THE RADIO OPERATOR

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*This edition of TM 11-454 includes C1, June 23, 1941, and C2, January 19, 1942.
SECTION I
GENERAL

1. Purpose.—The purpose of this manual is to provide a text for the training of radio operators and to establish an authoritative basis for coordination between all units of the Army in the use of radio procedure in the conduct of radio communication. Since operators of manual field telegraph equipment, signal lamp equipment, and wigwag flags also employ the International Morse Code and applicable portions of radio procedure, this text is suitable for the instruction of those operators also.

2. Scope.—This manual covers the selection of personnel which will probably absorb instruction most quickly, the basic instruction of all operators, and radio procedure in tactical and other nets. While the bulk of the content is devoted to the radiotelegraph operator, such instruction as is considered essential for the radiotelephone operator is also included. Typewriting instruction is covered only to the extent of showing how it fits into basic operator instruction. Such material as is included can be given effectively with other instruction without appreciable loss of time. The ability to use a typewriter increases the value of an operator, and this fact should be emphasized when code instruction is initiated.

3. Basic radio procedure.—a. The radio procedure prescribed herein is for use in radio communication within the Army.

   b. Intercommunication between the Army and the Navy is conducted as prescribed in FM 24–10.

SECTION II
SELECTION OF PERSONNEL

4. General.—Because of the relatively great length of time required to train radio operators, the prior determination of the aptitude of students is essential. Consequently, within the limitations of available equipment, all personnel to be trained as operators will be selected as indicated in paragraphs 5, 6, and 7.

5. Radiotelegraph operator aptitude test, U. S. Army.—a. This test, heretofore known as the Signal Corps Code Aptitude Test,
has been used for many years by schools and units of all arms and may be considered a standard test. It is designed to determine the aptitude of an individual for learning the International Morse Code phonically by requiring him to indicate whether or not certain tone signals sound exactly alike.

b. A complete test, consisting of an answer sheet, the test, and a solution sheet, is included in appendix I. The test may be given manually with the use of organizational equipment, but is given preferably by phonographic transcription. Phonographic transcriptions for use with code transmitter and recorder TG-8-A, or disk phonograph records which may be played directly on any standard phonograph, are available.

c. The nature of the test makes it difficult for anyone to memorize correct answers. However, available copies of the test and of the solution, as well as all phonographic transcriptions, will be safeguarded to the extent necessary to assure that no person to be tested has had an opportunity to study the test before taking it.

6. Testing.—a. The aptitude test is given in about 20 minutes and can be taken simultaneously by as many men as the receiving equipment will permit. Having decided upon the number of men to be trained, give the test to double that number. One copy of the answer sheet is required for each man to be tested. Allow sufficient time prior to the start of the test for men to comply with the directions indicated on page 1 of the answer sheet.

b. When giving the test manually, speak those portions of the test shown in quotation marks and transmit by means of a telegraph key and tone source, the characters shown in parentheses. Transmit all characters at a speed corresponding to 20 words per minute of normal transmission, but allow a time interval of approximately 2 seconds between paired characters. Where test characters are overscored, transmit them as a continuous character without pause between them. Thus, transmit (A|) as . . . . . . not as . . . .

c. When the test is given by means of phonographic transcription, set the code transmitter and recorder or the phonograph at a speed corresponding to 20 words per minute of normal transmission. Monitor the transcription of the test to insure that satisfactory transmission is being accomplished. When the transcription consists of two or more disks, change disks promptly at the proper time.

7. Selecting students.—The test is objectively scored; that is, the person scoring the test needs no knowledge of its subject matter in order to score it properly. The final score is determined by deducting one point for each unmarked or incorrectly marked test pair.
Thus, with every pair correctly marked, a maximum score of 78 is obtained. With 16 pairs unmarked or incorrectly marked, the score is 62. The test of each man is scored in about 2 minutes. After scoring the tests, tabulate scores and select students as follows:

a. Place each test paper in one of the following groups:
   (1) Those which show that the man tested has had previous experience, however slight, in radiotelegraph or telegraph operation.
   (2) Those which show that the man tested has had no previous experience in radiotelegraph or telegraph operation.

b. From each group list the name of each man, followed by his score, in order from the highest to the lowest score.

c. Select the proper number of men to be trained in the order listed below, taking all men from the first category before taking any from the next, and so on.
   (1) Those in group a(1) above with scores of 60 or higher.
   (2) Those in group a(2) above with scores of 60 or higher.
   (3) Those in group a(1) above with scores of 50 or higher.
   (4) Those in group a(2) above with scores of 50 or higher.

d. If a sufficient number of men are not obtained from the first group, follow the same procedure with another group of prospective students.

e. If, after testing all available men, a sufficient number in the first four categories cannot be obtained, select those with scores of 40 or higher, and then those with scores lower than 40. The former may be expected to become operators only after long training, but in general, instruction of the latter is not productive.

f. Do not inform any student of his score while he is undergoing instruction.

Section III

BASIC INSTRUCTION
8. **International Morse Code.**—In the International Morse Code, all letters, numerals, and punctuation marks are represented by short and long signals. A short signal is called a dot and is printed as . and a long signal is called a dash and is printed as —. These signals may be transmitted visually as flashes of a lamp for short and long periods or as positions of a flag to the right and left of the flagman. They may also be transmitted phonically, as by a buzzer making short and long sounds or by a telegraph sounder making two successive different sounds with short and long intervals of time between successive sounds. Finally, they may be recorded as transmitted on a tape and read therefrom, by eye, as short and long inked lines. Figure 1 is a full-size sample of receiving tape. This manual is concerned primarily with the instruction of students in recording dot and dash characters as received by ear, and in transmitting similar signals by means of manually operated telegraph keys.

9. **Mental processes.**—The whole process of receiving consists of recognizing combinations of short and long sounds and recording the characters they represent.

a. **Recognizing sounds.**—(1) The short and long sounds in each character could be memorized and the characters identified by counting the sounds of each length and noting their arrangement. This process is limited to a very slow receiving speed of about 50 characters per minute.

(2) A better method is to recognize the sound of a complete character without regard to its components.

(3) In order to keep the student from following the faulty mental process in (1) above, experience has shown that it is better to begin by teaching the sound of the character when it is made at a speed used in normal operation, which is about 100 complete characters per minute, corresponding to about 20 words or groups of five character each per minute. Such a speed discourages the counting of separate dots and dashes. Consequently, in all instruction, individual characters are transmitted at a speed corresponding to 20 groups of five characters each per minute. The speed of transmission is increased by shortening the silent periods (spaces) between successive characters. The longer spaces afford the beginner more time to identify each character. With practice, this thinking process becomes faster and
faster until the student recognizes the characters without conscious mental effort, just as he recognizes words in conversation.

b. Recording the characters.—Characters are recorded by the typewriter or by lettering as prescribed in FM 24–5. Instruction in lettering is given concurrently with that in a above, and performance in both is graded. When a student has attained a receiving speed of about ten groups of five characters each per minute, instruction in recording by typewriter may be initiated.

(1) Lettering.—In order to insure legibility and thus prevent errors, the prescribed lettering is used. To assist in the grading of lettering, a board may be prepared and kept exhibited to students showing various degrees of excellence in lettering the same message. Examples may be arranged in order from the best to the poorest which is to be accepted as satisfactory. All performance is graded accordingly, and deficiencies are pointed out to the student.

(2) Typewriter.—The touch system of typewriting is taught by arranging characters in each lesson so as to cause the recording of characters by certain fingers. Thus, the sound of a character is mentally connected with the action of a specific finger, and an operator while training, simultaneously becomes a touch typist of sounds heard. With a little additional practice he can readily become proficient also as a touch typist in transcribing written or dictated material.

10. Instruction periods.—a. Duration.—The duration of an instruction period should not exceed 1 hour, and such a period should be followed by one or more similar periods of instruction which does not require close mental effort. (See par. 11.)

b. Frequency.—Two or more code instruction periods may be scheduled daily, but a total of more than three hours per day is not desirable. However, if periods cover such varied matters as receiving, transmitting, procedure, etc., and if the allotted training time is short, productive instruction may be given for as much as 6 hours daily.

c. Relaxation.—One or two 5-minute periods of relaxation during an instruction period are desirable for maintaining mental alertness.

11. Sequence of instruction.—Code instruction is given in the sequence indicated below concurrently with instruction in the operation of authorized unit equipment. Each operator in a unit should be capable of operating any set with which the unit is equipped. Consequently, instruction in the various sets, including nomenclature, composition, methods of installing, methods of transporting, characteristics, and technical design, together with such fundamental electrical studies as are necessary, should begin when the code course starts. The periods of code and operating instruction are alternated at the discretion of the instructor;
a. Initial reception of five groups per minute.—Initially, separate periods are devoted to each of the five lessons given in paragraphs 14 to 18, inclusive, and in that order. These lessons contain the letters of the alphabet and the numerals. Transmission is at the rate of five groups (25 characters) per minute, and in each lesson the characters of that lesson are transmitted in random order. As soon as the student is able to receive 50 consecutive characters (10 groups) of lesson No. 1 without error, lettering them satisfactorily, he is advanced to lesson No. 2. He is similarly advanced to lessons Nos. 3, 4, and 5. As soon as he has completed lesson No. 5 in this manner, all the letters and numerals are transmitted at the same rate in random order. He qualifies at five groups per minute when he is able to receive 50 consecutive characters (10 groups) without error, recording them satisfactorily.

b. Reception of seven groups per minute and initial transmission.—After the student has qualified as prescribed in a above—

(1) The rate of transmission is increased to seven groups per minute. He qualifies at this rate when he is able to receive 70 consecutive characters (14 groups) without error, lettering them satisfactorily.

(2) Instruction in transmission is begun. From this point approximately one-third to one-half of the student's instruction time is devoted to transmitting, with the object of bringing his transmitting speed to at least eight groups per minute by the time he has qualified in reception at the rate of 12 groups per minute. Thereafter, approximately one-third of his time is devoted to transmitting. If the equipment is available, the student is required to transmit to an instrument which records his transmission and reproduces it later. He then is required to receive his own transmission as it is reproduced before he is considered to have qualified at that transmitting speed. He is required to transmit for 2 minutes, and the number of consecutive groups transmitted correctly during that period (as indicated by the student's received copy), divided by 2, is his transmitting speed in groups per minute. If the reproducing equipment is not available, the student is required to transmit to an experienced instructor, who grades the transmission for accuracy, proper spacing, correct manner of transmitting, and speed.

c. Reception of ten groups per minute.—After the student has qualified as prescribed in b(1) above, the rate of transmission is increased to ten groups per minute. He qualifies at this rate when he is able to receive 100 consecutive characters (20 groups) without error, lettering them satisfactorily.

d. Recording by typewriter.—After the student has qualified as prescribed in c above, and if he is to be instructed in recording by
typewriter, he is returned to lesson No. 1 and repeats the instructions indicated in a, b, and c above, except that all recording is accomplished on the typewriter. At the outset of this instruction he should be furnished an instruction book on the care and use of the machine and a copy of the keyboard chart as shown in figure 2.

c. Subsequent reception.—When the student has qualified as prescribed in c above—

(1) All transmissions to him are in the form of messages or procedure signals, and he is required to record them on the prescribed message form. If the student is being trained to record reception by typewriter, he receives the bulk of his instruction in that manner, but is given one period daily in which he is required to record by lettering. For code speeds under 20 words per minute, the student is advanced only when he is able to record properly by both printing and typing. For code speeds above 20 words per minute, reception recording is exclusively by typewriter.

(2) The rate of transmission is increased successively to 12, 15, 20, 25, 30, and 35 groups per minute. When the student is able to receive three consecutive messages averaging 12 groups each without error at any rate, recording them satisfactorily, he is permitted to advance to the next higher rate.

12. Suggestions for instructors.—If a copy of this manual is not available for each student, furnish each man with a copy of the suggestions indicated below at the beginning of his instruction and a copy of each of the lessons given in paragraphs 14 to 18, inclusive, at the beginning of his instruction in each of those lessons. When instruction in transmission is begun, furnish the student with a copy of paragraph 19, and a copy of each of the exercises given in paragraphs 20 and 21 at the beginning of his instruction in those exercises.

13. Suggestions for students.—a. Try to recognize the sound of the entire character and to ignore the number of dots and dashes that make it up.

b. Letter the characters exactly as shown in each lesson. Practice lettering until it requires no conscious effort when receiving.

c. Work hard, but if after a while you feel so tired that you are not learning or you become disgusted, lean back, relax, and think of something else for a few minutes in order to restore your mental alertness.

d. Never look back over your copy while you are receiving.

e. If you do not recognize a character immediately, skip it, write down a small dash in place of it, and go on to the next. You will eventually realize what sound combinations you do not recognize and can then give special attention to them.
f. After having qualified at ten groups per minute, develop the habit of lettering one or two characters behind the sender. This will allow your lettering to become smooth and easy. It will also prevent you from forming the habit of trying to guess a word and of recording it before it has been completely transmitted.


b. Information.—The characters consist of dots (short sounds—dit) sounds—dah). The dashes are three times as long as sounds making up a single character are separated but uniform space of no sound. The characters inson, together with the dots and dashes and the sound as follows:

<table>
<thead>
<tr>
<th>Dots and dashes</th>
<th>Sound</th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
<td>Dit dit dah dit</td>
</tr>
<tr>
<td>--</td>
<td>Dah dah dit</td>
</tr>
<tr>
<td>.....</td>
<td>Dit dit dit dit</td>
</tr>
<tr>
<td>---</td>
<td>Dah dah</td>
</tr>
<tr>
<td>.-- .</td>
<td>Dit dah dah dah</td>
</tr>
<tr>
<td>:-- :</td>
<td>Dit dah dit</td>
</tr>
<tr>
<td>:-- :</td>
<td>Dit dit dah</td>
</tr>
</tbody>
</table>

-(1) Listen to the sounds and record the characters size.
g by typewriter, use only the first finger of the proper aracter as shown on the keyboard chart.

![Figure 3](image-url)

Figure 3.
g by lettering, letter each character as shown in figureokes in the directions shown and in the order in which ed.
I have recorded 100 consecutive characters that you st, request the instructor to check your paper. If characters are all correct and the recording has been ly, you will be advanced to lesson No. 2.

15. lesson No. 2.—a. Objective.—To teach the sounds B, D, K, N, T, V, and Y and the correct methods of recording them.
c. Directions.—(1) Listen to the sounds and record the characters you recognize.

(2) If recording by typewriter, use only the second and third fingers of the proper hand for each character as shown on the keyboard chart.

(3) If recording by lettering, letter each character as shown in figure 5, making the strokes in the directions shown and in the order in which they are numbered.

(4) When you have recorded 100 consecutive characters that you think are correct, request the instructor to check your paper. If 50 consecutive characters are all correct and the recording has been done satisfactorily, you will be advanced to lesson No. 4.

### Figure 5.

17. Receiving lesson No. 4.—a. Objective.—To teach the sounds of the characters A, P, Q, X, Z, 4, and 5 and the correct methods of recording them.

b. Information.

<table>
<thead>
<tr>
<th>Character</th>
<th>Dots and dashes</th>
<th>Sound</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>.-</td>
<td>Dit dah</td>
</tr>
<tr>
<td>P</td>
<td>---</td>
<td>Dit dah dah dit</td>
</tr>
<tr>
<td>Q</td>
<td>-----</td>
<td>Dah dah dit dah</td>
</tr>
<tr>
<td>X</td>
<td>-----</td>
<td>Dah dit dah</td>
</tr>
<tr>
<td>Z</td>
<td>-----</td>
<td>Dah dah dit</td>
</tr>
<tr>
<td>4</td>
<td>.-----</td>
<td>Dit dit dit dah</td>
</tr>
<tr>
<td>5</td>
<td>.-----</td>
<td>Dit dit dit dit</td>
</tr>
</tbody>
</table>

### Figure 6.

c. Directions.—(1) Listen to the sounds and record the characters you recognize.

(2) If recording by typewriter use only the first, third, and fourth fingers of the proper hand for each character as shown on the keyboard chart.
(3) If recording by lettering, letter each character as shown in figure 6, making the strokes in the directions shown and in the order in which they are numbered.

(4) When you have recorded 100 consecutive characters that you think are correct, request the instructor to check your paper. If 50 consecutive characters are all correct and the recording has been done satisfactorily, you will be advanced to lesson No. 5.

18. Receiving lesson No. 5.—a. Objective.—To teach the sound of the characters 1, 2, 3, 6, 7, 8, 9, and 0 and the correct methods of recording them.

b. Information.

c. Directions.—(1) Listen to the sounds and record the character you recognize.

(2) All fingers are used in typing these characters. Use the proper finger of the proper hand for each character shown on the keyboard chart.

```
1 2 3 6 7 8 9 0
```

**Figure 7.**

(3) If recording by lettering, letter each character as shown in figure 7, making the strokes in the direction shown and in the order in which they are numbered.

(4) When you have recorded 100 consecutive characters that you think are correct, request the instructor to check your paper. If 50 consecutive characters are all correct and the recording has been done satisfactorily, you will be advanced to receiving practice on all characters transmitted in random order at five groups per minute.
19. Transmitting.—a. General.—The ability of a radio operator to transmit well-formed code characters is just as important as is his ability to recognize and record them accurately. In furtherance of this end it is essential that a student's practice transmissions be accomplished in the correct manner; habits formed when beginning to learn to send will remain with operators throughout their careers. Continuous accurate transmission of characters requires a properly adjusted key, a proper position of the operator at the key, and key operation in accordance with the principles enunciated below. When a student has demonstrated his familiarity with these principles, he begins his first transmitting exercise.

b. Key adjustment.—Figure 8 shows an ordinary closed circuit key. To adjust the key—

(1) See that the hammer is directly over the anvil. If not, loosen the lock nuts on the trunnion screws and turn these screws until the hammer is in the proper position and the key lever works freely without undue play. Tighten the lock nuts.

(2) Loosen the lock nut on the adjusting screw and turn this screw until the distance between the hammer and the anvil is about 0.008 inch (about the thickness of three sheets of bond paper) with the front of the key lever raised. Tighten the lock nut.

(3) Loosen the lock nut on the tension screw and turn this screw until the key can be closed easily by the hand and will be broken sharply by the spring. Tighten the lock nut.

(4) If difficulty is experienced in forming dots or dashes after the tension screw has been adjusted as in (3) above, change this adjustment until you are able to send both easily. Too much tension is usually identified with short dashes, irregular and long spacing between characters, and dot skipping. Too little tension is usually identified with long dots and short and irregular spacing between characters.

c. Position at key.—The proper position of an operator at a key is illustrated in figure 9.
(1) To assume a correct position at the key—

(a) Place the elbow on the table in prolongation of the key lever and at such distance from the key button that, with fingers slightly curved and the wrist about 1½ inches above the table, the ends of the first and second fingers rest easily on the distant half of the key button.

(b) Rest the ends of the first and second fingers lightly but firmly on top of the key button, the first joint of each finger being more nearly vertical than horizontal.

(c) Place the thumb lightly on the edge of the key button.

View from above

Side view

(d) Allow the third and fourth fingers to curve naturally under the palm without tension or rigidity.

(2) After the sending arm, wrist, and fingers have been placed as indicated above, check their positions. See that—

(a) The elbow, not the forearm, rests on the table.

(b) There is space between the table and the forearm and wrist.

(c) The fingers are curved and flexible, not straight or stiff.

(d) The finger ends (pads) of the first and second fingers rest on top of the key button near the back edge.
(e) The thumb is on the edge of the key button, resting lightly against it, but not grasping it.

d. Key operation.—(1) Method.—Having assumed the proper position at the key, press down the key button by a straight downward motion of the forearm. In doing this, let the wrist break or bend downward a little, acting as a hinge between the forearm and the hand. Keep the fingers loose so that they can bend a little; in any event, do not let them be stiff. When the key contacts have been closed, release the pressure on the key button and allow the spring to return the key to the up position, keeping the fingers in light contact with the key button.

(2) Precautions.—(a) Make sure that the key button goes down because your forearm is moved down.

(b) Do not actuate the key with the finger muscles. The fingers are merely the medium through which the stroke of the forearm is transmitted to the key.

(c) Do not actuate the key with the wrist muscles. The wrist is merely a hinge through which the stroke of the forearm is transmitted to the key.

(d) Avoid all stiffness and rigidity in the fingers and wrist. Any such stiffness not only makes for ragged transmission but is very conducive to fatigue.

20. Transmitting exercise No. 1.—Check the key, making adjustments if necessary. Take the correct position for sending, checking the position of your forearm, wrist, fingers, and thumb. Start making dots at the rate of about 100 per minute. Continue to transmit dots until your forearm, wrist, or fingers become tired. Rest for a short time, then transmit again. Do not make anything but dots. Try making dots faster as you feel your muscles limbering up. Do not permit your practice to become erratic. Send smoothly. Try constantly to make the dots equal. If you are trying to transmit faster than you should, your sending will be rough (unequal and not rhythmie) and may “stutter.” Continue your transmission of dots 0 dots in one group smoothly in about ten seconds. You have acquired this ability, ask the instructor mission. If it is satisfactory, you will be advanced case 2.

21. Transmitting exercise No. 2.—Transmit a few groups of 30 the position of your forearm, wrist, fingers, and the character V (dit dit dah), making the dits at the same rate at which you made them upon completion of exercise 1 and holding the key down for the dah 3 times as long as the time
required to transmit a dit. Allow the same space between the third
dit and the dah as exists between the dits. Begin making the charac-
ter V at the rate of about 35 per minute. Keep your fingers and
wrist flexible. If you feel them tightening up, remove your hand from
the key and flex the fingers and wrist until the muscles are completely
relaxed. Continue transmitting V’s until you can send 20 conces-
tive characters smoothly. When you feel that you have acquired this
ability, ask the instructor to check your transmissions. If it is satis-
factory, you will be advanced to practice transmission of the ma-
terial included in appendix II.

SECTION IV

TRAINING IN RADIO OPERATING PROCEDURE

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| Flexibility of training program | 24        |
| Instructional material | 25        |
| Conducting the class | 26        |
| Measurement of progress | 27        |

22. General.—The purpose of the radio operating procedur
employed by the Army is to promote accuracy and speed in the ex-
change of radio messages. Radio operators trained at widely scatte-
estations may ultimately find themselves obliged to communicate with
one another and under conditions of stress. With this in mind, it is
evident that the necessity for a single precise and completely uniform
system of handling radio traffic cannot be too strongly emphasized.

23. Phases of training.—a. The training of a radio operator in
procedure may be divided into four phases:

(1) The basic training phase using code room equipment and
devoted to a study of the fundamentals of procedure.

(2) A survey phase using code room equipment and devoted ex-
clusively to the handling of traffic, simulating actual field operation as
closely as possible without the use of field radio transmitters and
receivers.

(3) An introductory field phase using field equipment at reduced
distances.

(4) An actual field phase using regular field equipment at normal
distances.

b. Phases (3) and (4) above may appear to be properly a part of
technical radio operation instruction. However, there is a definite
and important aspect of radio operating procedure, entirely aside from
any technical problems of the radio equipment, which can only be mastered under genuine field conditions. The radio operating procedure lessons covered herein deal only with the phases (1) and (2) enumerated above.

c. Study and practice in radio operating procedure may begin after the student has attained a code speed of five words a minute. The time required to attain proficiency in field radio operating procedure depends largely upon the individual student, but a satisfactory knowledge of procedure is usually obtained in 25 to 75 hours of operation and study.

d. The comments given in paragraph 10 on duration, frequency, and relaxation for operating study apply equally well to procedure studies.

24. Flexibility of training program.—It is not essential that the instructor adhere rigidly to the training program described herein. In fact, the instructor is encouraged to inject his own personality into his teaching and to alter the style of the course freely to suit his own purpose and the needs of his class. However, the system suggested below has been found highly successful in the training of radio operators, and the program, in the main, should serve as a useful guide.

25. Instructional material.—a. Text material.—If this manual is available for each member of the class, the instructor should provide mimeographed copies of the first lesson to the entire class at the beginning of the course and copies of additional lessons to students as their progress warrants it. Further, a list of procedure signals and procedure signs as found in the appendixes should be made available to each student. In all units using the abbreviated form of message exclusively, sections V to IX, inclusive, XI, and XII provide adequate training material for the essential principles.

b. Station logs.—During the initial training phase, logs should be employed which provide for the recording of all signals heard and transmitted. A suitable training log is shown in FM 24-5. During the second phase of training, when operators are able to carry on with a minimum of supervision, the practical type of log is the regular field log. This type of log is shown in figure 10.

c. Prepared messages.—Beginning with radiotelegraph procedure lesson IV, it is necessary for the instructor to prepare "canned" messages for transmission. The messages listed in appendix II may serve for this purpose, or these specimen messages may be used as guides to assist the instructor in preparing additional messages.

d. Message book.—The standard field message form is used for both transmitted and received messages.
## THE RADIO OPERATOR

### SIGNAL CORPS, UNITED STATES ARMY

**LOG**

Enter opening and closing time, frequencies and frequency changes, traffic delays and any incidents or conditions affecting circuit efficiency.

<table>
<thead>
<tr>
<th>Time</th>
<th>Operator</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1212 P</td>
<td>W-A</td>
<td>W RELIEVES X</td>
</tr>
<tr>
<td>1235</td>
<td>W-T</td>
<td>T RELIEVES A</td>
</tr>
<tr>
<td>211</td>
<td></td>
<td>BLUE GLOW IN AMPLIFIER TUBE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DRAWING EXCESSIVE CURRENT</td>
</tr>
<tr>
<td>214</td>
<td></td>
<td>REPLACE AMP TUBE PLATE CURRENT OK</td>
</tr>
<tr>
<td>450</td>
<td>A-X</td>
<td>RELIEVE W-T</td>
</tr>
<tr>
<td>632</td>
<td></td>
<td>CLOSE STATION FOR MOVE</td>
</tr>
<tr>
<td>840</td>
<td></td>
<td>BLUFTON 4100 KC REPORT IN TO LA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OUR SIGS ZSB4 AT LA ZSB3 AT LB</td>
</tr>
<tr>
<td>910</td>
<td></td>
<td>NET SHIFTS TO 4120 KC ON ORDER OF LA</td>
</tr>
<tr>
<td>1026</td>
<td></td>
<td>MICROPHONE ACCIDENTALLY DROPPED</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LA REPORTS PHONE QUALITY POOR NO SPARE</td>
</tr>
<tr>
<td>1119</td>
<td></td>
<td>CLOSE STATION FOR MOVE</td>
</tr>
</tbody>
</table>

**Figure 10.—** Sample station log with typical entries.
26. Conducting the class.—a. The order of administering an instructional period is as follows:

1) The instructor distributes the necessary text material and delivers any introductory remarks which he feels advisable for supplementing the text.

2) The students study the text.

3) The students ask questions of the instructor on any point which they do not understand.

4) The instructor gives a written quiz on the subject matter of the lesson.

5) The students practice transmitting individually, during which time the instructor grades the quizzes.

6) Those students who pass the quiz are grouped into nets of three stations each to carry out the operations prescribed in the operation exercise for the corresponding lesson. Any student who fails initially to pass the quiz must review the lesson at his desk. He is then given a second opportunity to take the same quiz whenever he feels adequately prepared. This process is continued, if necessary, until each student successfully completes the quiz and proceeds to the operation exercise.

7) Students completing an operation exercise submit their log sheets and copies of all messages handled, both transmitted and received, to the instructor for check, and then study the next lesson.

8) A written quiz on the information contained in the next lesson is given to any student who feels adequately prepared and whose log sheet on the previous lesson is found to be satisfactory.

9) At the close of an instructional period, nets which have not completed their operation exercises simply stop at any convenient point and resume operation at that point at the opening of the following instructional period without any apparent break being shown on the log sheets. Operators always retain their log sheets until all operations described in that lesson are completed.

b. The method of teaching indicated in a above has the advantage of automatically dividing the class into groups, so that the instructor may concentrate his attention on the slower students, who need the most assistance; and of providing an incentive to the better students to work as fast as they desire, and so reducing the training time to a minimum. One or more assistant instructors are desirable if the class is large, although it is possible for one instructor with some experience to handle successfully a class of as many as 50 men.

c. In this series of lessons all references to recording received material imply lettering with pencil. The instructor checking
received messages should emphasize good lettering as much as accurate copying, since the radio operator's copy must normally be legible to other personnel for deciphering. Typewritten copy is permissible. However, typewriters are rarely available to field radio stations, and training should be handled accordingly.

d. An effective arrangement of the three key operators in any one net is one fast operator and two slower operators rather than three fast operators in any one net and three slow operators in another. A man who shows good aptitude for transmitting and receiving ordinarily also exhibits ready understanding of procedure. Such a man generally sets an example of good operating procedure, and, if desired, he may incidentally be employed as an assistant instructor to guide the operators at the other two stations of the net. It is not intended that the net control station (NCS) assignment should be confined to the best operator; this assignment should be rotated to provided equal opportunity for all students to practice NCS responsibility.

27. Measurement of progress.—a. General.—The objective of net training is to provide operators with a thorough understanding of operating procedure. Emphasis is placed on thorough training rather than on putting all men through the course in the same length of time. If any individual student is unreasonably slow, it is best to arrange for his release from training and to recommend his transfer to other duty. All grading of individual items in the course should be either "pass" or "fail." A student must repeat each item as many times as necessary to insure mastery before proceeding to the succeeding material.

b. Grading quizzes.—Quizzes are retained by the instructor. The instructor summons each student to his desk individually, or the instructor may visit each student at the latter's desk, and grades each particular quiz in the writer's presence. In this way the student sees his paper checked and has an opportunity for personal discussion of any item with the instructor. Quizzes are graded either "pass" or "fail" according to the judgment of the instructor on how well the student has grasped the essential points involved.

c. Grading logs.—Log sheets may be partially checked by the instructor, using a colored pencil, as he observes the various nets in actual operation. This system of checking logs, over the students' shoulders, promotes further close contact between student and instructor and facilitates both teaching and grading. Occasionally, if errors of important basic points of operation are indicated by the logs of any one net, it may be well for the instructor to stop that
particular net, point out the errors, and have all stations in the net repeat the complete operation. Logs are graded "pass" or "fail" depending upon whether or not the indicated performance of the operations is satisfactory.

d. Progress chart.—The instructor will find it advantageous to employ a wall or blackboard chart such as shown in figure 11 for keeping a record of the progress of each member of the class.

<table>
<thead>
<tr>
<th>Name</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allen</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doe</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Johnson</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Key**

\ completed quiz
/ completed operation
X completed lesson

**Figure 11.**—Progress chart.

SECTION V

RADIOTELEGRAPH PROCEDURE LESSON I, THE CALL-UP AND ANSWER

<table>
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<th>Paragraph</th>
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</thead>
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<td>Collective call-up</td>
<td>29</td>
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<td>Multiple call-up</td>
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<td>The answer</td>
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<td>Procedure signs</td>
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<td>Procedure signals</td>
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<td>Repetitions</td>
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<td>Questions for self-review</td>
<td>37</td>
</tr>
<tr>
<td>Sample quiz</td>
<td>38</td>
</tr>
<tr>
<td>Operation exercise</td>
<td>39</td>
</tr>
</tbody>
</table>

28. Call signs.—All radio stations are identified by call signs, for example, WLW is the call sign of a broadcasting station in Cincinnati; WAR is the call sign of the War Department station in Washington, D. C. Call signs for the various Army stations in the field are nor-
mally assigned in Signal Operation Instructions (S. O. I.). An example of a list of call signs is given in FM 24-5. The S. O. I. in effect may prescribe that call signs change at a time when stations are in operation. This change is made automatically by each station at the specified time with no attendant formalities and with no interruption of radio communication.

29. The call-up.—a. Definition.—A station whose call sign is LB contacts a station whose call sign is LA by means of the “call-up”:

\[ \text{LA V LB AE} \]

In the above, V is an abbreviation for “from”, and AE means “end of transmission and standing by to receive your reply”.

b. Repetition of call signs in a call-up.—Each station’s call sign may be transmitted more than once in a call-up but not more than three times. Example:

\[ \text{LA LA LA V LB LB LB AE} \]

In establishing contact between two stations, the transmitting operator may call three times and sign three times, as in the above example in order to give the receiving operator the utmost opportunity to tune in the signal. Repeated calls are also permissible at any time under doubtful or definitely adverse communication conditions, such as during heavy static. However, the student must constantly bear in mind the possibility that in actual field operations enemy position-finding stations will welcome a radio operator’s prolonged transmissions. One goal of training should be station contact and message exchange with the fewest and shortest possible transmissions. Recommended procedure in this connection is illustrated in c below.

c. Repetition of call-up.—In an initial call-up call signs are transmitted only once. If a called station fails to answer an initial call-up promptly, the call-up may be repeated immediately, with the call signs therein sent three times. If the second call-up is not answered, the calling station should wait at least two minutes before transmitting a third call-up. Any additional call-ups necessary before receiving an answer should be at intervals of at least five minutes, except when the calling station has an urgent or priority message for the called station, in which case no restriction is placed upon such repetitions.

- Original call-up: \[ \text{LA V LB AE} \]
- Second call-up: \[ \text{LA LA LA V LB LB LB AE} \]
  - 2 minute (or greater) interval
- Third call-up: \[ \text{LA LA LA V LB LB LB AE} \]
  - 5 minute (or greater) interval
- Fourth call-up: \[ \text{LA LA LA V LB LB LB AE} \]
30. **Collective call-up.**—In the event that a station wishes to gain the attention of two or more stations simultaneously, a prearranged "collective" call sign may be used. Thus, the call sign ABC may be designated to include three stations, LA, LB, and LC. One of the stations, LC, should call LA and LB simultaneously by transmitting the collective call-up:

\[
ABC \text{ V } LC \text{ AE}
\]

31. **Multiple call-up.**—In the absence of a prearranged collective call sign which includes all the stations with which communication is desired, these stations may be called simultaneously by simply transmitting the call signs of each desired station in sequence. This is known as a "multiple" call-up. Example:

\[
LA \text{ LB } \text{XA V } LC \text{ AE}
\]

The prescribed order of call signs is alphabetical if their first symbol is a letter as in the above illustration. The call signs are arranged in ascending numerical order if their first symbol is a number as shown below.

\[
2C 3A 4B \text{ V } LC \text{ AE}
\]

32. **The answer.**—*a Definition.*—Station LA, upon hearing a call-up from LB, would answer by transmitting:

\[
LB \text{ V LA } K
\]

\(K\) means "go ahead (transmit)".

*b. Order of answering.*—(1) The order of stations answering a multiple call-up is the same as the order in which their calls appeared in the original call-up.

- Call-up.............................................. LA LB XA V LC AE
- First station to answer.................... LC V LA K
- Second station to answer................... LC V LB K
- Third station to answer.................... LC V XA K

(2) In answering a collective call-up, the called stations answer in alphabetical or numerical order of call signs. If call signs beginning with both numerals and letters are used in the same net, the stations having call signs beginning with letters will answer first, alphabetically; they will be followed by the stations having call signs beginning with numerals, answering in numerical order. Again taking the collective call sign ABC to include LA, LB, and LC:

- Call-up.............................................. ABC V LC AE
- First station to answer.................... LC V LA K
- Second station to answer................... LC V LB K
(3) If a called station fails to answer a multiple or collective call-up in its turn, the next station in order, after waiting 15 seconds, answers; and the delinquent station does not answer until all other stations have answered.

Call-up........................... LA LB XA V LC AE
First station to answer........... LC V LA K
15-second interval
Second station to answer.......... LC V XA K
Third station to answer........... LC V LB K

c. Answering a station whose call sign is unknown.—Occasionally a receiving station recognizes its own call in a call-up but fails to distinguish the call sign of the calling station. Such a call-up would be answered by the use of the "unknown station" procedure sign AA. Thus FG, having heard someone call him but not being certain who called, transmits:

AA V FG K

The calling station then repeats its call-up:

FG V XY AE

33. Procedure signs.—The abbreviations V, AE, and K, which appeared in the above call-ups and answers, are three of a group of commonly used radio abbreviations referred to as "procedure signs." The complete list of procedure signs is given in appendix III. A partial list is given below:

<table>
<thead>
<tr>
<th>Procedure sign</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>---------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>AA --------------</td>
<td>End of transmission.</td>
</tr>
<tr>
<td>EE EE EE EE EE EE</td>
<td>Error. Erase.</td>
</tr>
<tr>
<td>IMI -------------</td>
<td>Repeat. Question mark.</td>
</tr>
<tr>
<td>K -------------</td>
<td>Go ahead. (Transmit.)</td>
</tr>
<tr>
<td>V -------------</td>
<td>From. Calling.</td>
</tr>
<tr>
<td>VA -------------</td>
<td>Finish.</td>
</tr>
</tbody>
</table>

34. Procedure signals.—a. Definition.—Another type of abbreviation used in Army radio communication is the "procedure signal." A procedure signal is a three letter group, often called a "Z" signal because its first letter is Z, representing some frequently used complete expression which facilitates conversations between operators. The second letter of a procedure signal characterizes the signal as of a particular classification, and the third letter distinguishes any one procedure signal from others of the same classification. With some procedure signals, as will be seen in the partial list below, blanks are indicated in the meanings given. All blanks except those in
Parentheses are required to be filled in by the transmitting station. Those in parentheses are filled in if desired. In all cases filled-in data follow the procedure signal and appear in the same order as the blanks filled in. Except as otherwise noted, words rather than numerals are used to complete the meanings of procedure signals. Thus, to express “I am in radio communication with LA”, a station transmits: ZCB LA ONE and not ZCB LA 1.

b. Examples.—A partial list of procedure signals is given below. A complete list of procedure signals will be found in appendix III.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Procedure signal</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>C: Calling; communication.</td>
<td>ZCA</td>
<td>Are you (or is _____) in communication with _____ (by _____) (1. Radio; 2. Wire; 3. Visual)?</td>
</tr>
<tr>
<td></td>
<td>ZCB</td>
<td>I am (or _____ is) in communication with _____ (by _____) (1. Radio; 2. Wire; 3. Visual).</td>
</tr>
<tr>
<td>M: Messages</td>
<td>ZMA</td>
<td>I have (or _____ has) (_____ ) messages (numeral indicating number of messages may be followed by O, P, or D to indicate precedence other than routine) for you (or ______).</td>
</tr>
<tr>
<td></td>
<td>ZMW</td>
<td>Of what precedence and to whom are your messages?</td>
</tr>
<tr>
<td>Z: Miscellaneous</td>
<td>ZZB</td>
<td>Negative, no, not.</td>
</tr>
<tr>
<td></td>
<td>ZSC</td>
<td>Affirmative, yes.</td>
</tr>
</tbody>
</table>

c. Use.—(1) As an illustration of the use of procedure signals, consider ZMW, meaning: “Of what precedence and to whom are your messages?” (Messages are given precedence according to their relative importance and urgency as designated by the originator.) Station LB might ask station LA:

\[ \text{LA V LB ZMW AR} \]

to which, in the event that station LA has no messages whatsoever on hand to transmit, LA would reply:

\[ \text{LB V LA ZMA ZERO AR} \]

ZERO is used in the above rather than NONE to avoid the possibility of the receiving operator’s mistaking NONE for ONE.

(2) Procedure signals are the only authorized means other than regular messages for conversations between operators. If procedure signals are found to be inadequate, the chief operator or chief of a
station may authorize the transmission of messages relating to the conduct of communications.

**35. Terminating transmissions.**—Some sort of terminating sign is necessary to indicate when the transmitting station cedes the air to the receiving station. The following examples illustrate the uses of various procedure signs which are employed for the purpose.

a. **AE:** "End of transmission."—This has the meaning, "I am through with this transmission, you may respond if a response is in order or necessary." Example:

```
LA V LB ZMW AE
```

LB expects a reply to his query and so terminates his transmission with **AE**. For an additional example:

```
LA V LB AE
```

Station LB has called up station LA with the intention of sending LA something and now anticipates a "go ahead" sign from LA before proceeding. Without the **AE** on the end, LA is not sure whether LB has just paused briefly in his transmitting or is definitely standing by waiting for LA to reply. The use of the **AE** removes this uncertainty.

b. **K:** "Go ahead, transmit."—One station LA, having been informed that another station, LB, has something to transmit to LA advises LB to proceed by means of the terminating sign **K**, which means "Go ahead, transmit." LB might have advised LA of his desire to transmit something to LA by stating:

```
LA V LB ZMA ONE AE
```

LA prepares his message form in anticipation of receiving a message from LB and transmits:

```
LB V LA K
```

that is, LA says to LB, in effect: "Go ahead, transmit. I am ready to copy."

When a receipt is required, a transmission will end with **K**. This applies mainly to regular messages, but it may also apply to any special instructions in the form of procedure signs or signals for which the transmitting station wants receipts as a matter of record or information. For example, station CB desires station RU's last message verified and repeated, and also desires a receipt for this request itself:

```
RU V CB J K
```

RU receipts simply:

```
CB V RU R
```

As soon as the message is verified, RU calls CB back and repeats the
message as requested. Examples of the use of K with messages will be found in sections VIII, IX, and X. When a receipt is not required, a transmission will end with AR or some other appropriate terminating sign.

c. VA: "Finish".—VA is employed—
(1) To terminate a transmission to which an acknowledgment or reply is prohibited or not expected, or:
(2) To indicate to the receiving station that henceforth until some future time, the transmitting station will no longer be in communication with the receiving station, as, for instance, should the transmitting station be closing down to displace to a new position, or closing down until the next regular operating schedule, or leaving the net (by shifting frequency) to operate with a station in another net.

d. Other procedure signs which may be employed for terminating transmissions are B, which means "More to follow"; C, "Affirmative. Correct"; IMI, "Question mark"; N, "Not received. Negative"; R, "Receipt"; J, "Verify and repeat"; Y, "Acknowledge." Various examples of the uses of these procedure signs occur in the text of this manual.

36. Correction of error.—When an error is made in transmission, the transmitting operator immediately makes the "error" sign (EEEEEEEE), then repeats the last word, group, or procedure sign or signal which was correctly made and continues with the transmission. Example:

LA U EEEEEEE LA V LB AR

37. Repetitions.—a. Repetition of transmission.—A request for a repetition of a complete transmission is made by sending IMI. Thus:

LA V LB IMI AR

In response to the above request station LA would repeat its entire previous transmission.

In this case IMI is a little message meaning "Please repeat the last transmission", and it therefore requires a separate terminating sign. IMI is a terminating sign by itself when it is used as a question mark after some other procedure sign or signal, to give it an interrogatory meaning, as in paragraph 46c and f.

b. Repetition of difficult portion.—IMI may also be used to indicate that the transmitting operator is about to repeat a difficult portion to insure the correct reception by the receiving operator. Example:

LA V LB BT BODY OF VISCAY A ZULANGLA IMI VISCAY A ZULANGLA FOUND 1052P K.
38. Questions for self-review.—The student should answer each of the following questions as a test of his understanding of the lesson.

a. How does one station contact another?

b. How many times may each station’s call sign be transmitted in a call-up?

c. What action would you take if a station failed to answer your initial call-up?

d. What is a collective call-up?

e. What is a multiple call-up?

f. In what order is a multiple call-up answered?

g. If a called station failed to answer a collective call-up in its proper turn how long should the next called station in order wait before answering?

h. The meaning of the procedure signal ZMA is given as: “I have (or —— has) —— messages (numeral indicating the number of messages may be followed by O, P, or D to indicate precedence other than routine) for you (or ——).” Of the blanks provided in the stated meaning of ZMA, the first and third are inclosed in parentheses whereas the second is not. What is the significance of this usage of parentheses?

i. How would you request a repetition of a complete transmission which you had missed?

j. In a message made up of code groups, which you are about to transmit, one group is SEIS, conceivably difficult to receive on account of the succession of dots involved. How might you make your transmission to assist the receiving operator on this difficult group?

k. Correct the following transmissions:

(1) LA LA LA V LB LD TM Y LB LB LB AR
(2) LA LA LA V LB LD EEEE EEB LB LB LB AR
(3) LA LB FG V LC AR
(4) NOW IS THE TIME EEEEEEE TIME FOR ALL GOOD MEN
(5) ZCA LB 3 LA
(6) ZCB ZSB LA LC

39. Sample quiz.—The following is a suggestion for a quiz covering the principles enunciated in lesson I. Sample quizzes are not illustrated in this manual for any of the succeeding lessons, the writings of these quizzes being left to the instructor. The instructor is cautioned to examine quiz questions carefully to avoid ambiguities. Having an assistant take the quiz before it is submitted to the students will often serve to bring out any unsuspected defects in the quiz.
Quiz on operation lesson I

Directions to the student: Fill in all spaces. Print plainly. Assume that you are the operator at station LA.

1. You wish to ask LB of what precedence and to whom are his messages. Show your transmission to LB.

2. You intend to transmit the following.

   LB V LA AR

However, you accidentally make LR instead of LA in the actual transmission. Show your complete transmission to LB including the error and its correction.

3. Assume that CD did not receive your transmission of question 2. Show how he would request a repetition.

4. Using a multiple call-up, indicate how you would request LB, LE, LD, and LC to inform you if they are in communication with BZ by wire.

5. Show the replies of the individual stations in the proper order of your request of question 4. Assume that LE and LB are not in wire communication with BZ but that LD is; LC has just developed transmitter trouble and is unable to reply by radio. Indicate the occurrence and the duration of any extended pauses.

40. Operation exercise.—a. Directions to the student.—The net consists of three stations, LA, LB, and LC. The collective call sign which includes all three stations of the net is ABC. For simplicity any repeated group may be recorded once with a superscript to indicate the number of times the group was actually transmitted. Thus

   LA LA LA V LB LB LB AR

may be recorded as

   LA V LB AR

Execute the following communications in the order listed, recording every transmission (including your own) directly on the log sheet.

b. Exercises.—(1) Station LA will call up station LB and ask if LB has any messages for LA.

   (2) Station LB will answer station LA, and state that he has no messages for LA.
(3) Station LA will call up station LC and ask if LC has any messages for LA.
(4) Station LC will answer station LA and state that he has no messages for LA.
(5) Station LA will call up stations LB and LC using a multiple call-up and ask if they are in wire communication with station BA.
(6) Stations LB and LC will answer in the proper order, LB answering in the affirmative, LC in the negative.

Request the instructor to check the log at this point before continuing

(7) LB will call up LC and ask if LC has any messages for LB.
(8) LC will answer LB and state that he has no messages for LB.
(9) LB will call up LA and ask if LA has any messages for LB.
(10) LA will answer LB and state that he has no messages for LB.
(11) LB will call up LC and LA using the collective call sign assigned to the net and ask them if they are in radio communication with FG.
(12) LC and LA will answer in the proper order, LC answering in the affirmative, LA in the negative.

Request the instructor to check the log at this point before continuing

(13) LC will call up LA and ask if LA has any messages for LC.
(14) LA will answer LC and state that he has no messages for LC.
(15) LC will call up LB and ask if LB has any messages for LC.
(16) LB will answer LC and state that he has no messages for LC.
(17) LC will call up LA and LB using the net call and ask if LA and LB are in communication with FG.
(18) LA and LB will answer in the proper order, LA stating that he is not in communication with FG, and LB stating that he is in communication with FG by wire.

Section VI

Radiotelegraph Procedure Lesson II, Readability, The Station Log
41. Readability.—a. Readability scale.—It is of interest to a transmitting operator to know the "readability" of his signal at the receiving station. By "readability" is meant an estimate of the ease with which the receiving operator can make intelligent copy. This estimate depends partly upon the relative strength of the desired versus the undesired (interference, static, inherent receiver noise, etc.) signal and partly upon the capabilities of the receiving operator. A numerical scale of readability has been adopted as follows:

1. Unreadable.
2. Poor but readable; make plain language messages through twice, code unreadable.
3. Fair; readable; plain language once slowly, make code messages through twice.
4. Good; readable; plain language or code once.
5. Perfectly readable.

b. Request for readability.—An operator may request a readability report by the use of the procedure signal ZSG. Thus:

LA V LB ZSG AR

LB might reply:

LB V LA ZSB4 AR (Readability 4)

Since ZSG means "What is my readability?", it is not necessary for LA to fill in the first blank in the meaning of ZSB, "I can receive —— Readability ——", as this would merely be a repetition of LB's own call. This is an exception to the rule that all blanks in Z signals not in parentheses be filled. However, note the full use of ZSB in case LB asks LA about a third station, LC.

LA V LB ZSA LC AR

LA would then answer

LB V LA ZSB LC 4 AR

c. Exchange of readabilities.—Operators may exchange readability reports without mutual request on first establishing communication with each other. Suppose station LA has heard station LB transmitting to station LC. LA, noting that LB's signal is perfectly readable, transmits a report of this readability on his initial call-up of station LB.

LB V LA ZSB5 AR

The AR with which LA concludes his transmission indicates that he expects a readability report from LB. LB then replies:

LA V LB ZSB4 AR
d. Change of readability.—In the event of any change of readability later in the day, a readability report so indicating is promptly transmitted. Thus, suppose that while LB is informing LA that he has a message for LA, an interfering station causes LB’s readability at LA to drop from 4 to 3. LA might send:

\[
\text{LB } \text{V } \text{LA } \text{ZSB3 K}
\]

LB would comply by transmitting all coded groups twice and all plain language once slowly, continuing in this manner until advised by LA of any further change in readability.

e. Change of readability due to frequency shift.—In the event of a readability drop caused by some drift or accidental shift in a transmitter’s frequency, the procedure for correcting the frequency to obtain better readability is illustrated in the following:

\[
\text{LA } \text{V } \text{LB } \text{ZFO } \text{AR} \quad (\text{Your frequency is too high.})
\]

or

\[
\text{LA } \text{V } \text{LB } \text{ZFO } 15 \text{ AR} \quad (\text{Your frequency is 15 kilocycles too high.})
\]

Station LA adjusts his transmitter to restore his frequency to the proper value and then asks:

\[
\text{LB } \text{V } \text{LA } \text{ZFM } \text{AR} \quad (\text{How does my frequency check?})
\]

To which LB might reply:

\[
\text{LA } \text{V } \text{LB } \text{ZFN } \text{ZSB4 AR} \quad (\text{Your frequency is correct. Readability good.})
\]

42. Signal and interference strengths.—Strength of signals and of interference may be expressed by the use of procedure signs S and W, respectively, together with an appropriate numeral according to the following scale:

- Very weak; hardly audible........................................... 1
- Moderately weak..................................................... 2
- Medium strong...................................................... 3
- Moderately strong................................................. 4
- Strong ..................................................................... 5

LB might report to LA:

\[
\text{LA } \text{V } \text{LB } \text{ZSB4 W3 FG } \text{AR}
\]

meaning “readability good; medium strong interference from station FG.”

43. Test signals.—If one station has difficulty tuning in another’s signals, the first station may request, by the use of the procedure
signal ZFD, that the second station send a series of V's (the standard test signal):

\[
\begin{align*}
\text{LA} & \quad \text{V} & \quad \text{LB} & \quad \text{ZFD} & \quad \overline{\text{AR}} \\
\text{LB} & \quad \text{V} & \quad \text{LA} & \quad \text{V} & \quad \text{V} & \quad \text{V} & \quad \text{V} & \quad \text{V} & \quad \overline{\text{AR}} \\
\text{LA} & \quad \text{V} & \quad \text{LB} & \quad \text{ZSB5} & \quad \overline{\text{AR}}
\end{align*}
\]

Or if LB wished to tune in LA on a different frequency, say 4210 kilocycles, LB might request:

\[
\text{LA} \quad \text{V} \quad \text{LB} \quad \text{ZFD} \quad \text{4210} \quad \overline{\text{AR}}
\]

(Numerals, not words, are used to indicate frequencies and frequency deviations in procedure signals.)

44. The station log.—a. Log material.—The station log is the radio operator's diary. A reasonable rule to follow in selecting material to be entered in the log is to enter sufficient information to enable a replacement operator to carry on at any point merely by reference to the log. In case of doubt as to whether or not an item is important enough to record, it is generally well to record it. What appears to be inconsequential at one time may develop to be of genuine importance later. However, the keeping of the log must not delay the handling of traffic. The log always includes, among other things, such data as—

1. Names of operators on duty.
2. Times of opening and closing of station.
3. Causes of delays in traffic.
4. Frequency adjustments and changes.
5. Unusual occurrences, such as procedure violations.

b. Recording.—Log items are a matter of semipermanent record. Items are entered in the log immediately following the occurrence of the incidents being reported, or as soon thereafter as the traffic situation permits. Entries are not erased. Any necessary changes are made by drawing a line through the original statement and indicating the changed version alongside or nearby.

c. Student log.—During the initial instruction phase and until advised to the contrary by the instructor, the student will enter the five minimum essentials listed in a above and will continue to record in the log every transmission in the net with the single exception that a transmitted message may be indicated in the log by a notation “Sent msg” or “Repeated msg”, instead of including the entire transmitted message in the log. The original copy of the message or the message blank delivered to the operator from the (simulated) message center will be considered adequate record of a transmitted message. However, any received message, regardless of whether it
corresponds to an original transmission or to a repeat, is copied completely in the log.

d. Log for trained operator.—The amount of detail to be entered in
the log may vary with the state of training of the student. As
training progresses to a point where the student is able to handle
traffic without close supervision, the entries in the log may be reduced
to simply the five minimum essentials listed in a above. A typical
log for an experienced operator is shown in figure 10.

e. Personal sign.—In the column marked “operator” in the log
shown in figure 10, each letter designates an operator and is known as
that operator’s “personal sign”. Each operator at a station has a
distinguishing personal sign of one or two letters (not necessarily his
initials) with which to identify himself in the station records. This
personal sign is never transmitted.

45. Time notations.—a. In Army radio operations, time nota-
tions in logs and elsewhere are in the usual 12-hour system, the new
day starting at midnight. Except for midnight and noon, which
are spelled out MIDNIGHT and NOON respectively, time groups
are always designated by numerals. 600A is used to indicate 6:00
A. M., 512P for 5:12 P. M. ZCC 733P means, “Call me again at
7:33 P. M.”

b. In joint Army and Navy communications, time is expressed in
the 24-hour clock system and is transmitted as a group of four figures.
The first two digits represent the hours from midnight and the last
two the minutes past the hour. Thus, 6:00 A. M. in the ordinary
12-hour system becomes 0600; 7:43 P. M. is 1943.

46. Procedure signs.—a. R: “Receipt.”—R is used to mean
“receipt” of a preceding transmission, particularly one ending in K.
For example, LA, having just received a message from LB, transmits:

L B V L A R

As a simple acknowledgment of receipt, R may be used alone, as
above. However, the terminating sign K may be necessary, as in b
below. R may also be followed by \( \overline{V}A \), when, for instance, a receiving
station acknowledges receipt of instructions from the net control
station to close down station. Example:

L A V L B Z W A K
L B V L A R \( \overline{V}A \)

b. B: “More to follow.”—B is used to terminate a transmission when
the transmitting operator wishes to indicate that there is more to
follow.

L A V L B _____ (message) B
When B is used along this way, the receiving operator knows that he must prepare another message form, and the transmitting operator pauses for a second or two to allow the necessary time.

If station LB desires a receipt for the first message before proceeding with the next one, he should send:

\[ \text{LA } V \text{ LB } \ldots \text{ (message) } B \text{ K} \] (more to follow; receipt for this one first)

If he received the message properly, and is ready for the next one, LA should transmit:

\[ \text{LB } V \text{ LA } B \text{ K} \] (message received; go ahead with next one)

c. Suppose that LA has transmitted a message to LB, and during the sending LB’s transmitter breaks down. On next contacting LB, LA might ask:

\[ \text{LB } V \text{ LA } B \text{ TMY} \]

meaning “Did you receive my last message?” to which, if LB had received the message, LB would reply:

\[ \text{LA } V \text{ LB } B \]

d. N: “Not received.”—If in c above, LB had not received the message, LB would reply:

\[ \text{LA } V \text{ LB } N \text{ K} \] (Not received; go ahead)

e. \( \overline{AS} \): “Wait.”—\( \overline{AS} \) is used to mean, “Wait, and stand by for further communication.” Example:

\[ \text{LA } V \text{ LB } \overline{AS} \]

LA may require a few seconds perhaps to locate a fresh message form or possibly to replace a lead in a pencil. LA sends:

\[ \text{LB } V \text{ LA } \overline{AS} \]

LB does not answer but stands by tuned in to LA awaiting further instructions by LA. The procedure sign \( \overline{AS} \) is transmitted once every 30 seconds until LA is ready for LB to transmit. LA then sends:

\[ \text{K} \]

and LB proceeds.

f. \text{TM1}: “Repeat. Question mark.”—To request repetition of doubtful or missed parts of a message, study the examples in paragraph 68.
IMI may be used to request verification of doubtful reception, without necessarily asking for repetition. For example, station LA questions his reception from LB of the word HANSE after LAROW:

**LB V LA LAROW HANSE IMI**

If this is correct, the reply is:

**LA V LB C**

IMI is especially useful as a means of enabling a procedure signal to be read as a question in case the desired question is not listed; IMI is simply placed after the signal whose meaning is to be changed to the interrogative sense. Care must be taken that the signal so constructed will not be interpreted wrongly at the receiving station. Likewise, the procedure signal ZZB may be put in front of another procedure signal to give it a negative meaning. The following examples show some of the possibilities:

"I have been calling you on 2980 kc."—ZCE 2980
"Have you been calling me on 2980 kc.?”—ZCE 2980 IMI
"I have not been calling you on 2980 kc.”—ZZB ZCE 2980
"Make preliminary call-up before transmitting traffic.”—ZCL
"Shall I make preliminary call-up before transmitting traffic?”—ZCL IMI
"Do not make preliminary call-up before transmitting traffic.”—ZZB ZCL

g. **XE**: Separator sign.—Just as punctuation marks are used to set off portions of a sentence for clarity, so the separator sign, XE, may be used to “punctuate” and clarify a transmission. The transmission illustrated in paragraph 42 might better have been:

**LB V LA ZSB4 XE W3 FG AR**

h. List of procedure signs.—Those procedure signs which are introduced in this lesson are tabulated below for convenience in reference and study.

<table>
<thead>
<tr>
<th>Procedure sign:</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS</td>
<td>Wait.</td>
</tr>
<tr>
<td>B</td>
<td>More to follow.</td>
</tr>
<tr>
<td>IMI</td>
<td>Repeat. Question mark.</td>
</tr>
<tr>
<td>N</td>
<td>Not received. Negative. Exempted.</td>
</tr>
<tr>
<td>R</td>
<td>Receipt. Routine.</td>
</tr>
<tr>
<td>S</td>
<td>Signal strength.</td>
</tr>
<tr>
<td>W</td>
<td>Interference.</td>
</tr>
<tr>
<td>XE</td>
<td>Slant (/) or separator.</td>
</tr>
</tbody>
</table>
47. Procedure signals.—The following procedure signals with their meanings should be memorized:

<table>
<thead>
<tr>
<th>Classification</th>
<th>Procedure signal</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>C: Calling; communication.</td>
<td>Z C C</td>
<td>Call me again at —— (on —— kc.).</td>
</tr>
<tr>
<td>F: Frequency; frequency adjustments.</td>
<td>Z F D</td>
<td>Send V's on this frequency (or —— kc.).</td>
</tr>
<tr>
<td>Z F M</td>
<td>How does my frequency check?</td>
<td></td>
</tr>
<tr>
<td>Z F N</td>
<td>Your frequency is correct.</td>
<td></td>
</tr>
<tr>
<td>Z F O</td>
<td>Your frequency is too high (or is —— kc. too high).</td>
<td></td>
</tr>
<tr>
<td>Z F P</td>
<td>Your frequency is too low (or is —— kc. too low).</td>
<td></td>
</tr>
<tr>
<td>O: Operating</td>
<td>Z O A</td>
<td>Send at speed of —— words per minute.</td>
</tr>
<tr>
<td>Z S B</td>
<td>I can receive ——. Readability ——.</td>
<td></td>
</tr>
<tr>
<td>S: Signals; readability</td>
<td>Z S F</td>
<td>What is my signal strength?</td>
</tr>
<tr>
<td>Z S G</td>
<td>What is my readability?</td>
<td></td>
</tr>
</tbody>
</table>

48. Questions for self-review.—a. A received signal is quite loud. However, on account of the presence of temporary unavoidable disturbances near the radio station, intelligent copy is impossible unless the transmitting operator sends plain language once slowly and code twice. What is the correct readability signal to describe these conditions?

b. What is the proper readability report to designate that the received signal, although discernible, is not good enough to permit copying plain language even if each group is sent twice?

c. In adjusting your transmitter for optimum output, which would you request of the receiving operator, ZSG or ZSF? Why?

d. In the ordinary exchange of traffic, which is of the most importance, readability or signal strength? Why?

e. How would you inform another station that its frequency is ten kilocycles too low?

f. Name the five items required to be entered in every station log.

g. Criticize the following transmissions:

1. Z C C N I N E A
2. Z C C 900 AM
3. Z C C 1200 P
4. L A V L B V V A

49. Operation exercise.—a. First exercise.—Directions to the student: The net consists of three stations, LA, LB, and LC. The net call sign is ABC. Execute the following communications.
(1) Station LA will ask the other stations of the net (collectively) for a report on the signal strength and readability of station LA.

(2) Stations LB and LC will answer in proper turn. LB will inform LC that his signals are moderately strong but that his readability is poor. LC will inform LA that his signals are moderately weak but perfectly readable.

(3) LB will request a report on his frequency by LA.

(4) LA will inform LB that his frequency in ten kilocycles too low.

(5) LB will simulate adjustment of transmitter to correct the frequency and ask LA to check the frequency again.

(6) LA will inform LB that his frequency is now correct, readability good.

(7) LA will direct LC to send a series of V's.

(8) LC will comply.

(9) LA will inform LC that his frequency is five kilocycles too high.

(10) LC will simulate transmitter adjustment and request frequency check from LA.

(11) LA will inform LC that his frequency is now correct, readability excellent.

(12) LC will inform LA that he has two messages for LA.

(13) LA will request LC to repeat his last transmission.

(14) LC will comply.

(15) LA will direct LC to send the messages.

(16) LC will ask LA if he (LC) should send at a speed of ten words per minute.

(17) LA will tell LC: "Yes."

(18) LA will ask LB is he is in radio communication with FG.

(19) LB will tell LA to wait.

(20) LB will call FG. (No reply from FG.)

(21) LB will call FG again. (No reply from FG.)

(22) LB will inform LA that LB is not in radio communication with FG.

(23) Using the net call-up LA will direct LB and LC to call LA again at 8:30 P.M. on 3900 kilocycles.

(24) LB and LC will acknowledge LA's order.

b. Subsequent exercises.—The instructor will check the logs at this point. After the instructor has done so, the operator originally at station LA will take over station LB, the operator at station LB proceeding to LC and the one at LC going to LA. With this new arrangement of operators, repeat the communications listed in a(1) through (24) above.
50. **Organization of tactical radio nets.**—Field radio stations are grouped into separate nets of a few stations each. All operations normally are confined to communications within the individual nets. For purposes of administration, one station, generally the one which is located at the highest headquarters, is appointed net control station (NCS) with authority to direct the net in the control of radio communication. All other stations of the net are referred to as secondary stations. A scheme of tactical radio nets showing net control stations and the normal traffic channels is shown in figure 12. The two stations with the same call sign, LA, are two distinct stations located at the same headquarters. One operates in the net SX on the frequency...
assigned to the net SX, and the other operates in the net VW on that net's frequency. The two stations are far enough apart, both in frequency separation and in physical distance, so as not to interfere with each other; and yet they are located close enough together to be cooperative in that each can serve as a relay station for internet traffic.

51. Establishing a net.—a. UN, LA, DM, and VK are stations in net SX (figure 12). The net is about to go into operation in a tactical situation. The operators are informed of their call signs and their frequency and of the time when complete communication within the net is expected. They know that UN is to be the NCS. This information, together with other pertinent instructions, appears in signal operation instructions issued to the units concerned.

b. LA, on completing the installation of his station, listens on the assigned net frequency. Hearing nothing, LA calls:

\[ \text{SX V LA ZGQ AR} \]

LA repeats the call-up once shortly afterward, and again at intervals as prescribed in paragraph 29c:

\[ \text{SX V LA ZGQ AR} \]
\[ \text{SX SX SX V LA LA LA ZGQ AR} \]

At this point UN has just completed his installation, and, listening on the assigned net frequency, hears LA's call-up. UN answers:

\[ \text{LA V UN ZSB4 ZGQ U AR} \]

U means "I am the NCS." And the complete transmission implies "Give me a readability report." LA answers:

\[ \text{UN V LA ZSB5 AR} \]

During the above intercommunication DM, completing his installation and listening on the assigned net frequency, overhears UN and LA working together. He waits for them to complete their transmissions and then calls:

\[ \text{UN V DM ZSB4 ZGQ AR} \]

UN replies, presuming DM's frequency to be too high:

\[ \text{DM V UN ZFO AR} \]

DM makes the necessary adjustments and transmits:

\[ \text{UN V DM ZFM AR} \]

UN replies:

\[ \text{DM V UN ZFN ZSB4 ZWG LA U K} \]