

THE GENERAL BOARD

United States Forces, European Theater

REPORT

ON

STUDY OF FIELD ARTILLERY COMMUNICATIONS

MISSION: Prepare Report and make Recommendations on Communication Equipment and Techniques Employed by the Field Artillery in the European Theater of Operations.

The General Board was established by General Orders 128, Headquarters European Theater of Operations, US Army, dated 17 June 1945 as amended by General Orders 182, dated 7 August 1945 and General Orders 312 dated 20 November 1945, Headquarters United States Forces, European Theater, to prepare a factual analysis of the strategy, tactics, and administration employed by the United States forces in the European Theater.

File 311/1

Study Number 63

Property of
Office of the Chief
Military History
General Reference Branch

TABLE OF CONTENTS

SUBJECT	PAGE
Chapter 1: General.....	1
Section 1 - Introduction.....	1
Section 2 - World War II and Communication Means.....	1
Chapter 2: Wire Communications.....	2
Section 1 - General.....	2
Section 2 - Types of Wire.....	4
Section 3 - Field Telephones.....	9
Section 4 - Switchboards.....	11
Section 5 - Wire-Laying and Wire-Recovery Equipment.....	14
Section 6 - Teletype and Telegraphy.....	18
Section 7 - Communication Within the Firing Battery Position..	19
Chapter 3: Radio Communication.....	19
Section 1 - General.....	19
Section 2 - Frequency-Modulated Equipment.....	22
Section 3 - Amplitude-Modulated Equipment.....	26
Section 4 - Radio Procedure.....	29
Allocation of Frequencies.....	30
Supply of Radio Equipment.....	31
Chapter 4: Visual and Sound Communication.....	35
Section 1 - Visual Communication.....	35
Section 2 - Sound Communication.....	35
Chapter 5: Codes and Ciphers.....	36
Section 1 - Signal Security.....	36
Section 2 - Codes.....	37
Section 3 - Ciphers.....	40
Chapter 6: Conclusions and Recommendations.....	41
Section 1 - Conclusions.....	41
Section 2 - Recommendations.....	44
Bibliography.....	49

THE GENERAL BOARD
UNITED STATES FORCES, EUROPEAN THEATER
APO 408

STUDY OF FIELD ARTILLERY COMMUNICATION

Prepared by:

Brig Gen J. D. Balmer - - - - - Chief, Artillery Section
Col I. J. Compton - - - - - Executive, Artillery Section
Lt Col H. L. Sanders - - - - - Artillery Section

Principal Consultants:

Brig Gen E. T. Williams, 012818, Artillery Officer, Third US Army.
Brig Gen J. E. Slack, 012271, Artillery Officer, XX Corps.
Col J. P. Winn, 019491, formerly Executive Officer, XIX Corps
Artillery.
Col E. T. Owen, 015488, formerly Executive Officer, 26th Infantry
Division Artillery.
Col H. H. Critz, 019786, formerly Executive Officer, 1st Infantry
Division Artillery.
Col J. R. Wheaton, 016458, Commanding Officer, 17th Field Artil-
lery Group.
Lt Col U. P. Williams, 019391, formerly Commanding Officer, 81st
Field Artillery Battalion.
Lt Col J. W. Brownlow, 021111, formerly Commanding Officer, 242d
Field Artillery Battalion.
Lt Col J. S. Billups, 021932, Commanding Officer, 77th Field
Artillery Battalion.
Lt Col J. R. Mc Lean, 023140, formerly Commanding Officer, Arm-
ored Field Artillery Battalion.
Lt Col L. W. Cather, 018510, formerly Executive Officer, 402d
Field Artillery Group.
Major R. W. Allen, 021810, formerly Commanding Officer 997th
Field Artillery Battalion.

THE GENERAL BOARD
UNITED STATES FORCES, EUROPEAN THEATER
APO 408

A STUDY OF FIELD ARTILLERY COMMUNICATIONS

CHAPTER 1

GENERAL

SECTION 1

INTRODUCTION

1. Purpose of the Study. The purpose of this study is to investigate the major items of communication equipment and the techniques employed by field artillery units in the European Theater of Operations.

2. Scope. In investigating the matter of communication equipment and techniques, comments have been obtained from officers and enlisted men who were responsible for the installation and operation of the systems. Some of the information was obtained from pertinent reports by Field Artillery and Army Ground Force boards or individual officers who investigated particular problems. Primarily, however, this report is a report of the combat soldier's feelings concerning the equipment he used and the problems he faced.

3. Method of Presentation. In presenting the study of equipment no attempt will be made to enter into the technical aspects of communication equipment. This report will confine itself to a discussion of the difficulties encountered and to non-technical recommendations for their solution. The problems of each type of equipment will be presented as they apply to that particular item and the recommendations for correction of the difficulties will be pointed to individual problems.

4. Quality of Communications in World War II. Artillery support for other arms is dependent upon adequate communications, and since it is recognized that the field artillery did support successfully the infantry, cavalry, and armored units, we may conclude, in general, that the communications systems used were adequate. However, on many occasions, it was only with the greatest of difficulty and through the superb heroism and devotion to duty of the artillery communication specialists that the system functioned properly. The margin between communication difficulty and communication failure is very small. This study, therefore, will emphasize those things which increased the communication problem.

SECTION 2

WORLD WAR II AND COMMUNICATION MEANS

5. Means of Communication. One chapter of this study is devoted to each of the two major means of communication, radio and wire, and one chapter to the other means, visual and sound. World War II, as fought in the European Theater of Operations, focused the attention of artillerymen upon the two major means of communication almost to the exclusion of others, namely, wire and radio. Messengers as a means of communication were used to a great extent but seldom for more than regular message center delivery service or the delivery of fire plans and orders. Semaphore flags and signal lamps were used so seldom that

they practically disappeared.

6. Relation of Wire and Radio. A change came about in the relationship of wire and radio as means of communication. Prior to World War II an often heard statement was to the effect that wire was the primary means of communication for field artillery. That statement is still heard, but today the statement that wire and radio are the primary means is heard more frequently. An example of the partnership of wire and radio in the communication picture is found in the radio link (used between higher headquarters) where both radio and wire communication are used simultaneously. The theory that radio stations would close down when wire circuits were completed was not followed in all cases. In many instances, even though the traffic was being carried by the wire system, radio nets remained in operation in order that there might be immediate communication if wire went out. Many units maintained the radio net as a listening net and during a short period each day closed out the wire system making the radio net carry all traffic. Thus, both means of communication were in use, or ready for use, all the time. Wire and radio became a closely knit team.

CHAPTER 2

WIRE COMMUNICATION

SECTION 1

GENERAL

7. The Importance of Wire Communication. In a summary of operations of XIII Corps Artillery¹ the following statement is found:

"Effective fire direction control under any and all conditions was absolutely dependent upon reliable wire communication."

Colonel J. P. Winn, Executive Officer, XIX Corps Artillery, stated:

"I believe very definitely that wire communication is essential to the prompt and efficient handling of artillery fires. Our wire communication was, in general, very good. I can recall only a very few times when wire communication was out of order. However, this was achieved by laying double lines over separate routes to all units. Frequently from two to three hundred miles of wire was installed and maintained by Corps Artillery units."

Both comments indicate that efficient control of artillery depends upon wire. Both units went to considerable effort to establish and maintain wire communication.

8. The Success of Wire Communication. Wire communication was successful in this theater. Practically all Field Artillery officers agree that, with few exceptions, wire communication was dependable and suitable. There were cases where wire as a means of communication failed, instances where wire lines were broken by armored or wheeled vehicles, instances where wire lines were late in being established. However, for every case of failure, there are many instances of prompt, reliable service. The support which the field artillery rendered the other arms is the greatest testimony to the success of wire communication.

9. Major Cause of Communication Troubles. One of the major causes of communication troubles was the problem of personnel.

a. Wire Crews.

Colonel B. Conn Anderson, War Department Observer, in Army Ground Force Report Number 283, stated that from his personal observation of the duties being performed in combat by enlisted personnel of field artillery, he was convinced that the wire crews were having the hardest and most difficult work to do.

Brigadier General H. C. Vandevor, Artillery Officer, 5th Infantry Division:

"Wire section not big enough. We are 32 men over-strength in our Headquarters and Headquarters Battery. I took these additional men from the firing batteries. I could do it in view of the small amount of ammunition we have available to shoot."

The chart below is a comparison of the wire section of Corps Artillery Headquarters Battery, T/O & E 6-50-1, and the construction platoon of Division Signal Company, T/O & E 11-7.

	Hq Btry, Corps Arty	Const. Plat., Div. Sig. Co.
Mission: to install and maintain wire communication with:	at least 3 FA Gps, at least 2 Div Arty Hq, and general support Bns not in groups.	3 Inf Regts, Div Arty Hq, Separate Bns of Div.
Types of wire system installed	Field wire Open wire rehabilitation Spiral-4 cable occasionally	Field wire Open wire rehabilitation Spiral-4 cable
Comparison of normal distances	Usually longer	
Personnel	22, including 3 drivers and 2 switchboard operators	55, including 2 drivers but no switchboard operators
Wire Teams	3, consisting of 2½ ton truck Wire Corporal, 3 Wiremen 2, consisting of ¾ ton WC Wire Corporal 2 Wiremen	6, consisting of 2½ ton truck ¾ ton WC Wire Sergeant 7 Wiremen

The comparison indicates that, for comparable missions, the Field Artillery is authorized considerable fewer men.

b. Switchboard Operators. Another place where the personnel shortage created difficulty was in switchboard operation. In all units, under the T/O in effect during combat, two switchboard operators were authorized. Apparently no provision was made for the operation of forward switching centrals which were used in many cases. It is inefficient and not practicable for two enlisted men to operate one switchboard 24 hours per day. In order to keep switchboard operation at peak efficiency, where it must be if the artillery is going to take proper advantage of its ability to mass fires along the front, three men are needed for each switchboard in operation.

Col F. M. Day, Assistant Artillery Officer, XII Corps:

"We had to have four switchboard operators and at that they were working 12 hours per day."

Brigadier General R. M. Montague, 83d Infantry Division
Artillery:

"Additional desirable enlisted personnel. Wire section - 1 switchboard operator (those now provided are adequate for one switchboard, but are not sufficient when additional forward switching central is employed, which is about 50% of the time)."

Many units solved this problem by making wiremen perform the duties of switchboard operators. This solved the switchboard problem but aggravated the wire crew difficulties.

SECTION 2

TYPES OF WIRE

10. Types Authorized.

a. Number of Types. Two types of wire were authorized for general use by field artillery units in the European Theater of Operations; general purpose field wire, W-110-B, and light field wire, W-130-A. An additional type of wire was used to a much lesser degree: field wire, W-143, which was issued as a substitute for W-110-B although it was not in widespread use.

b. Characteristics.

- (1) Wire, W-110-B, a field wire consisting of two twisted conductors, each with four steel strands and three copper strands, rubber and braid covered. It has a tensile strength of 300 pounds and weighs approximately 130 pounds per mile.
- (2) Wire, W-130-A, a field wire consisting of two twisted conductors, each of six steel and one copper strands with synthetic thermo-plastic insulation. It has a tensile strength of 110 pounds and weighs approximately 34 pounds per mile.
- (3) Wire, W-143, a field wire consisting of two parallel-lay conductors, each of seven soft copper strands. The wire is shielded with rubber insulation over each conductor and overall braid covering. It has a tensile strength of 270 pounds and weighs approximately 300 pounds per mile.

c. Quantities Authorized. The bulk of the wire communication load was to be carried by W-110-B while W-130-A was to be used by forward observers and liaison sections for communication in forward areas. A small amount of W-130-A, approximately two or three miles, was authorized for use in local installations. Units which were expected to maintain liaison officers with the infantry were allowed up to fifteen miles. W-110-B wire was authorized for headquarters batteries in amounts varying from twelve miles for a battalion unit to thirty miles for a corps artillery unit. Approximately twelve miles of W-143 or W-110-B, as desired, was authorized for issue to the batteries of field artillery observation battalions. In some areas, however, a temporary supply emergency caused substitution of this wire for W-110-B and therefore comments on this wire are included.

11. Wire, W-110-B.

a. Comments by Troops.

Captain L. V. Hancock, Communication Officer, XX Corps Artillery:

"W-110-B was satisfactory, except that a greater range would be desired."

Col F. H. Boucher, War Department Observer, stated in Army Ground Force Report Number 978:

"W-110-B. This is satisfactory when new and in good condition."

Col E. T. Owen, Executive Officer, 26th Infantry Division Artillery:

"W-110-B wire was definitely the best we had."

It Col U. P. Williams, Commanding Officer, 81st Field Artillery Battalion:

"W-110-B wire was very satisfactory. We had no trouble with it."

Ten battery and three battalion commanders assembled by a group commander for discussion of communications agreed unanimously that W-110-B wire had been satisfactory in all respects.

Communication non-commissioned officers, 241st Field Artillery Battalion:

"W-110-B was good wire. We'd like a little tougher insulation on it though."

b. Comments by Boards in United States. During the fall of 1944 a board of officers was convened at the Field Artillery School for the purpose of studying current and post-war developments. The comments of this board are interesting because, although convened in the United States, the board had available to it the experience of officers and men in many theaters. The board says of wire:²

"Standard all purpose wire currently in use, W-110-B, is satisfactory for electrical characteristics, tensile strength and insulation. Developments should be continued to provide for twisting wire strands together, reduction of weight, and obtaining additional tensile strength."

The Army Ground Force Equipment Review Board³ which later studied the artillery board report concurred in the statement by the artillerymen with regards to wire W-110-B.

c. Discussion. Comments in sub-paragraph "a" are typical of the reaction of using troops to W-110-B wire. These units, such as corps artillery headquarters, said that it was good but it needed more range. Personnel of the observation battalions said that it was good when new; they desired better insulation and conductivity. However, all persons concerned with wire communication felt that W-110-B wire was generally satisfactory. The reports from the United States indicate that the weight is unsatisfactory. That is true, efforts must continually be directed toward reducing the weight of telephone wire.

12. Wire. W-130-A.

a. Comments by Troops.

Ten battery and three battalion commanders at a group conference agreed that wire, W-130-A, was satisfactory except for the insulation, that it could only be used once, and that it was practical for forward observers and OP's only.

Lt Col U. P. Williams, Commanding Officer, 81st Field Artillery Battalion (155mm How)

"W-130-A wire was satisfactory when used for OP lines only, and then only with careful handling. Its insulation was insufficient and it could not be recovered."

Lt Col J. W. Brownlow, Commanding Officer, 242d Field Artillery Battalion (105mm How)

"Wire, W-130-A, was satisfactory if properly laid and used. The big difficulty was that it had to be handled so carefully."

Captain L. V. Hancock, Communication Officer, XX Corps Artillery Headquarters:

"W-130-A was not satisfactory except for local installations, radio lines, etc."

Commanding Officer, 284th Field Artillery Battalion (105mm How)

"We used W-130-A for forward observer lines and locals. In the case of the observer lines we replaced them with W-110-B whenever possible. We never did have any confidence in W-130-A, the insulation was too poor."

Lt Col J. S. Billups, Commanding Officer, 77th Field Artillery Battalion (155mm How)

"W-130-A was not satisfactory. The insulation was not strong enough. We could not depend on it at all. It is not even worth including in the T/E for locals around the comm post."

Communication non-commissioned officers, 241st Field Artillery Battalion (105mm How)

"W-130-A was not reliable; you had too much trouble

with the insulation."

b. Comments by Boards in United States. The special board of officers convened at the Field Artillery School stated:²

"Light wire.--W-130-A is satisfactory for use in local installations and outpost circuits except for a tendency to kink and for lack of ruggedness of insulation."

The Army Ground Force Equipment Review Board³ concurred in the statement by the Field Artillery Board.

c. Discussion. The issue of W-130-A light field wire brought an immediate and positive reaction from the using troops. It was not well received. The principal objections were with regard to the insulation and the tensile strength. It is quite probable that the troops, hoping for a light wire suitable for forward observer use which would stand up as well as W-110-B wire, expected too much. W-130-A wire would definitely not meet these conditions. It is evident that the using troops considered W-130-A wire satisfactory only when they could take special precautions for its protection. Many unit commanders stated that they found it useful for locals at the command post and favored its retention in the T/E for that reason. Opinion varied as to its value beyond that point, however.

13. Wire. W-143.

a. Comments by Troops.

Army Ground Force Report Number 978:

"W-143. This is of stranded copper, with good conductivity. It is difficult to lay, because of kinks and loops in the wire caused by stiffness. The straightening of wire during laying causes delay, and when kinked by pulling a loop without straightening, the wire is subject to shorts in the kinks."

Extract, Letter, Headquarters 10th Field Artillery Battalion, APO 3, dated 2 January 45, sub: "Lessons Learned in Combat for the month of December."

"The new W-143 telephone wire has proved to be very good for long lines in that a clear, readable conversation is possible without resorting to the use of a booster."

Extract from Army Ground Force Report Number 800 - Communications:

"3. Use of 143 Wire.

a. Found 143 wire more difficult to handle, strong, difficult to splice, a good conductor, difficult to use test clips on. (Comdg. O, 1st Bn, 71st Infantry, 15 February 1945)

b. Our regimental wire section has used very little of the 143 wire. It has been found that the 143 will withstand the elements longer than either 110 or 130 wire. However, it takes more time to install the wire 143 and maintenance is made more difficult by the compactness of both strands enclosed in one insulation. (Comdg. O, Hq Co, 71st Infantry, 15 February 1945)"

It Col J. C. Harding, Commanding Officer, 17th Field

Artillery Observation Battalion, stated:

"We used a considerable quantity of W-143 and did not like it. It was hard to handle and kinked very easily. We had to be particularly careful in wet weather because, if the wire became imbedded in ice, the insulation would be stripped off when the wire was picked up."

b. Discussion. Wire, W-143, was intended only to be a stop-gap as far as field artillery wire was concerned. It was not considered satisfactory for field artillery uses. Although it had excellent conductivity and practically solved the problem of communication over long lines, the disadvantages outweighed the advantages. Poor insulation and the tendency to kink, with resulting short circuits, made it an unsatisfactory type of wire.

14. Spiral-4 Cable. The use of Spiral-4 cable by field artillery units, except for observation battalions, was a rare occurrence. On several occasions, for specific operations, authorization for cable was obtained. Spiral-4 cable has the advantage of excellent conductivity and insulation but has the serious disadvantage of considerable bulk and weight. Even in the observation battalions, where conductivity is so important in the wire to the microphones of the sound base, the problem of bulk and weight was one which was difficult to solve. Other disadvantages include the increased time of installation, difficulty of locating faults in the cable, and difficulty of splicing once the fault has been found.

15. Wire Authorization and Supply. Combat in the European Theater of Operations brought out a new concept of the size of unit wire systems. By the time operations were concluded, communication officers had become accustomed to installing and maintaining extensive wire nets.

Extracts from a report by XII Corps Artillery Headquarters: 4

"This Corps has operated with fronts of 11 to 25 miles. The wire circuits have averaged nine miles in length, and the installation of single wire circuits have frequently required 14 miles of wire. Wire circuits as long as 28 miles have been established. At one time, the Corps Artillery Fire Direction Center installed and maintained a 265-mile wire system.

"The Field Artillery Groups have averaged three to four battalions attached and have at times reinforced two division artilleries. The lines have averaged eight miles in length and are frequently as long as 14 miles. The longest line to date was 28 miles in length. At one time, the average of five Field Artillery Groups was 107 miles of field wire to install and maintain.

"The Infantry Division Artillery has four assigned Field Artillery Battalions and has substantially the same wire problems as the Field Artillery Group. The lines average seven to eight miles in length. The Division Artilleries have averaged as much as 110 miles in one installation."

Extract, Army Ground Force Report Number 230. Captain Charles E. Burlison, Communication Officer, 83d Division Artillery, stated:

"During one operation we were maintaining some 135 miles

of wire."

Extract, Army Ground Force Report Number 957 (202d Field Artillery Group (XIII Corps Artillery)):

"For more than a month it maintained as much as 168 miles of wire."

The foregoing comments illustrate the size of the wire nets in actual operation. Although these statements were made with reference to wire nets at corps artillery and division artillery level, the same condition existed in practically all units in that the nets were much larger than had been contemplated. The result was that all units were forced to carry a much greater load of wire than had been planned for.

Extract from Army Ground Force Report Number 230:

"Our normal load of wire is 60 miles, wire dumps being formed where practicable." (Capt Charles E. Burleson, Communication Officer, 83d Infantry Division Artillery)

Extract from Army Ground Force Report Number 1073, Col F. H. Boucher, War Department Observer:

"In nearly all cases, lines had to be laid and maintained to four group headquarters, the observation battalion, and to three division artillery headquarters, over a wide corps front. This generally meant that from 80 to 100 miles of wire was in use. The T/O and E authorizes only 30."

Brigadier General Julius Slack, Artillery Officer, XX Corps, states:

"The allowance of wire for Corps Artillery is 40 miles. This allowance should be 100 miles."

Commanding Officer, 284th Field Artillery Battalion (105mm How), stated:

"We always carried from two to three times our allowance in wire. We had to do it in order to be able to displace and operate in a new location promptly."

Thus it is evident, that because of the size of the wire nets, units carried much wire in excess of T/E allowance. Fortunately, the wire supply situation was generally good; there were times when it was precarious but not to the extent of endangering the success of operations. Had the wire supply picture become bad, it is quite possible that the artillery might have suffered from lack of wire. If the initial allowances and basic loads of wire had been greater, a better cushion for absorbing supply shocks would have been available.

SECTION 3

FIELD TELEPHONES

16. Telephone. EE-8, EE-8-A, EE-8-B. The field telephones used by the field artillery in the European Theater of Operations were the EE-8, EE-8-A, or EE-8-B. The latter two models have only slight changes from the EE-8 and for purposes of brevity in this discussion all three will be considered when the term EE-8(*) is used. Technical Manual TM 11-333 describes this instrument as follows:

"CHARACTERISTICS. Telephone EE-8(*) is a portable telephone designed for use on either local or common battery telephone systems. It is compact, rugged, and portable, and in performance equals the best present day commercial telephones. The talking and signaling range of the telephone varies with the type of wire used, the condition of the wire, whether the wire is dry or wet, and whether the wire is on the ground or in the air. The telephone will operate satisfactorily over the distances usually found in corps and subordinate wire systems, provided the lines are well constructed.

a. Comment by Troops.

Captain L. V. Hancock, Communication Officer XV Corps Artillery Headquarters:

"The EE-8 telephone was very satisfactory. The leather case is much better than the fiber case."

Ten battery and three battalion commanders in a group conference on communication equipment agreed:

"EE-8 telephone generally satisfactory as to reliability, lacking in signal strength, and satisfactory as to ruggedness except that it should be waterproofed. A cutout ringer device should be provided for forward observer telephones."

Commanding Officer, 241st Field Artillery Battalion
(105mm How):

"The EE-8 telephone was a good telephone. It was rugged, reliable, and if used within the recommended limits, gave good signal strength."

It Col J. . Brownlow, Commanding Officer, 242d Field Artillery Battalion (105mm How):

"The EE-8 was a good telephone and we had very little maintenance trouble with it."

Commanding Officer, 284th Field Artillery Battalion
(105mm How):

"Our telephone equipment was excellent. The EE-8 is a very good telephone and gives good service if you use it as recommended."

b. Comments by Boards in United States. The board convened at the Field Artillery School² had this to say concerning telephones:

"Telephones. - Telephones will continue to be the most satisfactory instrument electrically. However, it was heavy, bulky, and is not weatherproof. Continued development to reduce the size, weight, increase the efficiency, provide for weatherproofing, and a provision for silencing the ringer is indicated."

The Army Ground Force Equipment Review Board³ concurred in the above statement.

c. Discussion. The general opinion of troops using the EE-8(*) telephone was that it was a good instrument. It stood up well in the field and presented little difficulty from a maintenance

point of view. The fact that corps frontages were much greater than was expected did lead to some difficulty with telephone equipment. The technical manual gives eleven miles as the maximum length of non-loaded EL-110-B wire over which two EE-8(*) telephones will give good service. Frequently it was necessary to use this telephone on lines as much as two or three times the recommended length. Various solutions were attempted. The use of loading coils helped but did not solve the problem completely. In many headquarters the solution was found in the use of the telephone repeater EE-89-A. This repeater was originally intended to be placed at the middle of a long line to amplify the signal, however, a modification was made by Signal Corps personnel which permitted its use at the end of a local line within the command post. With this modification the EE-89-A repeater was used with success at corps artillery and division artillery headquarters. This solved the problem at higher headquarters but not at the battalion level. The development and issue of a new instrument to make conversation possible over long lines is indicated. Such an instrument will not replace the EE-8(*) telephones but rather supplement them with only two or three being required at each headquarters, from battalion level upwards, for use on special lines.

17. Telephone Authorization and Supply.

a. Authorization. The most frequent comment on the telephone situation was with regard to quantity rather than quality. Many units used a considerable number of telephones in excess of table of equipment allowance. Some of these instruments were captured German equipment and some were EE-8(*) telephones which had been specially authorized. Most communication officers stated that they were able to "get along" with authorized allowances but that operations were vastly improved with the added telephones. An interesting coincidence of the comments is that practically all headquarters considered that an increase of from five to ten telephones would solve the problem. This increase has been included in the report by the section of the Theater General Board studying T/O's and T/E's.

b. Supply. The supply of telephones in this theater was generally good. Few complaints were heard. Exchange of damaged telephones was prompt and repair was good. Communication officers and supply officers expressed satisfaction with the manner in which this was handled.

18. Sound-Power Telephone Equipment. Numerous battalion commanders were questioned concerning their reaction to sound-power telephone equipment for field artillery use. They were unanimous in the opinion that there was not sufficient value to be derived from the use of this equipment to warrant adding another item to the already long list of signal equipment. Several battalion commanders stated that their forward observers were not in favor of adding this item for field artillery use. The observers had stated that the EE-8 telephone was not too inconvenient to carry and that they favored its continued use.

SECTION 4

SWITCHBOARDS

19. Types of Switchboards. Three types of switchboards were used by field artillery units in the European Theater of Operations. The switchboards BD-71 and BD-72 are identical except for the number of drops, the BD-71 having six and the BD-72 having 12. The third type is the telephone central office set, TC-4, which was issued to higher headquarters.

20. Switchboards, BD-71 and BD-72.

a. Comments by Using Troops.

Ten battery and three battalion commanders at a group conference on communication equipment gave as their consensus:

"BD-71 and 72 were not satisfactory."

Communication non-commissioned officers, 241st Field Artillery Battalion (105mm How):

"The BD-71 and BD-72 switchboards were not satisfactory. They were too bulky and heavy for the good we got out of them. The contacts at the ring-talk key were too weak. We had trouble getting spare units. Both boards are too small; the BD-72 should have about eighteen drops."

Lt Col J. W. Brownlow, Commanding Officer, 242d Field Artillery Battalion (105mm How):

"The BD-71 and BD-72 switchboards were all right. I think the BD-72 should have eighteen drops and six repeating coils."

Lt Col J. S. Billups, Commanding Officer, 77th Field Artillery Battalion (155mm How):

"The switchboards we had were good, sturdy boards and stood up well in combat."

Commanding Officer, 284th Field Artillery Battalion (105mm How):

"The BD-71 and 72 switchboards were not satisfactory. They were entirely too big for the amount of service we obtained; we need a much smaller board. I would like to have a cordless board and one that is much lighter."

Col E. T. Owen, Executive, 26th Infantry Division Artillery:

"The BD-71 and BD-72 boards were too big. We should have a smaller switchboard with a greater number of drops. We should also have some kind of a board like the Germans had, -a board which does not use cords."

b. Comments by Boards in United States.

The Field Artillery School board² on equipment stated:

"Switchboards from 8 drops in the firing battery to 50 or more drops in the corps and division artillery will continue to be necessary for switching centrals. Switchboards now in use are satisfactory except for size, weight and weatherproofing. Further development should include great reduction in size and weight, should provide units in appropriate size from 8 drops to 50 or more for the highest echelons."

The Army Ground Force Equipment Review Board³ concurred in the above statement.

c. Discussion.

- (1) Size and Weight. The Bd-71 and Bd-72 switchboards had a varying reception by the using troops. The general opinion was that they were good sturdy boards which would take a considerable amount of rough treatment but that they were too large. In order to give switching service to six circuits, it was necessary to handle a 60 pound instrument with dimensions of 18-1/2 x 10-1/4 x 15 inches. In order to handle twelve circuits, the instrument weighed approximately 85 pounds and had the dimensions 27 x 10-1/4 x 15 inches. When it was necessary to provide switching service for more circuits than either board provided, two or more boards were placed in position for parallel operation. This was an unsatisfactory arrangement because the operator had difficulty in handling the two boards. That situation gave rise to the almost unanimous comment that the switchboards should have more drops--at least eight on the small board and eighteen on the larger board.

- (2) The Cordless Switchboard. Another comment which was heard with great frequency concerned the development of a switchboard which did not employ cords. All of our switchboards are built upon the principle that an operator connects one circuit to another by using a cord to make the complete wire circuit. This requires that the board be set up in such a manner that the cords hang from the front of the board without touching the ground, thereby requiring that it be approximately 24 inches above the floor or ground. The question has been asked as to why a board cannot be developed which will utilize a system of dials or bus-bars to make connections within the board and thereby obviate the need for cords. The German army had such a switchboard and in one case where one was captured and used by an American artillery unit, it proved to be very popular with American personnel.

21. Telephone Central Office Set, TC-4. This item of equipment consists of a switchboard BD-96, a 40 drop instrument, and certain accessories; in the comments which appear below, reference is made to BD-96 instead of TC-4.

a. Comments by Using Troops.

Ten battery and three battalion commanders in a group conference on communication agreed:

"Three BD-72's should be issued per unit. A BD-96, or larger, is needed for higher echelons."

Captain L. V. Hancock, Communication Officer, XX Corps
Artillery:

"Corps Artillery requires a BD-96 and three BD-72's."

Army Ground Force Report Number 1077, Col F. H. Boucher,
Air Department Observer:

"The 40 drop switchboard usually provides sufficient drops, but on moves all communications must be interrupted when moving the switchboard. Three 20 drop switchboards would facilitate continuous communication."

Captain Charles E. Burlison, Communication Officer 83d Division Artillery:

"The greatest need is a larger switchboard than the BD-72. In every setup we have at least 24 drops filled and at one time were using three BD-72's completely filled. To do this the boards have to be connected in parallel, one board placed on top of another, then one at right angles to those two. This reduces the operating efficiency of the switchboard operator and delays the servicing of calls. We strive to maintain continuous communications from one position to another and that requires the use of all switchboards, which sometimes proves to be not enough. The issue of a 40 drop BD-96 to a Division Artillery Headquarters Battery would do much to solve this problem."

Col F. K. Day, Assistant Artillery Officer, VII Corps:

"We got an extra BD-72 switchboard, and we had to have it. We need a 40 drop switchboard and two BD-72's."

b. Discussion. In those headquarters where the normal number of telephone circuits exceeded 24 it was necessary that a bigger switchboard be used because it is impractical to operate more than two BD-72 boards in parallel. The TC-4 equipment practically solved the problem of switchboard facilities at higher artillery headquarters. General satisfaction with this equipment was indicated.

22. Switchboard Authorization. The table of equipment authorizations of switchboards was generally considered to be insufficient. In practically all recommended changes to T/O & T/E, an increase in the number of switchboards was requested. A resume of T/E allowances and the consensus of requests is shown below.

	T/O & T/E			Recommended		
	BD-71	BD-72	TC-4	BD-71	BD-72	TC-4
Firing Battery	2			2		
Hq Btry, FA Bn	1	2		1	3	
Hq Btry, FA Gp	1	2		1	3	
Hq Btry, Div Arty	1	2	1	1	3	1
Hq Btry, Corps Arty	1	2	1		3	1

These requests were based upon experience in combat and were an attempt to secure sufficient flexibility to maintain maximum efficiency.

SECTION 5

WIRE-LAYING AND WIRE-RECOVERY EQUIPMENT

23. Types of Reels. Several types of reels were used by artillery units in the European Theater of Operations. Each had its specific place in the establishment of wire communication.

a. RL-39. This was the smallest reel used. It was an axle and handle arrangement for unreeling wire, W-130-A, from the drum, DR-8. This reel was used principally by forward observers and liaison personnel in laying wire in forward areas where the personnel moved on

foot.

b. RL-27. This was the simplest of all reels, consisting merely of an axle which projected on each side of a drum, DR-4. The actual axle portion was mounted in bearings within the projections so that two men could carry the reel between them paying out wire on the ground as they walked.

c. RL-31. The reel, RL-31, was intended for either vehicular or ground use. It consisted of an axle supported by a pair of hinged A-frames with a crank handle on the axle for picking up wire. A variety of positions of the A-frame permitted several different uses of the reel. With the frame in the 'A' position it could either be mounted in a vehicle for wire laying and recovery or it could be placed on the ground and the wire pulled from it. With the frame opened so that the legs were in prolongation of each other it could be carried by two men like a litter and wire unreeled as they walked. With the frame closed the reel could be used as a wheelbarrow with a DR-5 acting as the wheel, or it could be mounted vertically on the rear of a 1/4-ton car and wire laid from the moving vehicle.

d. RL-26. The reel unit, RL-26, was the most complicated of all reel equipment. It consisted of a frame containing two axles for drums, DR-5, a gasoline engine as power plant for wire recovery, and clutch mechanisms to control the transmission of power to the axles. It could be operated from a vehicle or from a stationary position on the ground; the normal manner was to operate it mounted in a vehicle.

24. Vehicles Used. Three types of vehicles were used for wire-laying and wire-recovery. The 1/4-ton truck with the RL-31 was used principally in the forward areas where the requirements of low silhouette and maneuverability were essential. The 3/4-ton weapon carrier with either an RL-31 or an RL-26 proved to be a very maneuverable wire vehicle and was used in the area immediately in rear of the forward area. The 2-1/2-ton truck with the RL-26 was the combination used most frequently for the installation of long lines, the large cargo capacity of the truck permitting the carrying of an ample supply of wire.

25. Comments by Using Troops.

Communication non-commissioned officers, 241st Field Artillery Battalion (105mm How):

"The RL-26 is not satisfactory. It has a poor motor and continually gives trouble. The RL-31 gave trouble in that it was always breaking near the hinges."

Lt Col J. W. Brownlow, Commanding Officer, 242d Field Artillery Battalion (105mm How):

"The RL-26 was a satisfactory piece of equipment. I believe that the substitution of a more powerful motor could be an improvement."

Lt Col J. S. Billups, Commanding Officer, 77th Field Artillery Battalion (155mm How):

"I was surprised at the excellence of the RL-26's we used. Prior to combat, we were always having trouble with them but the ones we had in combat never did give trouble."

"The RL-26 reels that we had were very satisfactory."

26. Comments by Board in United States.

Report of Field Artillery School Board² appointed to review developments in Field Artillery, dated 27 November 1944:

"The RL-26 gasoline reel currently issued is extremely heavy and cumbersome. This reel will lay two circuits simultaneously. The power feature is desirable in recovery of wire. Normally field artillery wire laying does not demand that circuits be laid in pairs. Only DR-5 (1 mile) reels may be used. Complete redesign of this reel should include the following: Great reduction in size and weight. An improved motor more dependable and more rugged should be provided. When DR-4 (1/2 mile) and DR-5 (1 mile) have been standardized for diameter the RL-26 should be capable of taking two DR-4's or one DR-5.

"RL-31b. This reel is hand operated and capable of installation in any vehicle. Its undesirable features include weakness of the bearing latch and cross-bracing. Redesign of this reel should include cross-bracing securely installed and a more rugged bearing latch.

"RL-27b is an axle equipped with crank, is hand operated using one DR-4 (1/2 mile). This axle is satisfactory for the purpose for which issued. Upon standardization of the DR-4 and 5 the RL-27b must be altered to conform to any possible change of the DR-4 (1/2 mile)."

The Army Ground Force Equipment Review Board³ concurred in the above statements.

27. Discussion. It is apparent that the reels RL-26 and 31 met with a varying reception. In the higher headquarters where the longer wire lines were used the RL-26 received favorable comment. In units where long wire lines had to be laid and picked up the RL-26's received more care than where the recovery of wire by manual labor with an RL-31 was a normal operation. Few comments were noted regarding the RL-27 and RL-39 equipment. Many units improvised racks for holding drums of wire on vehicles to supplement the allowance of reel equipment.

28. Table of Equipment Authorization.

a. Authorizations. Wire-laying and recovery equipment was authorized by table of equipment generally as shown below:

	RL-39	RL-27	RL-31	RL-26
FA Btry	6	1	2	
Hq Btry FA Bn	5	3	6	1
Hq Btry FA Gp	2	-	4	1
Hq Btry Div Arty	3	-	3	1
Hq Btry Corps Arty	3	-	3	2

The authorization for vehicles as laid down in T/E was as follows:

	1/4 ton	3/4 ton	2-1/2 ton
FA Btry	1	1	
Hq Btry FA Bn (Corps Arty)	0	3	1
(Div Arty)	3	3	1
FA Gp		2	2
Div Arty		2	2
Corps Arty		2	3

An analysis of these authorizations indicated that the wire teams were to be set up on the basis shown below. For purposes of this discussion teams have been named according to the load of wire the vehicle will carry--a light team using a 1/4-ton truck which can carry three miles of wire, a medium team using a 3/4-ton weapon carrier which can carry four to six miles of wire, or a heavy team using a 2-1/2 ton truck which can carry 12 to 15 miles of wire.

Teams Authorized	Light	Medium	Heavy	Total
FA Btry	1	1		2
Hq Btry FA Bn (Corps Arty)		3	1	4
Hq Btry FA Bn (Div Arty)	3	3	1	7
Hq Btry FA Gp		2	2	4
Div Arty		2	2	4
Corps Arty		2	3	5

b. Comments by Troops. There were many comments concerning the authorized allowances of wire-laying and wire-recovery equipment. The following data is extracted from an analysis of wire communication by XII Corps Artillery Headquarters:⁴

"Add two 2-1/2 ton wire trucks for Corps Artillery Headquarters Battery

Add one 2-1/2 ton wire truck for Division Artillery Headquarters Battery

Add one 2-1/2 ton wire truck for Field Artillery Group Headquarters Battery

All 2-1/2 ton wire trucks should have RL-26 reels."

Brigadier General John Lewis, Artillery Officer, 30th

Division:

"The cry from all combat organizations in field artillery is, 'We need an additional 2-1/2 ton truck short wheel base right now to handle the wire transportation and wire laying problem'."

It Col J. D. Peet, S-4, XX Corps Artillery:

"We need more wire teams in the Corps Artillery Headquarters Battery. We have borrowed additional teams from the Signal Corps."

Communication non-commissioned officers, 241st Field Artillery Battalion:

"We need one more 3/4 ton wire truck in battalion headquarters battery."

Captain L. V. Hancock, Communication Officer, XX Corps

Artillery:

"All units need a 2-1/2 ton truck for signal supply purposes."

Commanding Officer, 284th Field Artillery Battalion:

"We had to convert our 2-1/2 ton wire truck into a wire supply vehicle and 'manage' for another 3/4 ton to use for a wire truck."

The above comments indicate that the personnel who were responsible for wire communication feel that the wire systems will be more efficiently installed and maintained by the addition of one more wire truck to practically all units. In the higher headquarters 2-1/2 ton trucks are desired because of the long lines; in the lower headquarters 3/4 ton trucks are desired because of the increased maneuverability. Practically all units except the firing batteries needed a 2-1/2 ton truck to carry wire supplies. With the increased amount of wire that had to be carried it was necessary to convert some vehicle to serve as a signal supply truck.

SECTION 6

TELETYPE AND TELEGRAPHY

29. Teletype Equipment. The use of teletypewriting equipment in field artillery units was only slightly exploited in World War II. Tables of equipment did not authorize this equipment. In some corps artillery headquarters equipment was obtained by special authorization, but it was used to communicate with the corps headquarters and was not used in the artillery net. Factual data is not now available on the artillery use of teletype communication equipment. A considerable number of individuals were interviewed and asked a rather general question as to what use could be made of teletype in the artillery. Many felt that there would be a place for it down to battalion level if a small compact piece of equipment can be developed but that present equipment is too bulky. Some officers were of the opinion that teletype was unnecessary in headquarters below corps artillery or division artillery. The outstanding feature of the study of teletype equipment for artillery use is that thought is still not crystallized.

30. Telegraphy. The wire telegraph equipment issued for artillery use in the European Theater of Operations was the TG-5. Opinion on this item was unanimous in condemnation, partially because of the equipment. Officers and enlisted men stated: "**** it was never used"; "**** saw the TG-5 only for equipment inspections"; "**** a completely useless item which we had to carry around". The Field Artillery School teaches that telegraphy can take a portion of the traffic load and make telephony more available for person-to-person calls. This was predicated upon a good, sturdy telegraph set and its employment over a simplex circuit. The employment of telegraphy broke down for two reasons:

- a. The TG-5 was a difficult piece of equipment to maintain.
- b. Whenever a simplex circuit would work it was used to provide a fire direction channel.

The second reason was, by far the more important. Every effort was devoted to making a simplex circuit work, but the resulting communication was devoted to telephony for fire direction. The almost unanimous opinion of officers and enlisted men was that there is no longer a necessity for telegraphy in the field artillery.

SECTION 7

MISCELLANEOUS WIRE COMMUNICATION

31. Communication Within Firing Battery Positions. The problem of controlling the fire of the battery when pieces were dispersed presented itself to the battery executive as battery frontages often reached and sometimes exceeded three hundred yards. Practically all units improvised some sort of wire communication between the executive and the sections. Some units used a type of public address system with a loudspeaker in each gun pit. This had the limitation that communication was all one way; a chief of section could not ask for a command to be repeated, nor could he report over the system. A more popular system was the installation of a firing battery telephone net with a telephone in each gun pit. Some units used a terminal strip at the executive post with rewiring to provide for "partying" all section lines with the executive. Other units used a BD-71, 6-drop switchboard at the executive post. In some batteries the wire net was duplicated by lateral lines between pieces. In one way or another field artillery batteries found solutions to this communication problem by utilizing standard equipment.

CHAPTER 3

RADIO COMMUNICATION

SECTION 1.

GENERAL

32. The Importance of Radio Communication. In Chapter 2 attention was invited to the dependence of artillery fire control upon wire communication. A decade ago, with the radio equipment then in use, the statement that wire was the primary means of communication was correct; when wire lines could not be established or maintained, communication usually failed. It was recognized that such a condition could not be permitted to exist, so research and development were carried on and the amplitude-modulated and the frequency-modulated series of radio sets now in use were produced. Radio has now filled in those breaks in communication which were so critical in previous wars. There are still many deficiencies to be corrected, but the improvement over previous conditions is so marked that radio must now be classed with wire as a primary means. There were three ways in which radio played its part in the communication picture:

In fast-moving situations where it provided the only means of communication.

In slowly-moving situations where it was combined with wire to provide positive communications.

In situations where it was available as a 'reserve' to carry the traffic load if wire communication failed.

a. Radio in Fast-Moving Situations. Radio was the only speedy means of communication when units were moving rapidly. It was the primary means of communication. Time and again during the pursuits across France and Germany, artillery batteries left the road, occupied hasty positions, and fired a few volleys in answer to a radioed fire mission from an observer with the leading elements. This type of operation was not restricted to direct support artillery alone. By the use of radio corps artillery commanders directed battalions, or even

whole groups of corps artillery, from one route to another to reinforce the fires of the artillery of a force which had encountered too much opposition to be dealt with quickly. The excellent mobility of heavy artillery made it possible for these weapons to keep up with rapidly advancing columns; radio communication made it possible to keep it up there.

b. Radio as a Supplement to Wire. The combining of radio and wire frequently was the only solution to the communication problem. The best example of this combination was found in higher headquarters in the use of the radio link. In this case part of the distance between two installations was spanned by wire which terminated in radio sets which spanned the remainder so the the communications went over the wire and the radio simultaneously. Few cases have been reported of the use of radio link by artillery units; however, the teamwork of radio and wire in the artillery was developed to a high degree. In the direct support artillery it was generally possible to establish wire communication with the liaison officers at the infantry battalion command posts, but often it was impracticable to reach forward observers with wire and in those cases the fire missions from the observers frequently came by radio to the liaison officer who relayed them by wire to the fire direction center. In practically all artillery battalions the first wire lines to be installed were the fire direction lines to the firing batteries. Initially, communication was by radio to observers and higher echelons. If the position was to be occupied for any length of time, more wire was installed; but for a portion of the time, both means were in use.

c. Radio as an Emergency Means. In all situations, no matter how extensive the wire net, radio was available in case the wire went out of order. As the wire net developed, radio stations became silent but the net remained established. If a wire line was broken, the radio connection to the installation concerned immediately became active again. In many cases the radio net was maintained constantly as a listening net in order to be prepared to operate at once. In some headquarters it was learned that, if the radio net was closed when wire was established, too much time was lost in reestablishing radio contact. Frequently, in order to maintain the radio net at peak efficiency, the wire net was closed for a few hours and the radio net required to carry all traffic.

33. Radio Nets. At this point it is desired merely to show which radio nets were used by field artillery.

a. Battalion Nets. Field artillery battalions, both division and corps artillery, used essentially the same nets. They were as shown below.

(1) Fire Direction Net.

Purpose - Handling of fire missions from liaison officers and observers.

Stations - Set, or sets, at fire direction center.
Liaison officers.
Observers.
Air OP

Equipment - SCR-608 or SCR-610 at fire direction center.
SCR-610 for all others.

(2) Command Net.

Purpose - Handling of command and administrative traffic, occasionally fire commands to firing batteries when wire was not installed.

Stations - Battalion commanders' station.
Battery commanders' stations.
Battery executives' stations (occasionally)

Equipment - SCR-608 for battalion commander.
SCR-610 for all other stations.

b. Division Artillery Nets.

(1) Fire Direction Net.

Purpose - Handling of fire missions from division artillery to battalions or vice versa.

Stations - Fire direction center, division artillery.
Fire direction centers of battalions.

Equipment - SCR-608 for all stations.

(2) Command Net.

Purpose - Handling of command and administrative traffic.

Stations - Division artillery commanders' station.
Battalion commanders' stations.

Equipment - SCR-284.

(Note: When the SCR-284 was not powerful enough for this net, permission was often obtained to use the SCR-193 on this net)

c. Field Artillery Group Nets. The nets of the field artillery group were essentially the same as the division artillery nets.

d. Field Artillery Brigade Nets. Field artillery brigades occupied varying places in radio nets. When used as corps artillery alternate fire direction centers, brigades established a fire direction net similar to the corps artillery fire direction net shown below for those units under their control; if necessary, they established a command net. When they were used merely in a supervisory capacity to assist in controlling several groups, they generally were secondary stations in the corps artillery nets.

e. Corps Artillery Nets.

(1) Fire Direction Net (Serenade Net).

Purpose - Handling fire missions between corps artillery fire direction center and all artillery with the corps.

Stations - Corps artillery fire direction center.
Each division artillery fire direction center.

Each organic division artillery battalion.
Each field artillery and tank destroyer
group.
Each corps artillery battalion.
Each tank destroyer battalion.

Equipment - SCR-193.

f. Army Artillery Nets.

(1) Purpose - Handling command and intelligence traffic.

Stations - Army artillery command post.
Each corps artillery fire direction center.
Army photo center.

Equipment - SCR-193.

SECTION 2

FREQUENCY-MODULATED EQUIPMENT

34. Types of Equipment Used. The field artillery used three types of frequency-modulated radio sets. The first two were strictly vehicular sets and the third was a combination vehicular or portable radio. These were the commonly called "600-series", the SCR-608, 628, and 610, and were issued to all except armored artillery units. A similar group of sets was used by armored artillery units but, because of the difference in frequency range, was known as the "500-series". Both series were essentially alike and in this report, although comments will refer to the 600-series, the same comments apply equally to the 500-series. The identification numbers for the 500-series radio sets are similar to the 600-series, namely, SCR-508, 528 and 510.

35. SCR-608.

a. Characteristics. The SCR-608 was a vehicular radio set weighing 306 pounds and having a rated range of ten to fifteen miles. It had one transmitter unit and two receiver units, all three were push-button controlled with ten frequencies available on each unit. It was mounted in the 1/4-ton truck, the 3/4-ton command and reconnaissance truck, or the 3/4-ton weapon carrier. The antenna consisted of a fishpole type antenna of three sections mounted on a bracket on the side of the vehicle. The major difference in the SCR-608 and the SCR-508 was in the frequency ranges; the SCR-608 ranged between 27.0 and 38.9 megacycles and the SCR-508 between 20.0 and 27.9 megacycles. (It is desired here to direct attention to the so-called overlap zone of 27.0 to 27.9 megacycles between these two sets).

b. Uses. This set was intended for use as the battalion commanders' station in the battalion command net and as a secondary station in division artillery or group fire direction net. This set also was used as a relay between battalion fire direction center and liaison officers or observers.

c. Comments by Troops. The following comments were made by troops concerning this equipment:

Ten battery and three battalion commanders in a group conference on communication agreed in this opinion:

"Range short, fidelity good, stability good, ruggedness fair. Minimum range should be 20 miles. Not sensitive to jamming."

Captain L. V. Hancock, Communication Officer, XX Corps Artillery, said this about the SCR-608:

"Insufficient range, but fidelity, stability, and ruggedness good."

Of six experienced battalion commanders questioned about the SCR-608 all agreed that it was very satisfactory as far as fidelity, stability, and ruggedness were concerned but that it was not satisfactory in regard to range.

d. Comments by Boards in United States. The board convened at the Field Artillery School to study equipment stated:²

"This set is satisfactory except for size, weight, weatherproofing, and lack of local power supply."

Army Ground Force Equipment Review Board stated,³ with reference to the field artillery board report:

"This report and all the analyses of radio equipment stress the necessity for reduction in weight and increase in range."

e. Discussion. The SCR-608 performed excellently in this theater; it contributed greatly to the smooth flow of orders, instructions, and intelligence information. Practically all officers who had experience with it agree that it was a good piece of equipment. It is interesting to note that the personnel who used it in the field state that they want increased range whereas the board convened at the Field Artillery School says nothing at all about range. This, it is believed, is due partially to the very important problem of siting the equipment. The SCR-608 has a rated range of ten to fifteen miles according to the specifications, based upon using the set in proper locations. When asked whether they felt that the range difficulties were due to inherent characteristics of the set or to improper siting, most field commanders admitted that they were due to the improper location of the set in the majority of cases. Because of the difficulty of providing security personnel for the radio station, it was often necessary to ignore an otherwise excellent location and site the equipment in a less favorable spot. Many times it was absolutely impracticable to place the radio where it could perform best. Therefore, it is believed that considerable weight should be given to the request by field commanders for a set with a greater range. Many commanders objected strenuously to the power supply feature. The radio operated from the vehicular battery and it was necessary to run the vehicle engine periodically in order to keep the battery charged. This continued operation of the engine without moving the vehicle resulted in the fouling of spark plugs and sticking of valves. Many engines had to be replaced merely because they had become worn keeping the radio in operation. A great number of officers recommended a separate power plant to take care of this radio when used at the command post.

36. SCR-628. The SCR-628 was identical with the SCR-608 except that it had only one receiver. In all other respects it was the same and the comments in paragraph 35 apply equally to this set.

37. SCR-610.

a. Characteristics. The SCR-610 was a frequency-modulated transmitter-receiver with two preset crystal-controlled frequencies, either one of which could be selected by turning a switch. The SCR-610 was used as a vehicular set operating from the vehicular battery or

from a self-contained battery supply. The same transmitter-receiver could be operated as a man-carried set, taking power from the self-contained battery supply, and was then known as the SCF-609. Common usage in the field artillery referred to this set, however, as the SCF-610 regardless of whether it was used as a vehicular set or as a man-carried set, and therefore this report will so refer to it; any reference to SCF-610 will apply equally to SCF-609. This set when mounted in a vehicle weighed 177 pounds; when used as a portable, it weighed 170 pounds and broke into two loads for carrying. It had the same frequency range as the SCF-608 and a rated distance range of approximately five miles.

b. Use. This radio was used by liaison officers, forward observers, firing battery commanders and executives, and battalion staff officers. It was also used as base set at the fire direction center and in the air observation post.

c. Comments by Using Troops.

Commanding Officer, 284th Field Artillery Battalion
(105mm How):

"The SCF-610 was not a satisfactory piece of equipment for forward observer use. It was entirely too heavy and bulky; it was too hard to carry and definitely identified the forward observer. It was too critical as far as line of sight was concerned and did not have enough range. The problem of battery supply was also difficult; the life of batteries in this set is entirely too short."

Communication non-commissioned officers, 241st Field Artillery Battalion:

"The 600-series radios were good but need more range. The 610 was too heavy. A good directional antenna answers the problem of range for the 610, but it is too often impractical for observers."

Lt Col J. L. Brownlow, Commanding Officer, 242d Field Artillery Battalion:

"The 600-series were good in level terrain but not good in rough terrain."

Practically all officers who were interviewed stated that the SCF-610 should have a range of about eight to ten miles.

b. Comments by Boards in United States. The board at the Field Artillery School made this comment on the SCF-610:²

"The limited range and line of sight characteristics of this set make it unsuitable under certain conditions without the use of relay stations. Its weight and size make it unsuitable for man packing. It has two preset channels only. The SCF-619 which will replace the SCF-610 is satisfactory for size but continues to be heavy for man packing - about 50 pounds on packboard. Range capability and line of sight characteristics are little better than the SCF-610. A set weighing not more than 35 pounds excluding external power supply and accessories, which is weatherproof, has small generator power supply, four preset channels and a 10 mile dependable range is necessary."

The Army Ground Force Equipment Review Board³ concurred, in general, with the artillery board's comment.

c. Discussion. The SCF-610 was not favorably considered by the using troops for four major reasons: size, weight, range, and line-of-sight characteristics. It was good from a standpoint of speech fidelity because it gave the usual clear reception peculiar to frequency-modulated equipment. It was entirely too heavy and bulky for forward observer use. In part this may be laid to the fact that, originally, the SCF-610 was not intended to be used by forward observers; it was intended to be a vehicular set. This, of course, caused it to be designed without consideration for the problem of transport. The forward observer must have a dependable radio which packs in one load of about 35 pounds, is not too critical for line-of-sight location, and utilizes a hand-generator as well as a battery power supply. The incorporation of four preset channels is also an improvement which will give greater flexibility of use. In range this set should have from eight to ten miles under adverse conditions.

38. General Discussion of Frequency-Modulated Equipment.

a. General. The frequency-modulated radio equipment used by the field artillery in the European Theater of Operations was a great improvement over the amplitude-modulated equipment of the past decade. The fidelity of speech reproduction and the freedom from interference made communication, within the range of the equipment, a certainty. The enemy made frequent attempts to jam the frequencies used by the artillery by transmitting a signal from a type of "howler" device. It is believed that the same interference would have blocked completely any communication on an amplitude-modulated radio set. This interference did create a great amount of background noise on the frequency-modulated set but it was possible to handle traffic through the noise. The greatest obstacle to dependable communication was the line-of-sight characteristic of the frequency-modulated equipment. This frequently made it necessary to use a relay station, and for this purpose one additional SCF-608 was authorized each battalion. This set was placed forward of the fire direction center and assisted in maintaining contact with liaison officers and forward observers. The selection of location for frequency-modulated equipment was a matter of great priority, and often radio stations had to be removed to a considerable distance from the command post in order to establish contact. This entailed a considerable problem of security for the station and several men usually had to be sent out as a guard. It is believed that a stronger signal, although not a positive cure for this trouble, will assist greatly in solving it.

b. The Forward Observer Problem. The problem of maintaining communication with forward observers was one of primary concern to all battalion commanders. Fire communication was always difficult and frequently impracticable to establish. The 600-series radios did help greatly, but it was in regards to observer communication that they came in for the greatest amount of comment. As has been noted earlier, the greatest criticisms were on size, weight, range, and line-of-sight characteristics. Observers tried many solutions but most of them failed to give a completely satisfactory answer. One was the use of remote control equipment; this was a partial solution but it required the laying of wire from the radio to the observer. Another solution was the use of the SCF-536 radio, a small "walkie-talkie" type radio, which will be discussed under amplitude-modulated radio equipment. In this solution the observer took one SCF-536 with him and left one at his SCF-610 radio; the radio operator then acted as a relay. This solution was the source of a suggestion which was heard frequently during the interviews in connection with this study. Several officers

suggested that the forward observers' radio be of a power comparable to the SCR-508, be mounted in a 1/4-ton truck with no provision for portable operation, and have some device built into the set which will permit its operation as an automatic relay. When the observer goes forward, he can leave his big radio in a favorable location and take with him a small "walkie-talkie" size radio with a range of one or two miles which will work back to his larger set which will relay automatically to the fire direction center. By this solution the time lost by having an operator act as relay is saved and greater accuracy obtained. This will also permit the observer to carry a much smaller set with him in the exposed area.

SECTION 3

AMPLITUDE-MODULATED EQUIPMENT

39. General. It might be said, generally, that amplitude-modulated radio took over and carried on where the voice range of frequency-modulated equipment ceased. In some instances amplitude-modulated voice communication was sufficient, as in the case of the SCR-536, but in a majority of cases continuous-wave key communication was necessary in order to force the signal through interference. Therefore, amplitude-modulated equipment was extremely important in the nets of higher headquarters. In the succeeding paragraphs each amplitude-modulated set which was used by the artillery will be discussed.

40. SCR-536.

a. Characteristics. This set was the "walkie-talkie" set used by the infantry. It was small in size, 15-3/4 x 5-3/8 x 3-3/4 inches, and weighed only six pounds. It had a forty-four inch whip antenna which telescoped into a small section of the case when not in use. The set had one preset frequency and a range of approximately one and a half miles. The power supply was obtained from self-contained dry batteries. It was for voice operation only.

b. Use. This radio was issued to artillery units for use by forward observers and survey sections. In some cases the observers used it to communicate with the supported infantry company commanders when the situation required that they be separated. In other instances observers used them to communicate with their SCR-610 operator when they went forward and had to leave the SCR-610 in a favorable spot for communication with the fire direction center. Survey personnel used this radio for communication from opposite ends of survey bases or to control the operations of survey crews.

c. Comments by Using Troops. Formal comments by using troops were not obtained but informal statements indicated that this item of equipment was thoroughly satisfactory and was well liked by all who had occasion to use it.

d. Discussion. The SCR-536 radio did not take a place in the organized nets of the field artillery. It was used for short-distance communication and was well liked by those who used it.

41. SCR-284.

a. Characteristics. The SCR-284 was a combination continuous-wave voice set for vehicular or ground operation. It had a rated range of thirty miles on continuous-wave and seven miles on voice. The power supply when mounted in a vehicle was from the vehicle battery and when used on the ground was from a hand generator GN-45-A. The total weight of all component parts was 250 pounds.

b. Use. This radio was designed to be used in the division artillery or group command net linking the battalions to the aforementioned headquarters. It was also intended for use in the corps artillery command net down to division artillery and group headquarters.

c. Comments by Using Troops.

Brigadier General J. F. Lentz, Commanding General, XII Corps Artillery:

"The 284 radio is out. It is not satisfactory for missions it is supposed to be used for."

Brigadier General J. E. Slack, Commanding General, XX Corps Artillery:

"The 193 radio has been a life saver. We have just about quit using the 284."

Army Ground Force Report Number 1077:

"The 284 sets were not used, since they were replaced by 193 sets. The 193 is preferable because the frequency band extends lower than that of the 284. In addition the 193 has more range and is a much better set."

A report from XII Corps Artillery Headquarters on radio communication⁵ contained the following statements:

"(1) SCR-284 radios in Corps Artillery Command Net had insufficient range for the purpose."

"(2) SCR-284 radios in Field Artillery Groups and Division Artillery Command Net had insufficient range to properly control their units."

Col E. T. Owen, Executive Officer, 26th Infantry Division Artillery, stated:

"There was not enough difference in size and weight between the SCR-193 and 284 sets to warrant the great difference in range. The 284 was definitely unsatisfactory for range considering its size."

Commanding Officer, 284th Field Artillery Battalion
(105mm How)

"The SCR-284 did not give us the contact we needed with higher headquarters. Frequently we had to obtain permission to use our SCR-193 in order to maintain communication with group headquarters."

d. Discussion. The SCR-284 was not well received by the using troops. It did not have sufficient range to insure communication within the nets for which it was intended. Too frequently it was necessary to withdraw the SCR-193 from the corps artillery fire direction (sercnade) net to operate in the division artillery or group command or fire direction nets. Another result of the signal strength weakness was the effect of enemy interference on this set. In cases where the net had been established with the SCR-284, enemy interference could completely cut out communication whereas the stronger signal of the SCR-193 could be heard.

a. Characteristics. The SCR-193 was an amplitude-modulated, vehicular mounted radio which could be operated on continuous-wave, tone, or voice. It had a transmitter frequency range of 1.5 to 4.5 megacycles and a distance range of sixty miles on continuous-wave, forty miles on tone, and twenty miles on voice while stationary, or thirty miles on continuous-wave, twenty miles on tone, and fifteen miles on voice while moving. It weighed two hundred pounds.

b. Use. This equipment was used in several artillery nets. It was used in the corps artillery fire direction (serenade) net and in the corps artillery command net in place of the SCR-284 which had been intended for use in this net. It was also used in the army artillery officers' net. On many occasions division artillery and group headquarters had to withdraw their stations from the higher echelon nets to operate in their own fire direction or command nets when the SCR-284 was inadequate as far as range was concerned.

c. Comments by Using Troops.

Captain L. W. Hancock, Communication Officer, XX Corps Artillery:

"The SCR-193 is good in all features."

Ten battery and three battalion commanders in a group conference on communication equipment said:

"SCR-193 suitable. Need more 193's--at least one spare set for every one in operation. Several instances reported of 193's being located."

Brigadier General J. M. Lentz, Commanding General, XII Corps Artillery:

"Don't know what we would have done without the 193 radio."

Brigadier General J. E. Slack, Commanding General, XX Corps Artillery:

"The 193 radio has been a life saver. We have just about quit using the 284."

Army Ground Force Report Number 957:

"During the rapid advance across the Cologne Plain, the maintenance of communication was an extremely difficult feat-ure. From the Corps Artillery standpoint, the range of the SCR-608 radio was found to be insufficient for satisfactory radio communication. The SCR-193 net functioned reasonably well and practically all tactical communication was handled over this net."

Army Ground Force Report Number 1077:

"Three SCR-193 radio sets were operated, only one of which is authorized by T/O & E, (two in lieu of the SCR-284 sets which were not used). These sets were used (a) in the corps artillery net, (b) the army artillery net, and (c) at corps command post by the corps artillery commander in the corps artillery net. A fourth SCR-193 set is needed for use of the liaison officer sent to the artillery of the corps on the left."

d. Comments by Boards in United States. The board of officers convened at the Field Artillery School² made the following comment:

" *** The only improvement desired is a reduction in weight and size."

The Army Ground Force Equipment Review Board³ concurred in this statement.

e. Discussion. The SCR-193 was the "workhorse" of higher echelon radio communication. It not only performed splendidly in the nets for which it was intended but it was frequently withdrawn from these nets to replace the SCR-284 in other nets. It was well liked by the using troops, and practically all officers who were interviewed recommended dropping the SCR-284 from tables of equipment and replacing it with the SCR-193. This set was generally mounted in a 3/4-ton weapon carrier and took its power from the vehicle battery. This introduced the problem of operating the vehicle engine for long periods to keep the battery charged. Many commanders suggested that a separate source of power be made available for use in static operation in order to conserve vehicle engines. No comment was made by the field commanders concerning the size nor the weight; their general satisfaction with the equipment precluded comment upon this feature. However, the comment by the boards in the United States as to size and weight was very pertinent. If the size and weight can be reduced without sacrificing any of the present characteristics it will be an improvement. It is very certain, though, that field commanders will recommend against any compromise in this respect.

43. SCR-506. In the discussion of frequency-modulated equipment the statement was made that armored artillery employed the 500-series radio sets in place of the 600-series used in other artillery units. Similarly, in the amplitude-modulated equipment, there was one set which was a counterpart for the SCR-193; this was the SCR-506. It was a vehicular-mounted combination continuous-wave voice set with a continuous-wave distance range of seventy miles and a voice range of twenty-five miles. It was used in the division artillery and battalion command nets and the battalion fire direction nets. It received the same high praise from armored artillerymen that the SCR-193 did from other artillerymen.

SECTION 4

MISCELLANEOUS

44. Radio Procedure. Radio procedure as used by field artillery units in the European Theater of Operations was as laid down in current field manuals. Informal discussion with unit commanders revealed that the consensus was that it was satisfactory. An interesting lesson in training policies resulted from a change of radio procedure. All radio operators were trained in the United States in the method of making a radio call whereby the station call-signs of both stations concerned in the traffic were mentioned over the air. Upon arrival in this theater operators were required to learn the new so-called "single call sign method" as outlined in FM 24-6. There were definite advantages to the new method and in instances where units remained in training areas long enough to thoroughly indoctrinate all personnel in this system, it was used consistently throughout the war. However, many units received their equipment and were sent into battle with insufficient time to complete this training. The result was that those latter units gradually drifted back to the old system with the consequence that both methods were in use by the end of the war. This illustrates the important point that radio procedure must not be changed without ample

time to thoroughly indoctrinate all personnel, including both operators and officers who will use the equipment

45. Allocation of Frequencies.

a. General. Frequencies for use in field artillery nets were assigned by Signal Officers of higher echelons in accordance with the principles laid down in field manuals. They were generally satisfactory. There were occasional instances of interference between nets but these were quickly adjusted by a new frequency assignment to one of the nets concerned. The most outstanding examples of interference occurred in December of 1944 and January of 1945 when units were rushed to Belgium to oppose the German offensive. It was inevitable that there should be some interference because units were moved rapidly from one area to another with no time for realignment of radio sets.

b. The Two-Channel System versus the Four-Channel System for Battalions. During training in the United States, all field artillery battalions operated on what was called the "four channel system." Under this policy each firing battery had one frequency and one net which included the fire direction center station, the battery commander, the battery reconnaissance officers and observers. The fourth frequency was a common frequency for the battalion command net, and all sets in the battalion were preset for operation on that frequency. This policy permitted maximum flexibility and operating efficiency. However, when the buildup of units in this theater began, it became evident that there would be too many units closely adjacent to each other to permit operation under this system without interference. With only a limited number of frequencies available it became necessary to reduce the number of frequencies per battalion and the "two-channel system" was adopted. Under this system all sets in the battalion carried the two battalion channels and operated in one of two nets, the command net or the fire direction net. The theory of this system was that all stations would operate in the command net until it became necessary to switch to the fire direction net to handle fire missions. The first reaction of unit commanders was that they could not operate efficiently under this restricted allocation. As combat progressed, many unit commanders changed their minds until, by the end of the war, opinion was divided. Commanders of corps artillery battalions were unanimous in their opinions that the two-channel system was adequate for their needs. Within divisional units there was a disagreement; some commanders felt that the number of missions which their battalions could handle in a certain period of time was reduced by this system. It is believed that there is good ground for this contention in that normally an organic divisional unit has three liaison officers with the supported infantry regiment and two or three observers operating under the supervision of each liaison officer. With several of these stations attempting to transmit traffic it is conceivable that a communication bottleneck may arise. In the corps artillery battalions such a probability is remote because normally only one liaison officer is used and he is at the fire direction center of the reinforced organic battalion. Therefore, it appears that a compromise is indicated with corps artillery units using the two-channel system and divisional units having four channels for us if needed, provided these additional channels are available.

46. Organization of Nets.

a. Desired Nets. In paragraph 33, a list of the more commonly used nets was presented. Those are the nets which were used by the majority of units. Presented in Figure 1 (see page 32) are the nets which are believed to be necessary for field artillery use. The

radio sets which are indicated are the sets which operated in comparable nets during combat; however, some of these sets will not meet the desired range requirements shown in the last two lines of the chart. In cases where there is a discrepancy sets which will meet these range requirements are desired. The nets of the field artillery brigade are omitted. This is due to the varying situations in which the brigade headquarters operated. Where the brigade functioned as an alternate fire direction center for the corps artillery headquarters, it had the same nets as the corps artillery headquarters. Where it assisted the corps artillery headquarters merely in a supervisory capacity, it was usually a secondary station in the corps artillery nets.

b. Analysis of Traffic on Desired Nets. The following is a resume of traffic to be normally handled on the above nets:

(1) Army Artillery Officers Net:

Command and Administrative traffic,
Intelligence information,
Photo requests,
High-performance aircraft adjustment requests.

(2) Corps Artillery Command Net:

Command and Administrative traffic,
Intelligence information,
Meteorological messages,

(3) Corps Artillery Fire Direction (Serenade) Net:

Fire missions for artillery with the corps.

(4) Corps Artillery Liaison Net:

All transmissions to and from liaison officers with adjacent corps and divisions of the corps.

(5) Division Artillery Command Net:

Command and Administrative traffic,
Intelligence information,
Meteorological messages.

(6) Division Artillery Fire Direction Net:

Fire missions to and from organic, attached or supporting artillery.

(7) Nets of the field artillery group handled the same type of traffic as the nets of the division artillery headquarters.

(8) Field Artillery Battalion Command Net:

Command and Administrative traffic.

(9) Field Artillery Battalion Fire Direction Net:

Fire missions within the battalion.

47. Supply of Radio Equipment.

a. Initial Supply and Replacement Parts. Initial supply of

Recommended Field Artillery Radio Nets

Units.	Army	Corps Arty			Division Arty		FA Gp		FA Bn	
	Army Arty Officers Net	Command Net	Fire Direction Net	Liaison Net	Command Net	Fire Direction Net	Command Net	Fire Direction Net	Command Net	Fire Direction Net
Army Arty Hq	193									
Corps Arty Hq										
CP	193	193								
FDC	193	193	193	193						
Ln officers				193						
FA Group Hq										
CP		193			284* (193*)		284 (193)			
FDC			193			608*		608		
Div Arty Hq										
CP					284 (193)					
FDC			193			608				
Div Arty Bn										
CP					284 (193)				608	
FDC			193			608				608**
FA Btry									610	610
Ln officers										610
Observers										610
Corps Arty Bn										
CP					284* (193*)		284 (193)		608	
FDC			193			608*		608		608
FA Btry									610	610
Ln officers										610
Observers										610
Normal Operating Range in Miles										
Continuous-Wave	75	50		50	40		50			
Voice			20		20	10		10	15	10

* When attached to or supporting Infantry Division Artillery

** Three frequencies are desirable; actually there may be three battalion fire direction nets if conditions warrant.

Figure 1, Recommended Field Artillery Radio Nets.

radio equipment was generally satisfactory since no adverse comments were received during the interviews. Supply of parts and of replacements, however, did excite unfavorable comment. The general tenor of comment on supply of replacement parts was exemplified by the answer given by Brigadier General E. T. Williams, Artillery Officer, Third Army, to a question as to whether an ample supply of spare parts and batteries existed. He said:

"At the close of the campaign, yes; during most of the war, no. Regarding parts, many times sets have been dead-lined for want of a single part. This led to cannibalization, which process, with the ability of a few skilled repairmen, was responsible for the continued performance of many sets; but many complete sets were thus rendered inoperative for lack of a few small parts."

The supply of batteries was exceedingly critical. The SCR-610 operated from battery power most of the time when it was in use by observers. This caused a severe drain upon unit battery stocks and, when supply became critical, reached major proportions as a communication problem. Most of the officers interviewed expressed a desire for a battery with longer life and a better supply of them.

b. Basis of Issue.

- (1) General. Attention is invited to comments of unit commanders upon the individual radio sets which were discussed in previous paragraphs. The comments are based entirely upon the equipment which was used in combat; the comments here recorded are also upon the sets with which they fought the war. If, in the discussion of set characteristics, they stated that they desired a set with greater range and if, here, they state that they desire more sets of that type, it is understood that they desire an increase in the number of sets with increased range. No mention is made here of new equipment.
- (2) SCR-608. Several battalion commanders expressed a desire for a return to the basis of issue which gave an SCR-608 to each battery commander because they felt that the increased range of this set was a decided advantage in displacements and reconnaissance.
- (3) SCR-508. A comment which was heard consistently was for the addition of an SCR-508 to the table of equipment for the field artillery group headquarters. At present the tables authorize the SCR-608. When armored divisions were supported it was necessary to borrow an SCR-508 for group fire direction or to make use of the overlap in channels between the SCR-608 and SCR-508. In paragraph 35a it was shown that this overlap was only between 27.0 and 27.9 megacycles, allowing only ten channels on each set which can be used. These were found to be inadequate with the overlap band being very badly crowded. The issue of SCR-508 radios to all group headquarters would permit any such unit to support armored units at any time with the desired flexibility of radio communications.
- (4) SCR-284. Opinion was practically unanimous that the SCR-284 should be deleted from field artillery tables

and replaced by the SCR-193.

- (5) SCR-193. The SCR-193 proved to be the most sought after item of radio equipment. Practically all unit commanders desired an increased authorization.

Army Ground Force Report Number 1077:

"Three SCR-193 radio sets were operated, only one of which is authorized by T/O & E, (two in lieu of the SCR-284 sets which were not used). A fourth SCR-193 set is needed for use of the liaison officer sent to the artillery of the corps on the left."

A recommendation by Commanding General, XII Corps Artillery included this statement:

"Provide Field Artillery Group with two additional SCR-193 or SCR-506 radio sets with 3/4-ton weapon carrier.

Reason - one for liaison officer to operate in Corps Artillery command net.

one for operation by Group Headquarters in Corps Artillery command net.

one (now provided in T/E) for operation in Corps Artillery (Serenade) fire direction net.

"Provide Corps Artillery Headquarters Battery with eight SCR-193 or SCR-506 radio sets with 3/4-ton weapon carrier.

Reason - one for Corps Artillery command post in command net.

one for Corps Artillery fire direction center in command net.

one for Corps Artillery fire direction center in (Serenade) fire direction net.

one for Corps Artillery fire direction center in Army Artillery net.

one for each of three liaison officers in command net.

one for Corps Artillery fire direction center for displacement."

Ten battery and three battalion commanders in a group conference on communication equipment stated:

"Need more 193's--at least one spare set for every one in operation."

Thus the comments ranged from a slight increase in some units to a very appreciable increase in others. The general concensus was that SCR-284 should be replaced with SCR-193, that each corps artillery liaison officer should have an SCR-193, and that there should be a relief set for every SCR-193 which is in continuous operation in order that sets may be rotated to insure positive communication.

CHAPTER 4

VISUAL AND SOUND COMMUNICATION

SECTION 1

VISUAL COMMUNICATION

48. General. Visual communication was used to a very limited extent by field artillery in the European Theater of Operations. This was due, in part, to the fact that wire and radio communication functioned well in practically all operations.

49. Air-Ground Communication. Radio was the principal means of communication between airplane and ground installations. In the event of a radio failure it was considered more economical of time for the liaison airplane to fly back to the landing strip and exchange the faulty radio set for another. The airplane could usually be back on its air mission before it could have completed the mission if wing signals and panel displays had been used. No instance was disclosed of ground-to-airplane communication through the use of standard panel sets. The only use of panel sets was at the air strip itself to indicate runways and wind direction. Identification panels of the fluorescent type, however, were used to identify friendly vehicles and front line elements to both organic artillery aircraft and to high-performance aircraft of the Air Force. During January and February 1945, because of the capture of many fluorescent panels by the enemy, it was necessary to use a code of color combinations, changed daily, to identify friendly vehicles and columns.

50. Pyrotechnics. There were few instances disclosed during the interviews of the use of pyrotechnics as a signal for artillery support. Although the emergency use of flares was provided for in case other means of communication failed, they were seldom employed. Infantry commanders preferred to seek out the forward observer or liaison officer and have him call for protective fires by wire or radio.

51. Other Means of Visual Communication. Semaphore as a means of visual signalling was practically never used. Signal lights were never used because troops were very "light conscious" and the flashing of any lamps was certain to provoke comment.

SECTION 2

SOUND COMMUNICATION

52. Whistles, Sirens, Klaxons. Sound as a means of communication was practically never used. The only instances reported were a few cases where whistles were used to alert the drivers when putting a motor convoy into motion. Signal Operations Instructions specified sound signals which were to be used in the event of air, gas, or armored attack, but no evidence of their use was found. This was undoubtedly due to the facts that chemical attacks never materialized, air attacks were over so fast that no opportunity was given to sound the signal, and warning of incipient attack by armor generally came by radio.

CHAPTER 5

CODES AND CIPHERS

SECTION 1

SIGNAL SECURITY

53. A German Secret Weapon. On several occasions during and after combat reference were made in various memoranda and bulletins to one of the so-called 'secret weapons' employed by the enemy. In this particular instance the subject referred to was the lack of signal security on the part of the American forces. Despite almost continued reminders from higher headquarters serious breaches of signal security discipline were reported.

Brigadier General E. T. Williams, Artillery Officer, Third Army, stated:

"*** In one case a time-on-target shoot at a division command post was put on the air in the clear about an hour ahead of time. The enemy moved his entire installation and observed the ineffective fire from a nearby hill. According to prisoners of war, the enemy has taken advantage of as little as fifteen minutes warning in similar cases. In another instance, a division was advancing on a city which straddled a river. Friendly aircraft reported, in the clear, locations of road blocks only on the south side of the river. The enemy acted on this by shifting all of his troops to the south and offered a very stubborn resistance."

The commander of a battalion of medium corps artillery reported this instance of violation of signal security:

"I was on reconnaissance for new positions when I encountered Col - - -, my group commander. We met in a little town just west of where I intended to go into position. After receiving my information, Col - - - went to his SCR-608 and transmitted this message in the clear to his executive, 'I am at - - - (the name of the village) at coordinates (the coordinates in the code for that day). Move the group command post here; we will be here with - - - (the battalion commander's name) and he will have the (--)th battalion in position just east of here.' Needless to say, I didn't occupy position east of that town and I didn't put my command post there either."

Violations of signal security were so frequent that it became necessary for higher headquarters to monitor radio frequencies and telephone lines in order to reduce the amount of information being given to the enemy. Not only was information being broadcast by radio means but indiscreet telephone conversations on lines which could be tapped provided another leak of information.

54. Causes of Violations.

a. The "Telephone Complex". One contributing factor to violations of signal security was what might be termed the "telephone complex". In the United States a person is seldom beyond reach of a telephone. The result has been the growth of a strong preference for person-to-person conversation; the writing of messages and orders was often merely a confirmation of a telephone call which set a train of

events into motion. With the advent of radio equipment which was no more difficult to use than the telephone, vital information took to the air instead of traveling by wire. Had the desire to use the telephone or the radio not been so strong, commanders and staff officers would have sent more written messages which would have followed the established message center channels. In those channels they would have been encoded and transmitted by personnel especially trained for that work. Much information would have been denied the enemy.

b. Failure to Change Frequencies. Another factor in the leak of information was the failure to change radio frequencies over long periods of time. For the best interests of communication security radio frequencies must be changed periodically. This entails a compromise between the principles of security and the practicability of such changing. As a general rule, once an operation was begun, it had to be carried to a conclusion without opportunity for the realignment of radio sets. Units changed frequency only for an urgent reason such as a move to another corps zone or the capture of an observers set by the enemy. One battalion of corps artillery which never changed corps and never lost a radio set to the enemy was using the same frequencies at the end of the war that had been put on the sets in England in August of 1944. This constant operation on the same frequencies gave the enemy an opportunity to establish well organized monitor systems to cover the frequency spectrum and listen to those stations which gave him the most information.

c. Improper Use of Codes. Not the least of the causes of failure of signal security was the improper use of codes. The instance cited in paragraph 53, where the name of a town and the coded coordinates were mentioned together, was not a remote case; violations of this type were frequent. Because of such actions many codes were compromised. It was with a high degree of chagrin, after hostilities ceased, that many American officers learned that one of the supposedly best codes, certainly one of the most used codes, had had a security period of approximately six hours after which the enemy was able to decode our messages almost at will. (See paragraph 56c)

SECTION 2

CODES

55. General. A study of the codes used by field artillery units in the European Theater of Operations reveals that a great number were employed. These fell into three general classes: Slidex, a code which used mechanical means for variation; prearranged codes which were set up by certain headquarters for, generally, 24-hour periods; and impromptu codes made up on the spur of the moment. The frequency of use of these codes varied in the order given above as the echelon of the artillery headquarters decreased; corps artillery headquarters used Slidex to a very high degree and battalions used it very slightly.

56. Slidex.

a. Characteristics. Slidex was a code device adopted from the British. It is a variable type prearranged message code but was used so extensively that it will be discussed as a separate type of code. The Slidex device was a semi-weatherproofed folder which enclosed within it a card with 144 squares on which were printed frequently-used phrases of field messages as well as numbers and a syllabus. At the top and left hand edges were slides holding acetate strips, called coursers, on which were printed 12 letters of the alphabet in accordance with a 'key' which was changed daily by the Signal Operation Instructions. In using this device, personnel encoding a message set

the two cursers at any desired place and read the 'letter coordinates' of the upper left-hand square; this was the initial code group of the message. The succeeding groups were the 'two-letter coordinates' of the phrases on the card which expressed the writers message. In decoding a message, the cursers were set to correspond to the initial group of the message and thereafter the process was the reverse of the encoding procedure.

b. Uses. Slidex was used to encode only secret portions of messages, not the entire text. It was used extensively in reporting coordinates of various installations and designation of future movement. It was employed to the greatest extent in corps artillery headquarters but its use decreased until battalion level was reached where it was used very seldom for intra-battalion traffic.

c. Comments by Using Troops.

Captain I. Sillins, Communication Officer, 10th Armored Division Artillery, said:

"Slidex was used only once: officers inclined to err. Repeats were numerous. Use discontinued after trial."

Lieutenant General P. T. Williams, Artillery Officer Third Army:

"Slidex is universally used by field artillery units with the Army. It supplements the prearranged message in battalions. An army key is used in addition to each unit's key, in order to provide a universal code between all artillery headquarters with the Army. Extensive liaison activity and rapid shifts of unit attachment made this necessary. The Army Signal Security Officer has been dissatisfied with the security afforded by Slidex because of its misuse--failure of message writers to follow instructions. Judging from reports by prisoners of war from enemy signal intercept units, Slidex was safe for no more than six hours, sometimes for much less time."

Artillery: Col H. V. Critz, formerly Executive Officer, 1st Division

"Slidex was too slow."

Artillery: Col L. T. Owen, formerly Executive Officer, 26th Division

"Slidex was probably the least cumbersome of our codes. We used it principally in traffic with division and corps artillery, seldom with the battalions. It was used principally for sending coordinates. The big drawbacks were that errors created great difficulties and the spelling out of long names was extremely hard."

Commanding Officer, 284th Field Artillery Battalion:

"We used Slidex extensively in traffic to group and corps artillery headquarters. It was a good code but required long experience and very frequent use before it could be employed rapidly."

d. Discussion. Slidex received a varied reception by the field artillery. In some units it was enthusiastically accepted and

widely used; in other units it was heartily condemned and never used except where absolutely required. If properly used by well-trained personnel it was a good code, but it did require long training and very careful use. An error in setting a courser or in reading a courser introduced a disproportionate amount of difficulty.

57. Prearranged Message Codes. Many kinds of prearranged message codes were used by field artillery units. These were employed to greatest extent within field artillery battalions. The need for a very short code of only a relatively small number of phrases which could be type-written on a sheet of 8 x 10 inch paper and carried folded in a pocket caused many units to develop their own codes. These codes consisted of 25 or 30 standard phrases to which were assigned two-letter code groups on a daily change basis. It was recognized that these codes had a low order of secrecy, but the redeeming feature was that the compromise of a battalion code did not effect codes in use by other units.

58. Map Codes.

a. Types. Map codes were undoubtedly the most numerous and most varied of the codes used by the field artillery. Formally the same system was used throughout the battalions of a division but there was little uniformity between divisions, and between battalions of non-divisional artillery. Above division artillery or group level Slidex was used consistently in traffic with corps artillery headquarters.

b. Enciphering of Coordinates. Although properly a cipher, but called a 'code' by common usage, was the practice of substituting letters for digits in discussing coordinates over radio and telephone. In one division each 1000-yard grid line was assigned a letter according to a prearranged sequence and the enciphered coordinates read directly from a map, as B6F8. Another division selected daily a ten-letter word in which no letter was repeated; these letters were then numbered from one to zero and after the numerical coordinates had been read, the letters were substituted, as - ECI. There were variations of both these methods but the principles were essentially the same.

c. Map Template Code. The map template code utilized a gridded sheet of transparent acetate which was placed over a prearranged reference point with the center over the point and the axis of the template coinciding with the x and y-grids of the map. The coordinates of the point to be designated were then read from the coordinates of the template. Various methods were used to designate the reference points. In one division villages were selected and names assigned to them; coordinates in this system were announced as - OMAHA I 87, OMAHA being the reference point, I being the square on the template, and 87 being the coordinates within the square. The map template code was not generally used, however, because it necessitated the carrying of the template which was a decided disadvantage for forward observers.

d. Point of Origin. Several units utilized a system of reference points for location of desired places. Prior to an operation a number of points such as villages, road junctions, bridges, etc., were selected and given a number. These would then serve as points of origin for rectangular coordinates to designate a particular location. For example, a house might be designated as - 74 right 1450 up 250, meaning that it was 1450 yards east of and 250 yards north of reference point number 74. This also had variations depending upon the unit using the code.

59. Impromptu Codes. Probably the lowest order of secrecy codes

in use were the impromptu codes used in emergencies by field artillerymen. Occasionally officers would find themselves forced to discuss matters over the telephone or radio which should have been encoded but had no simple, satisfactory code available. By reference to personal matters which were known only to a few it was often possible to carry on without a formal code. It was recognized that such impromptu codes had no appreciable secrecy value and their use was discouraged.

SECTION 3

CIPHERS

60. M-209 Converter.

a. Characteristics. The only cipher device used by field artillery units was the M-209 Converter. The following is quoted from TM 11-38C:

"Converter M-209-(*) is a small, compact, hand-operated tape-printing, mechanical device designed for rapid enciphering and deciphering of tactical messages. When properly set and operated, it will encipher a plain text message of any length, automatically printing the enciphered text on a paper tape in 5-letter groups; or it will decipher a message that has been previously cryptographed by another Converter M-209-(*), printing the clear text on a paper tape with proper spacing between words."

b. Uses. The M-209 Converter was issued to all headquarters of battalion and higher echelons. It was intended to be used in the message centers to encipher and decipher all traffic other than fire direction and urgent tactical traffic which had to be cryptographed.

c. Comments by Using Troops.

Captain Z. Stockton, Commanding Officer 9th Armored Division Artillery, stated in answer to a question as to how often the device was used by his unit:

"Constantly. One set up on Division Signal Operations Instructions; changed daily. All administrative traffic and the longer tactical messages, went on these converters. Slidex used for shorter tactical messages."

Brigadier General E. T. Williams, Artillery Officer, Third Army, answered the same question by stating:

"M-209 has seldom been used in artillery units throughout the war with the two exceptions of traffic between Army Artillery and Corps Artillery Headquarters. If much traffic were handled by M-209 in Corps Artillery and lower levels, a material increase in cryptographic personnel and devices would be required."

Message Center Chief, 241st Field Artillery Battalion:

"We used the M-209 a lot in combat for administrative messages. We liked it."

d. Discussion. The M-209 Converter, like many other items of equipment, met a varied reception in the field artillery. Some units used it extensively and were well pleased with it. Other units did not use it to a great degree and did not like it. It is believed

that the degree of satisfaction with this instrument depends very much upon the amount of experience in operating it. Where code clerks were well trained in its use and used it frequently, they were well satisfied with it.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

SECTION 1

CONCLUSIONS

61. Wire Communication.

a. Personnel.

- (1) That field artillery wire crews maintained wire communication satisfactorily between units.
- (2) That field artillery wire crews were undermanned and of insufficient number.
- (3) That although wire communication was maintained, there was not sufficient margin of safety in wire-crew reserve and stamina to protect against a serious communication failure.

b. Types of Wire.

- (1) That wire, W-110-B, was satisfactory although improvement in conductivity and strength of insulation is desirable.
- (2) That wire, W-130-A, was satisfactory as far as conductivity and weight were concerned but was unsatisfactory as far as insulation and tensile strength were concerned; and that it was suitable only for local circuits within command posts.
- (3) That wire, U-143, had sufficient conductivity but insufficient tensile strength, poor insulation, and was hard to handle; and that it was issued in lieu of wire W-110-B.
- (4) That Spiral-4 cable had excellent conductivity and insulation but was bulky, heavy and difficult to repair.
- (5) That field artillery units had need for and carried much more than the authorized allowance of wire.

c. Field Telephones.

- (1) That the field telephone, EE-8(*), was a satisfactory instrument from the standpoint of ruggedness and signal strength when used within its rated limits; that it was not sufficiently weatherproofed and could be improved by a device for cutting out the ringer.
- (2) That the EE-8(*) telephone was not adequate for com-

munication over long lines and special equipment (EE-89-A repeater) had to be used.

- (3) That units required from five to ten more telephones than were authorized.
- (4) That commanders did not, generally, favor the addition of sound-power telephones to the field artillery tables of equipment.

d. Switchboards.

- (1) That the switchboards, BD-71 and BD-72, are too large and heavy; that each contains an insufficient number of drops; and that parallel operations of more than two boards was difficult.
- (2) That the Telephone Central Office Equipment, TC-4 was a satisfactory item of equipment and was suitable for use in higher artillery headquarters.
- (3) That an increase of one 12 or 18-drop switchboard per headquarters above the firing battery is indicated.
- (4) That there are advantages to be found in the use of cordless type switchboards by field artillery units.

e. Wire-Laying and Wire-Recovery Equipment.

- (1) That the reel, RL-39, and the axle, RL-27, are satisfactory and are issued in proper quantity.
- (2) That the reel, RL-31, was satisfactory except for a tendency to break near the hinge, and that it was issued in proper quantity.
- (3) That the reel unit, RL-26, was generally satisfactory but would be improved by the substitution of a more powerful and rugged motor.
- (4) That the 1/4-ton and 3/4-ton vehicles with RL-31 reels mounted are satisfactory wire trucks for front line units and that the 2-1/2 ton truck short wheel base with reel unit, RL-26, is satisfactory as a wire truck for higher echelon communication nets.
- (5) That the authorization of wire trucks was insufficient and hampered the speedy installation of wire nets.

f. Teletype.

- (1) That the teletype equipment as used in certain corps artillery headquarters was large and heavy and not adapted to use in lower echelons.

g. Telegraph.

- (1) That the telegraph set, TG-5, was an unsatisfactory item of equipment.
- (2) That simplex wire circuits were utilized for simplex telephony whenever they could be installed.

- (3) That wire telegraphy was not used in combat in the European Theater of Operations by Field Artillery units.

62. Radio Communication.

a. Frequency-Modulated Equipment

- (1) That the SCR-608 was not satisfactory in respect to range, size, weight, weatherproofing, and power supply; it was satisfactory as far as fidelity, stability, and ruggedness were concerned.
- (2) That the SCR-610 was unsatisfactory from a standpoint of range, size, weight, power supply, and line-of-sight characteristics; it was satisfactory in regards to fidelity and stability.

b. Amplitude-Modulated Equipment.

- (1) That the SCR-536 was a satisfactory radio set for forward observer and survey party use.
- (2) That the SCR-284 radio was unsatisfactory in all respects.
- (3) That the SCR-193 was satisfactory in respect to range, fidelity, stability, and ruggedness; that reduction in size and weight, which will not reduce range is indicated; that the power supply in static operation is not satisfactory.

c. Miscellaneous.

(1) Procedure.

- (a) That the radio procedure used by the field artillery was satisfactory.

(2) Frequency Allocation.

- (a) That frequencies were properly allocated. That corps artillery battalions need only two frequency-modulated frequencies and that division artillery battalions can operate on two but need three or four frequencies.

(3) Organization of Nets.

- (a) That nets were satisfactory but the addition of one more net for corps artillery headquarters, for liaison officers, is needed.

d. Supply of Radio Equipment.

- (1) That the supply of spare parts and of batteries was not satisfactory during combat.
- (2) That the authorized quantity of radio sets was not adequate.

63. Visual Communication.

a. Air-Ground Communication.

- (1) That the only use made of visual means of air-ground communication was the use of fluorescent panels for identification of front-line troops and vehicles to aircraft.

b. Pyrotechnics.

- (1) That pyrotechnics were very seldom used in calling for prearranged fires.

64. Sound Communication.

a. That sound communication was not used to an appreciable extent by the field artillery in this theater.

65. Codes and Ciphers.

a. General.

- (1) That signal security was unsatisfactory in the field artillery in this theater.

b. Codes.

- (1) That Slidex was used to a great extent, but that it was not sufficiently secure because of misuse.
- (2) That short prearranged message codes were necessary in lower units, but that there was little uniformity among them.
- (3) That many map coordinate codes were employed with little uniformity between systems.

c. Ciphers.

- (1) That the M-209 Converter was a satisfactory cipher device.

SECTION 2

RECOMMENDATIONS

66. Wire Communication.

a. Personnel.

- (1) That wire crews be authorized on a strength-principle of no less than the following:
 - (a) For 1/4-ton wire vehicles--one driver, one corporal, one lineman.
 - (b) For 3/4-ton wire vehicles--one driver, one corporal, four linemen.
 - (c) For 2-1/2 ton wire vehicles--one driver, one sergeant, one corporal, five linemen.
- (2) That authorization for wire crews follow a principle that there be one more crew than the number of subordinate units normally served by the superior unit.

b. Types of Wire.

- (1) That wire, W-110-B, be continued as the basic type of field wire, but that research be continued to improve conductivity, strengthen the insulation, and reduce the weight.
- (2) That wire, W-130-A, be used only for local installations within command posts and that development of a suitable light field wire be continued.
- (3) That the use of wire, W-143, by field artillery units be discontinued.
- (4) That Spiral-4 cable not be included in field artillery tables of equipment.
- (5) That efforts be directed toward development of a wire which will combine the desirable characteristics of W-110-B and W-130-A, plus added conductivity, in order to reduce the number of types of wire in use to one general purpose wire satisfactory for installations in forward and rear areas.
- (6) That table of equipment allowances of wire be doubled for all units and W-110-B authorized in place of all but two miles of W-130-A.
- (7) That sufficient transport be added to carry the additional wire recommended above.

c. Field Telephones.

- (1) That the field telephone, EE-8(*), be continued as a standard item of issue for field artillery units until such a time as the development agencies can produce an instrument comparable in ruggedness and signal strength, lighter and smaller, with better weatherproofing, and incorporating a device for cutting out the ringer.
- (2) That field artillery units down to and including battalions be provided with three telephones specifically designed for use on wire lines in excess of the range of the EE-8(*) telephone.
- (3) That the authorization in tables of equipment for field telephones be increased as follows:

For battalions by	-	5 telephones
For units above battalion by	-	10 telephones
- (4) That sound-power equipment not be included in artillery tables of equipment.

d. Switchboards.

- (1) That a new switchboard be developed to replace the BD-71 and BD-72 type equipment. That this new type be of light weight, smaller than the present type, weatherproof, and of an 8-drop and 18-drop size.
- (2) That the Telephone Central Office Equipment, TC-4

be continued in authorization for higher headquarters.

- (3) That one more switchboard of the B-72 type be authorized all headquarters of battalion and higher level.
- (4) That research be conducted to determine the feasibility of cordless switchboards for artillery use.

e. Wire-Laying and Wire-Recovery Equipment.

- (1) That the reel, RL-39, and axle, PL-27 be continued in authorization.
- (2) That the reel, RL-31, be continued in authorization, but that it be of more rugged construction.
- (3) That the reel unit, RL-26, be continued in authorization, but that development be continued to improve the motor and reduce the weight.
- (4) That all 2-1/2 ton wire trucks be equipped with the reel unit, RL-26.
- (5) That the number of wire trucks be authorized as follows:

	1/4 Ton Truck w/RL-31	3/4 Ton Weapon Carrier w/RL-31	2-1/2 Ton Truck w/RL-26
FA Btry	1	1	
FA Btry FA Bn (Corps Arty)		3	1
(Div Arty)	3	3	1
Hq Btry FA Gp		3	2
Div Arty		3	2
Corps Arty		2	5

- (6) That all units above battery level be authorized one 2-1/2 ton short wheel base truck for signal supply truck.

f. Teletype.

- (1) That research be continued to develop a small, compact teletype for experimental use in artillery units down to battalion level to determine its value to the artillery.

g. Telegraph.

- (1) That telegraphy as an agency of communication for field artillery units be discontinued.

67. Radio Communication.

a. Frequency-Modulated Equipment.

- (1) That continued efforts be directed toward the development of a radio set which will be smaller, lighter, and better weatherproofed than the SCB-608 with the same characteristics as to fidelity, stability, and ruggedness but with a minimum voice range.

of 15 miles. That provisions be made for connection to power supply separate from the vehicle in static operation.

- (2) That continued efforts be directed toward the development of a radio set to replace the SCR-610. That this new set have the same characteristics as the SCR-610 as far as fidelity and stability are concerned. That it weigh not more than 35 pounds, be well adapted for packboard operation, and have a self-contained power supply permitting operation on the march. That it have four preset, crystal-controlled frequencies which can be selected by turning a switch on the control panel. That it also have a hand-operated generator to be a separate load. That it have an operating range of ten miles.

b. Amplitude-Modulated Equipment.

- (1) That the SCR-536 be continued in its present authorization.
- (2) That the SCR-284 be dropped from authorization for field artillery use.
- (3) That continued efforts be directed toward reduction of size and weight of the SCR-193, but that there be no reduction of its present operating characteristics. That provisions be made for connection to a source of power separate from the vehicle for static operation.

c. Radio Procedure.

- (1) That the present radio procedure, as laid down in current field manuals, be continued.

d. Frequency Allocation and Organization of Nets.

- (1) That battalions of corps artillery be allocated two frequency-modulated channels for battalion nets.
- (2) That battalions of division artillery be allocated at least two frequency-modulated channels with one or two additional channels being allocated if the available number will permit.
- (3) That corps artillery headquarters be allocated one additional amplitude-modulated frequency for use in a liaison officer net.
- (4) That except for (2) and (3) frequencies be allocated in the future as they were in the past.

e. Supply of Radio Equipment.

- (1) That the method of handling spare parts and replacement parts be investigated with a view toward avoiding future shortages such as existed in this theater.
- (2) That, upon completion of revision of tables of or-

ganization for all units, new authorizations of radio equipment be made to agree with requests for increased quantities of sets.

68. Visual Communication.

a. Air-Ground Communication.

(1) That, although not employed in this theater, visual air-ground communication methods not be abandoned by the field artillery but continue to be taught as emergency means.

b. Pyrotechnics.

(1) That, although not employed to an appreciable extent in this theater, pyrotechnics continue to be taught as an emergency means of communication.

69. Sound Communication.

a. That, although not used in this theater, sound communication continue to be taught as a means of communication.

70. Codes and Ciphers.

a. General.

(1) That continued efforts be directed toward making all artillerymen thoroughly signal security conscious.

b. Codes.

(1) That Slidex be retained in the field artillery.

(2) That a uniform type short prearranged message code be developed.

(3) That a uniform map coordinate code be developed.

c. Ciphers.

(1) That the Converter M-209 be continued for field artillery use.

Bibliography

1. XII Corps Artillery Combat, September 1945, File 37.2, Artillery Section, The Theater General Board.
2. Report of Special Board appointed to Review Developments in Field Artillery, Field Artillery School, Fort Sill, Oklahoma, 1 December 1944. Artillery Section, The Theater General Board, File.
3. Report of Army Ground Force Equipment Review Board. Artillery Section, The Theater General Board, File.
4. Letter, Headquarters XII Corps Artillery, AG 311.3, subject: Field Artillery Wire Communication. Artillery Section, The Theater General Board, File.
5. Letter, Headquarters XII Corps Artillery, AG 311.23, subject: Field Artillery Radio Communication. Artillery Section, The Theater General Board, File.