wiring, make a thorough study of panel-wiring diagrams. Knowing the sequence of operation will save you valuable time in an emergency.

TYPEWRITERS

A typewriter that is used with care will give many years of service. Typewriter manufacturers claim that the modern typewriter never really wears out if it is not dropped or otherwise abused. The fact is that with ordinary careful use, and with regular cleaning and adjustment, typewriters can be counted on for about 10 years of satisfactory service.

A typewriter should be brushed out by the operator at the end of each day. Keys should be cleaned often with one of the various cleaners available for the purpose. Nothing looks worse than messages written up for delivery with the o's and e's filled up because dirt in the characters is printing through the ribbon. Any commercial type cleaner procured by the Navy is satisfactory. Put out your cigarette before you start.

Eraser waste must be cleaned away often if the typewriter is to stay in good condition. It can be removed with a long-handled brush. The best way to prevent accumulation of rubber crumbs is to move the carriage far enough to left or right that the point of erasure is not over keys or other mechanical parts of the typewriter. The waste will then drop on your desk from where it can be brushed away.

The cylinder and rollers should be cleaned occasionally with alcohol. This will prevent their leaving streaks of dirt on paper inserted in the typewriter. In this connection, it is best to use only one typewriter in the office for cutting and correcting stencils; otherwise the rollers of all your typewriters will become coated with wax from the stencils.

The typewriter should be oiled occasionally. But do it carefully. Apply oil only at friction points, and don't use too much. When finished, wipe away excess oil; otherwise it will drip on other parts and in time form a gummy mass with dust and eraser crumbs. Keep oil from getting on rubber parts, the ribbon, and any place in the machine where it might stain the paper.

Keep your typewriter covered when not in use. No matter how clean the office, a certain amount of dust and foreign substances is always in the air. When the machine is uncovered for long periods, dirt gets into the moving parts of your machine and causes wear.

DUPLICATING EQUIPMENT

A number of different duplicators are in use by communication activities ashore and afloat. Some, such as those in the larger shore stations—where it is often necessary to make hundreds of copies of a single message—are large and complex pieces of machinery. Instructions regarding the operation and care of duplicators may be found in manufacturers' instruction manuals, and in *Instrumentman 1&C,* NavPers 10194–A.

QUIZ

1. What are two types of maintenance?
2. What is an important source of information necessary in the maintenance of equipment?
3. What are the two categories into which failure reports on electronic equipment are classified?
4. Why should transmitter insulators never be allowed to become coated with dust, dirt, or paint?
5. What is the most important factor in maintenance of teletypewriter equipment?
6. How often should a teletypewriter machine in continuous service be cleaned and lubricated?
7. What should always be remembered before attempting to clean or lubricate your equipment?
8. What is the most effective means of cleaning the interior parts of motors and generators?
9. Why should you never use emery cloth to clean the commutator?
10. What is the surest way to eliminate high mica trouble on a commutator?
11. What are two causes of sparking in a motor?
12. Why must you avoid overfilling containers for oiling motor bearings?
13. What is the purpose of cleaning the cylinder and rollers of a typewriter?
14. Why must excess oil be wiped away after oiling a typewriter?

CHAPTER 13

SAFETY

When working with radio, or with any electronic equipment, there is one rule that cannot be too strongly stressed: SAFETY FIRST. Dangerous voltages energize much of the equipment with which you work. Power supply voltages range up to 40,000 volts, and radio-frequency voltages are even higher.

Special precautions are also necessary because of the effect of electrical fields existing in the vicinity of antennas and antenna leads which may introduce fire and explosion hazards, especially where flammable vapors are present. Additional precautions are needed for personnel working aloft to prevent injuries due to 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. Check these before touching the gear. Read Chapter 1, "Safety and First Aid" in the BUSHIPS *Electronics Installation Practices Manual*; NAVSHIPS 250–660–42, *Electric Shock, its Causes and Prevention;* and chapter 18 of OPNAV 34P1, *U.S. Navy Safety Precautions*. If at any time there is doubt as to what steps and procedures you should follow while working on electronic equipment, consult the technician or Radioman in charge.

READ THE SIGNS

DANGER signs and suitable guards are provided to prevent personnel from coming in accidental contact with high voltages, and for warning against such hazards as possible presence of explosive vapors, and effects of stack gases aloft. Look for warning signs and obey them. Notify your supervisor if you notice that a dangerous condition exists without a warning sign.

FUNDAMENTALS OF ELECTRIC SHOCK

How Much Does it Take?

If a 60-cycle alternating current is passed through a man from hand to hand or from hand to foot, the effects when current is gradually increased from zero are as follows:

1. At about 1 miliampere (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 let go the conductor.
3. At about 100 milliamperes (0.100 ampere) the shock is fatal if it lasts for 1 second or more.

It is important to remember that current is the shock factor rather than the quantitative value of the voltage.

Body Resistance

It is important to recognize that the resistance of the human body is not enough to prevent fatal shock from 115-volt or even lower voltage circuits. It is true that when the skin is dry, it has high resistance where it makes contact with the electrodes through which current enters and leaves the body. The resistance may be high enough to protect a man from fatal shock even if one hand touches a bare conductor on one side of a 115-volt line while another part of his body touches a bare conductor on the other side of the line. On board ship it is far more likely that the skin will be wet with sweat or salt water. Contact resistance falls when the skin is wet, and body resistance, measured from electrode to electrode, is low. Under unfavorable conditions it may be as low as 300 ohms. If 0.1 ampere is enough to cause death, and if body resistance is as low as 300 ohms, it follows that 115-volt circuits can supply more than enough current to be fatal. The truth of this grim application of Ohm's law is shown by the fact that about 50 percent of shipboard electrocutions are caused by circuits of 115 volts or less.

Conditions for Shock

Two conditions must be met for current to flow through a man: He must form part of a closed circuit through which current can flow, and somewhere in the closed circuit there must be a voltage to cause current to flow.

The application to safety is obvious. A man should see to it that his body never forms part of a closed circuit through which current can flow. If it is absolutely necessary to work close to an energized conductor, he should be sure that (1) his body resistance to the circuit is high, or (2) voltage is low, or better that (3) body resistance is high AND voltage is low. High resistance and low voltage both mean low current.

Don't go aboard ship with a casual regard for the deadly potentialities of electric current which you may have acquired ashore. The 110-volt circuits and appliances in our homes are not unduly dangerous under ordinary conditions. Certain exceptions are well recognized. Few people would handle electric appliances while in the bathtub, or stand ankle-deep in a flooded basement and fumble for the light switch. What is not so well recognized by many Navy men 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

You have often read and heard that 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 failure or 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 which had given warning of an unsafe condition by giving one or more nonfatal shocks prior to 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 case a man erecting an antenna tied a rock to the end of a bare copper wire and threw it over a 3300-volt power line. 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 stories, but summaries of reports on the deaths of three men who were either ignorant or contemptuous of the lethal capabilities of electric current.

TAGGING

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 complete, tags are removed by the SAME person. If more than one party is working, a tag for each is placed on the supply switch. Each party removes only its own tag as it completes its share of the work.

Where 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 properly secured to prevent accidental removal. If the grounding point is not near the working party, the tagging procedure just described should be followed, with the wording of the tags changed.

WORKING ALOFT

You will have to go aloft to work on antennas. It is necessary to obtain prior permission from the OOD and CWO, and to inform them when work is complete and the men are down.

When radio or radar antennas are energized by transmitters, workmen are not to 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, for even though the spark itself may be harmless, it can force involuntary relaxation of a man's hand. 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.

Wear a safety belt aloft. To be of any benefit the belt must be securely fastened 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 more, but it is also true that a fall from the vicinity of an antenna is usually fatal.

There may be danger to personnel aloft from radar or other antennas which rotate or swing through vertical or horizontal arcs. 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 BUSHIPS 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 concentration to even small quantities is dangerous.

In one of the naval shipyards, a man was working at the top of a mast and the stack exhaust was blowing his way. He worked in it for half an hour and then came down, complaining that he couldn't stand it any longer and would have to wait for the wind to change. About an hour later he collapsed and was taken to the hospital. He died that night.

OPERATING SWITCHES AND CIRCUIT BREAKERS

As a general rule, use only one hand for opening and closing switches and circuit breakers. Keep the other hand clear. This is so that, in case of accident, current will not trace a path up one arm, through your heart, and out the other arm. Only one switch should be touched at a time by one person. Before closing a switch, make sure that—

1. The provisions for tagging described above have been 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. When opening switches carrying current, the break should also be positive and rapid. Be sure your hands are dry so that they will not slip off the switch handle and make contact with high voltage. Dry hands also offer better resistance in case the switch handle should be slippery.

All parts of a circuit breaker except the operating handle are usually good conductors of electricity. When working with circuit breakers, remember these rules:

1. Use only one hand.
2. Keep hands clear of parts other than operating handles.
3. Touch only one breaker handle at a time.
4. Positive and negative breakers with two handles should not be closed at one time.
5. Close breaker first; then close switches.
6. Trip circuit breakers before opening switches.
7. Never disable a circuit breaker.
8. Keep the face turned away while closing open-type circuit breakers.
9. Never stand over a circuit breaker while power is on.

FUSES

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. When possible, a circuit should be checked before the fuse is replaced, for such trouble usually indicates a circuit fault.

Don't change a fuse with your bare hands. Use an approved fuse puller (fig. 13–1). These pullers are made either of laminated bakelite or fibre, and will handle a

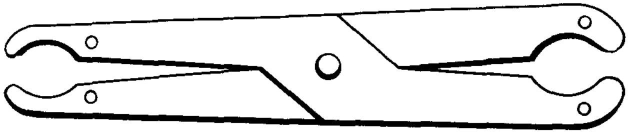


Figure 13–1.—Fuse puller.

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.

Unless work is going on, fuse boxes, junction boxes, lever-type boxes, and the like are kept closed.

CLEANING SWITCHBOARDS

Cleaning energized switchboards, panels, boxes, and so on is limited to removing loose dirt with a painter's duster which has no metallic part and is made of soft bristles about 4 inches long.

Alcohol is not used on energized equipment or on equipment near other electronic gear from which a spark is possible. Alcohol should be exposed in the smallest possible quantity and used only in well-ventilated compartments. Except in locations wholly in the open, alcohol should be limited in quantity to 1 pint.

When working with volatile liquids such as insulating varnish, turpentine, and kerosene, ample ventilation must be provided to prevent accumulation of flammable vapors. Carbon tetrachloride is especially dangerous. Careless use of this chemical compound may result in headache, dizziness, nausea, loss of consciousness, and even death. Never use it in a small or poorly ventilated compartment. Avoid direct contact of the liquid with the skin, and do not breathe the vapors.

WORKING ON ENERGIZED CIRCUITS

Insofar as possible, work on energized circuits is NOT undertaken except in case of emergency, and then only under proper supervision. Proper supervision is considered to mean supervision by a radio electrician or other experienced electronics maintenance personnel. In all such work care is taken to insulate the workman from ground and to apply every known safety precaution. Here are some of them:

1. Provide ample illumination.
2. Remove loose 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 at least be worn on hand not handling tools.
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.

TESTING FOR LIVE CIRCUITS

Intentionally taking a shock from any voltage is always dangerous and is strictly forbidden. When it is necessary to check a circuit to find whether it is alive, use a test lamp, voltmeter, or other suitable indicating device. Never trust insulating material too far when working with live circuits.

Before going near open electronic apparatus, remove metal objects from your pockets. Loose metal parts or liquids are not permitted near or above a starter box or other open electronic equipment. Stowing or inserting foreign objects in or near switchgear control appliances, panels, etc., is forbidden.

WORKING ON DEAD CIRCUITS

Even when secured, electrical machinery may retain a charge sufficient to cause a severe shock. Be safe! Discharge and ground all circuits.

Prior to touching a capacitor connected to a deenergized circuit, or entirely disconnected, short-circuit the terminals.

ELECTRICAL FIRES

In case of electrical fire the first thing to do is deenergize the circuit. Then, after securing ventilation in the area, begin fighting the fire. As soon as possible see that the casualty has been reported to the OOD.

CO_2 (carbon dioxide) fire extinguisher directed at the base of the flame is always best for electrical fires. Pyrene (carbon tetrachloride) extinguishers must not be used on electrical fires nor, for that matter, on any fire in a closed place. Heated carbon tetrachloride liberates phosgene, a gas so deadly it was used for World War I gas attacks.

Salt water is dangerous to use on an electrical fire. Fresh water is less dangerous, but not recommended. For cable fires, in which the inner layers of insulation (or insulation covered by armor) support combustion, the best way to prevent the fire from running the length of the cable is to cut out the burning portion.

HIGH-FREQUENCY OPERATING HAZARDS

Use of electronic equipment in the frequency range of 30 MCS and below may, under certain conditions, cause dangerous voltages to be induced in the standing rigging and other portions of a ship's structure. Such voltages may shock personnel. They may also produce sparks when the transmitter is keyed, the circuit opened, or when rigging is touched by a metal object.

Excessive radio-frequency pickup from ship's antennas has been observed on stack guys, davit head spans, and the like. A similar high radio-frequency pickup has been observed on board ships reeling in or paying out wire cable or hawsers when the length becomes resonant to the emitted frequency.

When HF transmitters are operated on 10 MCS or higher, radiating portions of their antennas must be a certain distance from certain "hazard centers," such as those below.

1. Guns fitted with electric firing circuits, both during the process of loading and in the loaded condition.
2. Aircraft using unshielded flare circuits when flares are installed.
3. Gasoline-handling operations (delivery of gasoline from hoses, spouts, cans, etc.), or any area where gasoline vapor is present.
4. Powder-handling operations when tanks are open or powder is exposed.
5. Fueling operations during time required to make or break metallic hose connections.

The "radiating portion" of an antenna includes the entire exposed portion not enclosed in a trunk or tube. The higher the power of the transmitter, the farther the radiating portion should be from hazard centers. The table below shows, for rated power of transmitter, the corresponding distance in feet that the antenna must be from the hazard center for safe operation above 10 MCS.

Rated power of transmitter (watts)	*Distance (feet)*
50 or less	15
51 to 200	25
201 to 1000	50
Over 1000	75

This does not apply to shielded and grounded shipboard installations.

PAINTING ELECTRONIC EQUIPMENT

When you paint electronic equipment make sure there is adequate ventilation in all enclosed compartments in which painting is to be done. Use both exhaust ventilators and power blowers. Blowers should be arranged to ensure rapid removal of explosive, combustible, or toxic vapors. Such 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, or allow any type of work which may produce flames or sparks. See that fire-fighting equipment is handy.

Practice good housekeeping. Keep unnecessary objects picked up and out of the way. Pay particular attention to rags, sweepings, and waste which may be contaminated with paint. Put such material in a covered metal container or in a bucket of water.

Never eat, drink, or store food in a compartment where painting is being done. Remove the coffee mess. Keep your hands out of your mouth. Paint is a poison, and ingesting the smallest amount can be serious.

USE OF SOLDERING IRON

The 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 the danger is minimized. Disconnect the iron when leaving work, even for a short period.

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.

CATHODE RAY TUBES

Handle cathode ray tubes with heavy gloves. Wear safety goggles to protect your eyes from flying glass in event of envelope fracture, which might cause implosion due to high vacuum within the tube. Goggles are recommended which provide side and front protection and have clear lenses which will withstand a fairly rigid impact test. 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. (These precautions also apply when removing tube from equipment socket.) 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.

FIRST AID

It is necessary that you understand first aid to be given for electric shock and burns, and how to revive a person by artificial respiration. You can find this information in *Standard First Aid Training Course,* NAVPERS 10081. You should know the back-pressure arm-lift method of artificial respiration, the back-pressure hip-lift method, and pole-top resuscitation.

In cases of electric shock, rescue action must be quick. Save seconds and you may save a life. Start to work on the patient at the scene of the accident; don't waste time moving him to a more comfortable location.

The first thing to do, if the victim is still in contact with the conductor, is to stop current flow through his body. You can shut off power by opening switches or circuit breakers, by cutting the conductor with a wooden-handle ax or hatchet, or with insulated pliers. If circumstances are such that power cannot be shut off quickly, use some dry material such as line, cloth, canvas, rubber, or wood to lift or pull the man away from the conductor. DON'T USE METAL OR MOIST MATERIALS.

Be very careful not to let your naked flesh come in contact with the victim, or you may receive the same shock that injured him. If you must grasp the man with your bare hands to pull him away from the conductor, stand on any dry, nonconducting material to prevent the current from reaching ground through your body.

QUIZ

1. Before going aloft to work, what must you do?
2. Name two conditions that must be met for current to flow through a man.
3. How do you close a switch with maximum safety?
4. Why should you check a circuit before replacing a blown fuse?
5. What is the best extinguisher for electrical fires?
6. Why is ample ventilation required when working with volatile liquids?
7. How should you check a circuit to see whether it is alive?
8. Prior to touching a capacitor connected to a deenergized circuit, or disconnected entirely, what should be done?
9. Why should you never eat while painting?

APPENDIX I

ANSWERS TO QUIZZES

CHAPTER 2

NAVAL COMMUNICATIONS

1. The three foremost principles of naval communications are reliability, security, and speed.
2. The mission of naval communications is to provide fast, trustworthy communications adequate to meet the Navy's needs, both in peace and war.
3. Four basic principles of naval communications are reliability, security, speed, and preparedness.
4. "Telecommunications" means "communicating over a distance."
5. The forms of electrical telecommunication which concern the Radioman as operator are radiotelegraph, teletypewriter, radioteletypewriter, radiotelephone, and facsimile.
6. FAX is suitable for pictorial material.
7. Three means of visual communication are flaghoist, flashing light, and semaphore.
8. The three major elements in the structure of naval communications are office of Director, Naval Communications; the Naval Communication System; and communication organizations of the operating forces.
9. DNC stands for Director, Naval Communications.
10. A JANAP is a Joint Army-Navy-Air Force publication; an ACP is an Allied Communication publication.
11. A NAVCOMMSTA is located on United States territory; a NAVCOMMFAC is on foreign soil.
12. Communication spaces amidships are radio I, the message center, and the cryptocenter.
13. Only designated cryptographers may enter the cryptocenter.
14. The shipboard communication organization is a part of the operations department. On large ships communications is divided into the OR (radio) and OS (signal) divisions. These are, respectively, headed by the radio and signal officers.
15. The four divisions of a NAVCOMMSTA communication department are the radio division, traffic division, material division, and facilities division.

CHAPTER 3

SECURITY

1. From highest to lowest, the three degrees of protection for classified matter are Top Secret, Secret, and Confidential. Confidential has a subdivision: Confidential—Modified Handling Authorized.
2. Your commanding officer may grant you a security clearance.
3. Communication security prevents the enemy from obtaining information from United States or allied communications. Physical security keeps classified matter solely in possession of properly authorized individuals entitled to make official use of it. Personal censorship prevents betrayal of official secrets through private conversations, correspondence, etc.
4. Two subdivisions of communication security are cryptographic security, which prevents the enemy from gaining information through cryptanalysis and the study of traffic trends; and transmission security, which protects transmissions from unauthorized interception, traffic analysis, and imitative deception.
5. The matter is said to be compromised.
6. If you find a message which you believe violates some principle of good communications, you should call it to the attention of the CWO and let him decide what action to take.
7. ARFCOS, the Armed Forces Courier Service, is the principal messenger agency for the Department of Defense.
8. An approved circuit is one designated by appropriate command as suitable for transmission in the clear of messages no higher than Secret.
9. The most secure of all the means of communication is messenger; the least secure is radio.
10. The most secure visual communication system is semaphore; the least secure is nondirectional flashing light.
11. Radio silence is placed in effect when it is reasonable to assume that the enemy is ignorant of the location or impending movements of a ship or force.
12. The best defense against imitative deception by the enemy is authentication.
13. The highest classification that may go through the United States mails is Secret.
14. If you accept a message that is not properly authenticated, make a notation to that effect on the face of the message.
15. Compute the numerical value of the facilities as follows:

	POINTS
Sheltered in masonry building	15
Stowed in heavy steel safe	30
System to detect entry into general area	25
Military guard checks container every 30 minutes	25
NUMERICAL VALUE	95

From figure 3–2, you can see that a numerical value of 95 is secure enough for large quantities of Secret documents of broad scope.

CHAPTER 4

INTRODUCTION TO RADIO EQUIPMENT

1. The unit of measurement of difference in potential is the volt; of electrical resistance, the ohm; and of power, the watt.
2. The amplitude of a wave is the difference from average level to the peak (or trough) of the wave. A wavelength is the difference from one crest to the next. A cycle is a complete sequence of variation of movement of the wave from a trough, through a crest, into another trough. The number of cycles which occur in a given unit of time is the frequency of a wave.
3. The metric prefix KILO means thousand; MEGA means million.
4. Radio waves moving along the surface of the earth are called GROUND waves; those going into the atmosphere are called SKY waves.
5. A change in the ionosphere affects radio transmission and reception because it causes more of the radio wave to be absorbed at one time, or bends it to a different angle at another time.
6. Every transmitter has an OSCILLATOR, which generates the basic signal.
7. The third harmonic of 4200 KCS is 12,600 KCS.
8. A dipole has a length equal to half a wavelength.
9. The five functions of a receiver are to (1) pick up signals; (2) select the desired station and reject all others; (3) amplify the signal from that station; (4) demodulate (detect) the carrier wave; and (5) reproduce the audio signal.
10. The sensitivity of a receiver is a measure of how well it can amplify weak signals. Selectivity is the ability of a receiver to respond to one particular signal and to reject all others.

11. The automatic volume control on a receiver serves to keep the output volume at a constant level, thus saving the operator the bother of repeatedly readjusting the volume control as a station fades and reappears in strength.
12. Two equipment designating systems are the AN nomenclature system and the Navy model letter system.
13. Facsimile is a method for transmitting pictorial and graphic information by wire or radio and reproducing it in original form at the receiving station.
14. The three operational adjustments occasionally necessary on motor generators are performed on the speed governor, the motor field, and the generator field.
15. You can check the speed or frequency of a motor generator by attaching a tachometer to the shaft, or by connecting a frequency meter to the output terminals.
16. The most useful application of facsimile is for transmitting fully plotted weather charts.
17. Portable and emergency radio equipment is placed in various parts of the ship in order to minimize the effects of casualty.

CHAPTER 5

INTERNATIONAL MORSE CODE

1. A dit is one-third the length of a dah.
2. Never count dits and dahs because when the code speed picks up you will not be able to count fast enough.
3. Counting a dit as a unit, there is one unit between each element of a character. There are three units between each character and seven units between groups or words.
4. When printing, you can avoid confusion between zero and the letter O by writing zero with a slant through it (Ø).
5. CLOSED and OPEN are terms applied to the gap between the contacts of a telegraph key. CLOSED indicates a short gap; OPEN a long gap.
6. Place just enough tension on the key so that it is easily depressed, yet springs upward at the end of each dit or dah.
7. When using a telegraph key, your elbow should not protrude over the edge of the table because the pressure on the underside of your forearm will obstruct blood circulation and cause fatigue.
8. A good way to learn to hold down a circuit is to spend several watches logging a circuit that another operator is manning. At the end of each watch you can compare your log with that of the regular operator and have him answer your questions.

CHAPTER 6

RADIOTELEGRAPH, PART I

1. An action addressee is responsible for taking action in the contents of the message and for originating any necessary reply. Information addressees have an official concern in the subject of the message, but do not have the primary responsibility for taking action.
2. Messages are divided into types, according to the way they are addressed, as follows: single address, multiple address, book, and general messages.
3. A geographic address group represents some particular geographic location or area. It is always preceded by a conjunctive address group.
4. AIG stands for "address indicating group."
5. The originator of a message is the command by whose authority the message is sent. The drafter actually prepares the message. The releasing officer authorizes transmission of the message for and in the name of the originator.
6. Greenwich mean time (GMT) is generally used in naval communications.
7. To communication personnel precedence indicates the relative order in which a message must be handled and delivered. To addressees it indicates the relative order in which the message is to be noted.
8. The prosign $\overline{\text{INT}}$ gives an operating signal a questioning or interrogatory meaning.
9. Q signals are employed in both military and civil communications, and are understood by ships of any nationality. Z signals are used only in United States and allied military communications, and represent meanings not found in the Q code.
10. The three major parts of a message are heading, text, and ending.
11. The parts of a message that cannot be changed by anyone except the originator are: preamble, address, prefix, and text.
12. A contact report is a message reporting the first sighting of an enemy force. Contact reports are assigned FLASH precedence.
13. Q messages contain information on changes in navigational warning systems of allied nations.
14. A service message is identified by reference to another service message, by the abbreviation SVC in the prefix or as the first word of the text, or by the fact that it is specifically addressed to a communication center.

15. Two types of messages that facilitate traffic handling are procedure messages and service messages.
16. The three forms in which a military message may be drawn up are plaindress, abbreviated plaindress, and codress.
17. The five classes of messages are A, B, C, D, and E.

CHAPTER 7

RADIOTELEGRAPH, PART II

1. The duties of a net control station are to speed flow of traffic on the net, to limit transmissions to the essential minimum, to settle disputes incident to traffic handling, and to monitor the net so that corrective action can be taken against poor operating practices.
2. A directed net is one on which no station may transmit without calling and obtaining permission from net control. A free net is one on which member stations are authorized to send their messages without obtaining prior permission.
3. The three types of nets according to mission or purpose are command, common, and functional nets.
4. The radiotelegraph error sign is a series of eight or more E's.
5. The addressee of the message originates the acknowledgment.
6. The prosign $\overline{\text{IMI}}$ means "Repeat"; the prosign J means "Verify and repeat."
7. The specific relay requires use of the prosign T.
8. The instant of execution of an executive message is the termination of the 5-second dash.
9. A station desiring to break in makes a series of dashes.
10. Five messages normally comprise a string or sequence.
11. The international radiotelegraph distress signal is $\overline{\text{SOS}}$; the international radiotelephone distress signal is MAYDAY.
12. A facsimile symbol is a character in facsimile copy, such as a number, letter, or geometrical shape; a model is a combination of symbols arranged to convey intelligence.

CHAPTER 8

ADMINISTRATION

1. The two broad divisions of message files are mandatory files and optional files.
2. Plain language translations of classified messages are stowed in the cryptocenter.

3. The tickler file is a temporary file holding copies of messages requiring a reply.
4. Originators' rough drafts go in the proof file.
5. An operator must make an entry in a net log at least every 5 minutes. If the net is quiet he logs "No signals."
6. To correct an error in a net log, line out the incorrect portion but leave it readable. Enter the change above or next to it, together with your initials.
7. The officers aboard ship who receive copies of all messages are the commanding officer, the executive officer, and the communication officer.
8. An operation plan is a directive outlining procedures to be followed for some particular operation, such as an invasion, air strike, or convoy. The part of it of concern to the communicator is the communication annex.
9. The services offered by WWV are standard radio frequencies, time announcements, standard time intervals, standard audio frequencies of 440 and 600 cycles per second, and radio propagation disturbance warnings for the North Atlantic area.
10. Before you sign a publication custody log, always sight the publications for which you are signing.
11. Destruction is authorized for the communication center and cryptocenter files after 1 year; for the radio station and visual station files after 6 months; for the general message file when contents are canceled or superseded.
12. One of the most important publications to the man at the operating level is the effective edition of DNC 5.
13. The transmission would be W6 sent five times.
14. WWV's sister station in the Pacific is WWVH.
15. Acceptable frequency tolerance range for shipboard stations is from 0.10 percent to 0.75 percent, depending on the band.

CHAPTER 9

TELETYPEWRITER OPERATION

1. There are seven units in a teletypewriter signal.
2. The start and the five intelligence units require 22 milliseconds. The stop pulse requires 31 milliseconds.
3. The use of upper and lower case for each intelligence combination almost doubles the number of characters (or operations) which may be transmitted.
4. An operator is mainly interested in TOTAL distortion.

5. The two types of range orientation are line and local (machine).
6. The start-stop method provides synchronization between the signal and the receiving machine with each character transmitted.
7. Theoretically, no time is required for a transition.
8. The 1-hole codes from top to bottom read: E, LF, SPACE, CAR RET, and T.
9. Only the LTRS code has perforations in all five positions.
10. The code for the letter A is common to U, J, and W.
11. The code for the letter I may be used as a reference for the letters D and Z.
12. The letters Q and X, K and V, S and H, E and T can be remembered as opposites.
13. Lettering out is a method of correcting errors in tape preparation. By using the backspacer the first wrong code is brought over the perforating pins of the punch block. By pressing the LTRS key the wrong codes are changed to LTRS codes.
14. To interrupt a line teletypewriter station press the BREAK lever for about 3 seconds.
15. The approach of the end of a roll of paper on a teletypewriter printer is indicated by a colored streak along the edge of the paper.
16. The two types of paper feeds on a Model 15 printer are sprocket feed and friction feed.
17. A receiving bank or console is a unit containing a number of reperforators mounted together.
18. A "washboard" is a tape grid used to hold tapes awaiting transmission.
19. The standard tape factory produces as many as six tapes with a single run.
20. You can tell that a printer is running open by the machine operating continuously without either printing or spacing. The machine also appears to run faster than during normal operation.
21. The term used to indicate teletypewriter messages in page form is "hard copy."
22. The two types of keyboards are communication and weather.
23. The guide keys on a teletypewriter keyboard are the CAR RET key for the right hand, and the A key for the left hand.
24. A functional or nontyping operation is the action of a teletypewriter key which serves some purpose other than printing a character on the page.
25. The standard teletypewriter line is 72 characters in length.

26. Chad tape is completely perforated and carries no printing. Chadless tape is only partially perforated and has printing.
27. The partial fourth row of keys contains six red keys for the special teletyping functions of local line feed, keyboard lock, keyboard unlock, line break, repeat character operation, and local carriage return.
28. Printing is produced by the type box in the Model 28.
29. A dry, hard-bristle brush should be used to clean the type in the Model 28. Cleaning solution must NEVER be used.
30. The tone-modulated system and the carrier frequency-shift system are the two systems used afloat to send and receive teletypewriter messages by radio.

CHAPTER 10

TELETYPEWRITER PROCEDURE

1. The usual component parts of a communication center are message center, relay station, cryptocenter, and transmitting and receiving stations.
2. An independent message center may serve outlying areas as a tributary.
3. The six primary COMMCENS are located in Washington, D.C., San Francisco, Calif., Honolulu, T.H., Guam, M.I., Balboa, C.Z., and Port Lyautey, Fr. Morocco.
4. The first letter of a United States routing indicator shows whether the message will be handled by the worldwide communication network or whether it will travel over a net serving some particular area. The second letter indicates the communication system of the particular armed service. The third letter indicates the geographical location of the area the station serves.
5. A routing indicator containing only four letters always indicates a primary or major relay station.
6. JANAP 117 holds routing indicators for the United States and Canada.
7. After a message has been punched or transmitted, it is followed by 2CR, 8LF, 4Ns, and 12 LTRS.
8. When 50 percent or less of the text is made up of figures, unusual letter combinations, for figure-letter combinations, you must confirm those groups. When over 50 percent of the text is made up of figures or difficult combinations, it is not necessary to confirm.
9. Two types of NTX message serial numbers are station serial numbers and channel numbers.

10. Plain language NTX messages longer than 900 groups, 90 lines, or 5 teletypewriter pages are prepared for transmission in parts.
11. An operator is warned of a FLASH or EMERGENCY message by five bells. preceding the repeated precedence prosign in line 2 of the message.
12. If you make a mistake in the routing line of a message, throw the tape away and start over.
13. A missent message has the correct routing indicator, but has been sent over the wrong circuit. A misrouted message carries the wrong routing indicator.
14. If you receive two copies of a multiple-address message, and the second is not marked SUSDUPE, you can assume that one of the addressees has not received his copy.
15. A message cannot be readdressed if any change is made past format line 5.
16. Tracer messages answer these three questions: Was the message actually lost? Who lost it? Why was it lost?
17. Tracer proceedings are usually handled by speedletter.
18. The operating signal ZEN in a joint message means "This message has been delivered by other means or by a separate transmission to addressees immediately following this signal."
19. The Navy uses TWX for extension of the NTX System. TWX serves outlying stations which do not send or receive enough traffic to warrant the cost of circuits and equipment that would make them a part of NTX.
20. The letters CX added to the routing indicator indicate that an activity is served by TWX.
21. You can identify a book message by the operating signal ZEX in line 5, following the DTG.

CHAPTER 11

RADIOTELEPHONE

1. You should listen before transmitting because breaking in is discourteous and causes confusion. Often neither transmission gets through.
2. You can find up-to-date radiotelephone procedure in the effective edition of ACP 125.
3. Prowords are words and phrases used to speed the handling of radiotelephone messages. They correspond to prosigns used in other procedures.

4. If you hold a microphone too far from your lips, speech is inaudible and background noises creep in; if you hold it too close, blaring and blasting result.
5. You can tell whether you are hearing a flag signal or a word phonetically spelled by listening for the proword I SPELL. Phonetic spellings are always preceded by I SPELL.
6. The governing pennants are PREPARATIVE, INTERROGATIVE, and NEGATIVE.
7. You can cancel a message prior to sending OVER or OUT by use of the proword DISREGARD THIS TRANSMISSION.
8. The executive method is used to execute tactical signals so that two or more units can take action at the same time.
9. An acknowledgment is a reply from an addressee indicating that he has received a certain message, understands it, and can comply with it. Only the commanding officer, or his authorized representative, can authorize sending an acknowledgment.
10. Stations reply to a collective call in alphabetical order.
11. If some station does not reply to a collective call, the next station should wait 5 seconds and then answer up.
12. The response to the question, "How do you hear me?" is a short, concise report of actual reception.
13. The proword used to correct transmission errors is CORRECTION.
14. The proword WORDS TWICE is used when communication is difficult.
15. Don't test a microphone by blowing into it.

CHAPTER 12

MAINTENANCE

1. The two types of maintenance are PREVENTIVE and CORRECTIVE.
2. The manufacturer's instruction book is an important source of information necessary in maintenance of equipment.
3. The two categories into which failure reports on electronic equipment are classified are—
   a. Electron tubes and piezo-electric quartz crystals.
   b. All other items or parts contained in or supplied as components, parts, or maintenance parts for use in or with electronic equipment.
4. Transmitter insulators should never be allowed to become coated with dust, dirt, or paint as this would increase the danger of arcover.
5. The most important factor in maintenance of teletypewriter equipment is proper lubrication and cleaning of the machines.

6. A teletypewriter in continuous service should be cleaned and lubricated every 200 hours.
7. Before beginning to clean or lubricate equipment, always turn the power off.
8. Compressed air, if dry, is the most effective means of cleaning the interior parts of motors and generators.
9. You should never apply emery cloth to the commutator because it is a metallic conductor and would short-circuit the segments.
10. Undercutting is the surest way to eliminate high mica trouble on a commutator.
11. Two causes of sparking in a motor are faulty brush contacts and defective coils.
12. Overfilling containers for oiling motor bearings will cause leakage along the armature shaft.
13. The cylinder and rollers of a typewriter are cleaned to prevent their leaving streaks of dirt.
14. Excess oil must be wiped away or it will drip on other parts and in time form a gummy mass with dust and eraser crumbs.

CHAPTER 13

SAFETY

1. Before going aloft to work, obtain permission from the OOD and CWO.
2. Two conditions that must be met for current to flow through a man are: (1) he must form a part of a closed circuit through which current can flow, and (2) somewhere in the closed circuit there must be a voltage to cause current to flow.
3. 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.
4. Check a circuit before replacing a blown fuse because such trouble usually indicates a circuit fault.
5. The best extinguisher for electrical fires is CO_2.
6. Ample ventilation is required when working with volatile liquids to prevent accumulation of flammable vapors.
7. Check a circuit for life by use of a test lamp, voltmeter, or other suitable indicating device.
8. Prior to touching a capacitor the terminals should be short-circuited and grounded.
9. Never eat while painting because paint is poisonous and getting even a small amount into your mouth is dangerous.

APPENDIX II

QUALIFICATIONS FOR ADVANCEMENT IN RATING

RADIOMEN (RM)

Rating Code No. 1500

General Service Rating Scope

Radiomen transmit, receive, log, route, file, and maintain security of messages in accordance with existing regulations, instructions, and procedures by applying thorough knowledge of U. S. Navy Security Manual for Classified Matter and the communications doctrine and procedures contained in DNC 5 and NWIP 16–1; and advise on capabilities, limitations, and condition of assigned equipment.

Radiomen operate typewriter and teletypewriter equipment; tune radio transmitters and receivers; operate and perform operational and preventive maintenance on, and locate the more common failures in radio equipment, including associated frequency shift keyers, converters, motors, motor generators, and power supplies; radiotelephone, facsimile, teletype, radio direction finder, and assigned communications countermeasures equipment.

Emergency Service Rating

Same as General Service Rating.

Navy Enlisted Classification Codes

For specific Navy enlisted classification codes included within this rating, see *Manual of Navy Enlisted Classifications*, NavPers 15105 (Revised), codes RM–2300 to RM–2399.

Qualifications for Advancement in Rating	APPLICABLE RATES RM
100 PRACTICAL FACTORS	
101 OPERATIONAL	
1. Start, stop, operate, and tune facsimile equipment to which assigned on own ship or station	3
2. Start, stop, adjust, and operate manual and automatic teletypewriter equipment on own ship or station	3
3. Energize, de-energize, and make operational adjustments on radio receivers, transmitters, and associated motors and motor generators on own ship or station	3
4. Assemble, energize, de-energize, tune, and make operating adjustments to emergency and/or portable radio equipment on own ship or station	3
5. Set up antenna patch panel, select proper antennas and antenna matching equipment for receiving	3
6. Set up radio patch panel. Patch transmitters and receivers into remote units	3
7. Identify all communication antennas on own ship or station	3
8. Tune transmitter, using dummy antenna	3
9. Compare WWV against frequency standard and log results	3
10. Operate telegraphic typewriter, using touch system	3
11. Read perforated teletypewriter tape	3
12. Stand watch on teletypewriter circuit, keeping required logs	3
13. Tune radio receivers and associated teletypewriter equipment for teletypewriter reception	3
14. Copy standard fleet broadcast	3
15. Transmit, receive, and authenticate on fleet CW circuit, handling traffic at approximately 18 words per minute, keeping required logs	3
16. Detect and report electronic jamming on radio receiving equipment. Demonstrate procedures for receiving through electronic jamming or other types of interference	3
17. Transmit, receive, and authenticate on radiotelephone circuits, using standards procedure. Keep required logs	3
18. Observe regulations governing communication procedures and use of DNC 5 and NWIP 16–1 publications in transmitting and receiving traffic on naval circuits	3

101	OPERATIONAL—Continued.	
19.	Use call signs, address groups, address indicating groups, routing indicators, prosigns, operating signals, and prowords in handling traffic	3
20.	Use call-sign cipher devices for encoding and decoding message headings and for frequency shifts	3
21.	Start, stop, operate, calibrate, and tune all radio equipment and assigned communications countermeasures equipment on own ship or station	2
22.	Tune radio transmitters and associated teletypewriter equipment for teletypewriter transmission	2
23.	Tune, calibrate, and adjust multicouplers and antenna matching equipment and select antennas for transmitting	2
24.	Transmit, receive, and authenticate on fleet circuit, handling traffic at approximately 25 words per minute, keeping required logs	2
25.	Transmit, receive, and authenticate on radiotelephone circuits, using standard vocabularies and techniques; be familiar with terminology utilized in tactical maneuvering, air control, air defense, naval gunfire support, electronic countermeasures control, and antisubmarine warfare	2
26.	Supervise communications watch	1
27.	Transmit, receive, and authenticate on any fleet CW circuit, using standard procedures. Keep required logs	1
28.	Take measures to restore communication facilities due to battle casualty and under other emergency conditions including fire, personnel injuries, and loss or damage to radios and associated communication equipment	1
29.	Determine radio frequency that will obtain maximum distance of transmission	1
102	MAINTENANCE AND OR REPAIR	
1.	Rig emergency radio receiving and transmitting antennas	3
2.	Clean and lubricate duplicating machines	3
3.	Clean and lubricate typewriters and change ribbons	3
4.	Clean and lubricate teletypewriters; change ribbon, paper and tape	3
5.	Determine whether teletypewriter failures are due to mechanical or electrical defects	3

102 MAINTENANCE AND/OR REPAIR—Continued	
6. Demonstrate under simulated conditions the rescue of a person in contact with an energized electrical circuit, resuscitation of a person unconscious from electrical shock, and treatment for electrical and acid burns	3
7. Demonstrate, while servicing equipment, safety precautions such as tagging switches, removing fuses, grounding test equipment, using shorting bars and rubber mats	3
8. Locate and identify units and component parts of radio and communications countermeasures equipment to which assigned	3
9. Repair radio headsets and microphones	3
10. Check and replace as necessary:	
a. Indicator lamps	3
b. Fixed fuses	3
c. Crystals	2
11. Make tests for short circuits, grounds, and continuity of interconnecting cables between components of electronic equipment	2
12. Test electron tubes for operational effectiveness and replace those found defective or below standard	2
13. Use test equipment, such as tube testers, multimeters, and output meters, required in operational and preventive maintenance of general purpose radio equipment	2
14. Inspect, clean, lubricate, and make adjustments on assigned radio and communications countermeasures equipment, as specified in routine checkoff lists	2
15. Identify, in schematic diagrams, basic radio circuits such as amplifiers, oscillators mixers, and rectifiers	2
16. Locate and identify maintenance test points and make tests on equipment to which assigned, as specified in technical manuals	2
17. Identify, by reference to block diagrams, circuits affected by operation of associated external controls	2
18. Maintain and repair teletypewriters	1
19. Locate electrical and electronic failures employing, systematized procedures of isolating inoperative sections of radio equipment and assigned radio countermeasures equipment as specified in technical manuals	C

103 ADMINISTRATIVE AND/OR CLERICAL

1. Perform routine clerical duties of a communications office, including maintenance of files	3
2. Enter corrections to communications publications	3
3. Prepare in naval form, plain dress, abbreviated plain dress, and codress messages for transmission	3
4. Keep required supervisory logs	2
5. Maintain records of intercepted electromagnetic radiations in accordance with current electronic countermeasures doctrine	2
6. Keep maintenance logs for radio equipment. Prepare required BuShips electronic failure reports	2
7. Route traffic to, from, and within own ship or station	2
8. Prepare international and domestic telegraph messages in commercial form	2
9. Prepare requests for survey; requisition equipment, parts, and supplies	1
10. Prepare naval shipyard and tender work requests	1
11. Instruct and supervise personnel in communication operation and procedure	1
12. Train, drill, and supervise radiomen at cruising watches and general quarters stations	1
13. Supervise and train personnel in performing operational and preventive maintenance functions on communications and associated equipment	1
14. Instruct personnel in radio theory	C
15. Serve as assistant to radio officer	C
16. Organize duties and assign communications personnel to tasks to be performed aboard ship or shore station	C

200 EXAMINATION SUBJECTS

201 OPERATIONAL

1. Purposes of common external controls on radio transmitting and receiving equipment	3
2. Types and functions of radio receiving and transmitting equipment	3
3. Meaning of terms commonly used in connection with manipulation of radio and related equipment, such as heterodyning, antenna loading, tuning, zero beating, calibrating, and audio band-pass and intermediate frequency band-pass	3

201 OPERATIONAL—Continued.

4. Procedures to be followed in tuning radio transmitting and receiving equipment, including use of audio band-pass control and selectivity controls	3
5. Procedures for energizing, de-energizing, and tuning emergency and portable radio equipment	3
6. Transmit: (See 400 Performance Test Instructions.)	
a. A file (containing 500 characters) of 3 messages by radio (international Morse) in 8 minutes	3
b. A file (containing 600 characters) of 3 messages by teletypewriter in 9 minutes	3
7. Receive a file (containing 500 characters) of 3 messages by radio (international Morse) in 8 minutes. (See 400 Performance Test Instructions)	3
8. General content of DNC 5	3
9. International radio procedures; regulations regarding communications as prescribed for the safety of life at sea and for communication with a merchant vessel at sea	3
10. Communication procedures prescribed for transmitting and receiving traffic on all naval communication circuits including use of call signs, address groups, address indicating groups, prosigns, routing indicators, prowords, and operating signals	3
11. Principles of, and requirements for, communications security as prescribed in the U. S. Navy Security Manual for Classified Matter, DNC 5, and ACP 122	3
12. Construction of naval messages; forms, types, and classes	3
13. Precedence of traffic, internal and external routing of traffic, and regulations governing circuit discipline on radiotelephone, radiotelegraph, and teletypewriter circuits	3
14. Time zone computations and conversions	3
15. Nomenclature and principles of operation of radio equipment and associated communications countermeasures equipment	2
16. Transmit: (See 400 Performance Test Instructions.)	
a. A file (containing 600 characters) of 4 messages radio (international Morse) in 8 minutes	2
b. A file (containing 750 characters) of 4 messages by teletypewriter in 9 minutes	2

	APPLICABLE RATES RM
201 OPERATIONAL—Continued	
17. Receive a file (containing 600 characters) of 4 messages by radio (international Morse) in 8 minutes. (See 400 Performance Test Instructions.)	2
18. Capabilities and limitations of radio equipment and associated communications countermeasures equipment	2
19. General content and application of Navy, Joint, DNC 5, and NWIP 16–1 publications used in naval, other military, commercial, and international communication procedures	2
20. Commercial traffic instructions and procedures related to naval communications	2
21. Transmit: (See 400 Performance Test Instructions.)	
a. A file (containing 700 characters) of 5 messages by radio (international Morse) in 8 minutes	1
b. A file (containing 1,200 characters) of 5 messages by teletypewriter in 9 minutes	1
22. Receive a file (containing 700 characters) of 5 messages by radio (international Morse) in 8 minutes. (See 400 Performance Test Instructions.)	1
23. Radio direction finding as utilized in interception of electronic emissions	1
24. Fundamental concepts of radio wave propagation, including skip distance, sky-wave, and ground-wave, and ionosphere and the effect on wave propagation	1
25. Rules and regulations of Federal Communications Commission pertaining to naval communications as set forth in naval communications publications	1
202. MAINTENANCE AND/OR REPAIR	
1. Lubrication and routine cleaning of standard office machines used in performance of communication duties	3
2. Lubrication and routine cleaning of typewriters	3
3. Definitions of common electrical and electronic terms used with radio equipment such as: Volt, ohm, ampere, watt, cycle, frequency, phase, resonance, and selectivity	3
4. First-aid procedures for treating electrical shock and burns	3
5. Safety precautions to be observed in connection with operating and maintaining electronic equipment	3
6. Types, physical structures, and electrical characteristics of batteries; proper care, maintenance, and safety precautions used in handling batteries	3

	Qualifications for Advancement in Rating	APPLICABLE RATES RM
202	MAINTENANCE AND/OR REPAIR	
7.	Reading and interpretation of block diagrams	2
8.	Types of information shown and meaning of electrical, electronic, and mechanical symbols used in schematic diagrams of radio equipment	2
9.	Elementary electricity; simple problems in a. c. and d. c. current	2
10.	Functions, physical structure, and operating principles of electron tubes used in radio equipment	2
11.	Handling and testing electron tubes	2
12.	Operational and preventive maintenance of radio equipment, teletypewriters, and communications countermeasures equipment	2
13.	Purposes and uses of test equipment in performing operational and preventive maintenance	2
14.	Procedures and purposes of routine tests on electronic equipment	2
15.	Construction of a block diagram of a transmitter and/or receiver, given specific components and symbols	2
16.	General effects of circuit components such as resistors, capacitors, and inductors on flow of direct and alternating current	2
17.	Basic circuits such as rectifiers, amplifiers, oscillators, detectors, and band-pass filters	2
18.	Color codes and circuit markings used to identify and describe electrical characteristics of circuit components and connections	2
19.	Operating principles of various types of teletypewriters, radiotelephones, and teletypewriter terminal equipment	2
20.	Characteristics of a. c. and d. c. current	2
21.	Methods of matching and loading shore-based antennas	1
22.	Types and uses of common antennas	1
23.	Compute length of an antenna at a given frequency	1
24.	Reading and interpreting circuit schematic diagrams of Navy communications equipment	1
25.	Operating principles of basic circuits such as rectifiers, amplifiers, oscillators, and detectors	1
26.	Functions and operating principles of special circuits such as bridge circuits, sweep circuits, and special oscillator circuits used with communications equipment	1
27.	Calculate current, resistance, and voltage through any part of a circuit	C

203 ADMINISTRATIVE AND/OR CLERICAL	
1. Security classifications of correspondence and regulations governing the transmission of each classification	3
2. Uses of and procedures for preparing operating logs	3
3. Missions, policies, and fundamental considerations of naval communications as outlined in DNC 5	3
4. Standard shipboard communication organization	3
5. Authority for, methods of promulgation of, and entry of various types of corrections in communications publications	3
6. Stowage requirements and other safeguards of registered and other classified matter	3
7. Regulations for sending messages involving tolls	3
8. Organization of the naval communications system	2
9. Uses of and procedures for preparing BuShips electronic failure reports	2
10. Destruction bill for registered publications and procedure for effecting destruction	2
11. Types, purposes, and entries made in equipment histories	1
12. Procedures for preparing requests for survey and requisition of equipment, parts, and supplies. Procedures for preparing naval shipyard and tender work requests	1
13. Commercial accounting and abstracting as used by Navy	1
14. Planning, organizing, and supervising a preventive maintenance program	1
15. Planning, organizing, and supervising training programs	C
16. Preparation and utilization of communications annexes to operation orders	C

400 PERFORMANCE TEST INSTRUCTIONS

420 PERFORMANCE TESTS (Examination Subjects.)

A. Telegraphy:

The following standard procedure shall be observed when conducting the performance tests (operational) for international Morse and teletypewriter—

1. Messages:

   a. Messages shall be approximately the same length, the heading containing about 30 percent and the text about

70 percent of the total number of characters. One complete rehearsal immediately preceding the official test is permissible. Results of the rehearsal test shall not preclude an individual from taking the official test nor affect the score of the official test.

b. Messages used for the official test must differ from messages used for the rehearsal, and must be unknown to the applicant before the test starts. Time limits for the official test shall include "servicing" each message by endorsing thereon the time of transmission or reception, circuit used, and operator's sign. Of the total number of messages required in the test, one message shall be plain language. The remaining messages shall be composed of 5-letter groups, random mixed letters, and random mixed numerals.

2. Transmitting (international Morse and teletypewriter):
   a. All known errors must be corrected.
   b. A total of 5 errors (uncorrected or omitted characters) in transmitting will be permitted in the official test.
3. Receiving (international Morse)—Receiving shall be done on a telegraphic typewriter. Five errors in receiving will be permitted in the official test.

Note.—For teletypewriter transmitting test, use of a teletypewriter is mandatory if one is assigned to ship or station.

500 PATH OF ADVANCEMENT TO WARRANT OFFICER AND LIMITED DUTY OFFICER

Radiomen advance to Warrant Electronics Technician and/or to Limited Duty Officer, Electronics.

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