THE GENERAL BOARD

United States Forces, European Theater

SIGNAL CORPS OPERATIONS

MISSION: Prepare a Report and Recommendations for Submission to the Theater Commander on Signal Corps Operations in the European Theater.

The General Board was established by General Orders Number 128, Headquarters, European Theater of Operations, United States 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.

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THE GENERAL BOARD
UNITED STATES FORCES, EUROPEAN THEATER
APO 408

SIGNAL CORPS OPERATIONS

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CHAPTER 1

RADIO

SECTION 1

FREQUENCY ALLOCATION FOR COMBINED OPERATIONS[1]

1. General. a. The development of a workable frequency allocation system to meet the needs of large naval and field (air, ground and service) forces in a Combined Theater of Operations of limited initial operational area is a difficult problem. This holds true even when the types of transmission, power ratings and frequency bands of the transmitters of but two nations are considered, and those nations speak a common language and employ common procedures.

b. It is entirely possible that at some future date we may be called upon to take part in combined operations involving a greater number of complicating factors than those encountered in the European Theater. These factors may include, possibly, operations in areas where of necessity radio will assume a major role in the signal communications scheme; a greater number of nations may be involved in the combat area; transmitters of considerably greater power than now used may be employed, etc. For this reason a brief study of the frequency allocation system employed in the European Theater of Operations, under conditions as outlined in subparagraph a. above, will be here considered.

c. This consideration does not include the system employed by DRAGOON forces in their advance from the south of France as no major problems was presented to them prior to their juncture with OVERLORD forces. When this juncture was made the system here outlined became applicable to them as well.

ALLIED EXPEDITIONARY FORCE FREQUENCY ALLOCATION SYSTEM

2. Basis for System. a. According to the "History of Frequency Allocation for Field Forces in the European Theater of Operations between September, 1939 and May, 1944", published by the Signal Division, Supreme Headquarters, Allied Expeditionary Force, the basis upon which the system ultimately adopted was developed was an existing British system. In general, it consisted of the allocation of lists of specific frequencies to General Headquarters, the various British Corps, the Royal Air Force, etc., and further subdivision of, and reallocation from these lists by the initial holders thereof where required.

b. Unfortunately at the time this system was introduced, the promulgators thereof did not envisage:

(1) The tremendous future increase in the use of radio by ground and air forces.

(2) Application of the system to large forces operating in a relatively limited area.

(3) The requirements of highly mobile warfare.

(4) The introduction of army group headquarters, each with major requirements for frequencies to be worked with considerable power.

(5) The close coordination required of allied forces in combined operations.

c. Despite the drawbacks outlined above, none of which was considered insurmountable, the system was adopted

by Headquarters COSSAC (Headquarters, Chief of Staff, Supreme Allied Command), the original planning headquarters, as a basis for the proposed Allied Expeditionary Force system. Development of the system was later taken over and carried on to completion by Supreme Headquarters, Allied Expeditionary Force.

3. System Fundamentals. a. Only those portions of the radio frequency spectrum of concern from an operational standpoint were considered. Frequencies required by the British government to meet its minimum needs and certain other frequencies serving essential war purposes were first earmarked. Usable operating frequencies were then designated throughout the frequency bands under consideration. A five kilocycle spacing usually separated designated frequencies, and only frequencies which were an exact multiple of five were generally used. Deviations were of course necessary in designating frequencies in the vicinity of earmarked frequencies which did not themsevles fall on an exact multiple of five.

b. Next, the area involved (the southern portion of the United Kingdom, the northwest section of France, and contiguous sea areas) was divided into zones. These nonuniform rectangles were arrived at from a study of operational plans, available propagation data, etc. Each zone was designated by a letter of the alphabet, no duplication being involved.

c. Finally, users were allotted frequencies based upon a study of bids submitted versus available frequencies, with restrictions being placed on the zone (or zones) in which they might be used and a maximum power that could be employed. The initial allocation to any user was known as his bulk allocation.

4. Bidding for Frequencies. The total number of usable frequencies available for the operations having been determined, prospective users were invited to bid for their estimated requirements in terms of band limitations (a specific frequency was rarely bid for), maximum power, and zone(s). Complete justification for the defense of each bid, together with a statement of possible alternative solutions in the event the bid was rejected or only partially accepted, accompanied all requests.

5. Bulk Allocation. a. The Combined Signal Board, Allied Expeditionary Force, which was responsible for the allocation of frequencies, found itself confronted with an expected situation; bids exceeded available frequencies in the ratio of three to one. To further complicate matters the Ninth Air Force, which had been represented in the initial bidding by 2 Tactical Air Force (British), submitted revised bids still further increasing the disparity between estimated requirements and available frequencies. However, after repeated conferences between interested parties and frequent meetings of the Frequency Allocation Sub-Committee of the Combined Signal Board, a workable solution was finally arrived at and published as Appendix D to Part I, Signal Instruction, Operation "OVERLORD".

b. Insofar as possible, allocation to each major user was made in the largest possible blocks of consecutive frequencies in order to facilitate the clearing of interference. Sharing of frequencies between users was held to a minimum. Such sharing was limited to certain frequencies (largely those restricted to low power operation) employed by army groups in the ground forces and between certain units of the tactical air forces. This sharing was not only necessary but entirely permissable in view of the separate operational areas involved, the restrictions imposed by the zoning system, and the use of separate frequency lists by adjacent major commands such as divisions.

6. Frequency Lists. a. Upon receipt of a bulk frequency allocation, a major user then had to break it down into the required number of frequency lists, each unique as to frequencies, for further distribution to interested subordinate users. In the case of the ground forces such lists permitted the changing at a given time of all frequencies in use by a major unit such as a division. The time of changing was controlled by higher authority. This control was essential from a signal security standpoint as frequencies oftentimes had to be changed due solely to a change in physical location of a unit.

b. Frequency lists for the ground forces were jointly prepared by the two army group headquarters (British and American) engaged in planning. Lists were required for army group, army and corps headquarters (and the organic troops of each), for infantry and armored divisions, for anti-aircraft artillery and engineer units, etc. Due to the limited bulk allocation received, the number of lists of each type had to be held to a minimum. In some cases, due to differences in frequency bands of related British and American transmitters, separate lists to serve the same purpose were required. However, in the majority of cases where this problem arose, a list suitable for combined use could be evolved by proper "padding" with a few additional frequencies. In the preparation of the lists certain frequencies not too urgently needed were exchanged for others considered absolutely essentiel. This was accomplished by direct negotiation with the original holders of the desired frequencies with the concurrence of the Combined Signal Board.

c. The assault phase of the operation required the preparation of certain special lists to meet the particular needs incident thereto. These were prepared by a Joint Signal Board set up at Headquarters 21st Army Group which included representatives of all major users. The lists were made up of frequencies from the regular lists which would not be required for normal use until after the assault phase.

7. Changes in System. With the following exceptions, few changes in the system or in its application were made during the operation:

a. The discontinuance of zoning once the area originally zoned on the Continent had been liberated. Experience proved zoning to be of value only during operations in a limited area.

b. Reduction, insofar as practicable, of the designated frequency spacing in the one point five (1.5) to four (4) megacycle band from five to four kilocycles, in order to provide additional frequencies in this overcrowded band.[1]

c. Increased sharing on a non-interference basis of certain frequencies authorized to operate at considerable power.

d. Issuance of a bulk allocation to the First Allied Airborne Army upon its inception. The required frequencies for this allocation were made available partially from the results obtained by changes listed in subparagraphs b, and c, above, and partially from frequencies held in reserve by, or which had reverted to the control of, the Combined Signal Board. (Similar action was not taken in the case of 6th Army Group and First Provisional Tactical Air Force upon their juncture with OVERLORD forces. Ground and air force lists already in use by them were equally applicable).

COMMENTS ON SYSTEM (See Also Appendix 1)

8. General Comment. The following quotation[2], although referring to the period from September 1939 to May 1944, is believed to carry equal weight now that operations are concluded and the system no longer in use:

"On the whole, the method as it now stands, operates satisfactorily for Allied Expeditionary Force purposes, though the constantly increasing frequency demands for civil, diplomatic and operational commitments is placing the severest strain on the system, with the result that cases of interference are increasing daily. It is, therefore, only a question of time before either a new system has to be found to permit an increased sharing, or a drastic reduction is made in the scale of provision of radio facilities through the entire Allied Expeditionary Force.

"So far as can be foreseen, at present, there is no other method which will meet the essential requirements of --

(1) Extensive controlled duplication of frequencies to meet all commitments.

(2) Sufficient flexibility to meet, without undue mutual interference, the quick frequency changes necessitated in mobile operations.

"There is therefore only one immediate solution to the existing congestion of the spectrum and that is a severe limitation in the provision of radio facilities. Had, however, more thought been given and more vision applied to the question of the initial provision of radio facilities, the position could have been ameliorated by an intelligent use of bands outside 2 - 8 megacycles.

"It is considered that the future solution of the problem of frequency allocation must lie in the design of radio equipment and allocation of separate bands for specific field purposes. There is, for example, no reason why man-pack sets for infantry purposes, or tank radio equipment, should be within the 2 - 8 megacycle band. In this respect the medium and Very High Frequency bands have been practically ignored by the British Army for widespread communication purposes. With increased knowledge of technical design and propagation characteristics, it should be possible to spread the radio communication commitments more widely throughout the spectrum and so materially reduce congestion in certain limited bands."

9. Unnecessary Retention of Frequencies.[3] An undersirable practice existed during operations which tended to nullify some of the benefits of the allocation system. Holders of frequencies who were located in areas well to the rear of the combat zone would insist on retaining frequencies, once they had been assigned to them, long after the status of wire and Very High Frequency radio relay communication had reached the point where radio communication could have been eliminated. The result of this was the unnecessary employment, or worse still, retention without use, of frequencies which could well have been used by organizations closer to the front.

10. Simultaneous Call Sign Frequency Change. The security potentially offered by the Single Call Sign Method was materially lessened by the fact that frequencies were not changed often enough. The ideal method would be a system wherein frequencies and call signs were changed frequently and simultaneously. Experience demonstrated that to accomplish this from a frequency standpoint would require many times the number of frequencies available.

11. Conclusions. It is concluded that:

a. The system of frequency allocation employed in the European Theater of Operations was satisfactory, and, all factors considered, the best system for the size and type of operation undertaken.

b. Future application of the same, or a similar system, can only be improved by:

(1) A decreased use of radio, with its corollary of increased use of wire and radio relay facilities.

(2) An increased, or better distributed, use of the radio frequency spectrum.

12. Recommendations. It is recommended that:

a. A continuing study be made of the various systems of frequency allocation available to determine the best system for use by the Army alone or in a joint or combined operation, considering such factors as characteristics and probable area distribution of transmitters, non-available frequencies, possible allies and associated factors, etc.

b. The development of multi-channel wire facilities and multi-channel radio relay sets (employing frequencies in the VHF, UHF and SHF bands) be given high priority, in the hope of lessening requirements for the use of medium, high and very high radio frequencies.

c. Any development program for radio sets other than beamed line-of-sight equipment have as one of its main objectives the distribution of frequency demands uniformly throughout the usable portion of the frequency spectrum.

NOTES:

1. See also "Report of Signal Division, Supreme Headquarters, Allied Expeditionary Force, Operation OVERLORD".

2. From the "History of Frequency Allocation for Field Forces in the European Theater of Operations between September 1939, and May 1944," published by the Signal Division, Supreme Headquarters, Allied Expeditionary Force.

3. Paraphrased from an "Analysis of Signal Problems", Signal Officer, Advance Section, Communications Zone.

SECTION 2

ORGANIZATION FOR CLEARANCE OF RADIO INTERFERENCE[1]

13. General. a. Operation "OVERLORD" required the concentration and use of an unprecedented number of radio transmitters, with power ratings ranging from a few watts to one-half kilowatt and higher, in a relatively small area. Initial planning called for a spacing between adjacent allocated frequencies of five kilocycles, a spacing known to be uncomfortably close for mobile field operations in a limited area. This spacing had to be reduced to four kilocycles in the one point five to four megacycle band in order to accomodate all transmitters whose operation was limited to this band or a portion thereof. These included a great number of transmitters operating at four hundred watts or higher power. This situation alone was expected to produce considerable interference irrespective of enemy use of the radio spectrum.

b. Cases of enemy interference, either planned or incident to normal hostile radio communication, were to be expected and did occur to a limited degree. A change of frequency by one or the other of the interfering transmitters was the only possible remedy. Short of this, an unsuccessful

attempt to copy through the interference meant a temporary shutting down of a friendly radio channel. In this section there will be considered only the measures taken to avoid mutual interference between friendly stations since, as indicated, intentional or accidental interference from enemy stations could only be remedied by shifting frequency.

14. Minimizing Interference. a. The Mutual Interference Sub-Committee of the Combined Signal Board was established during the planning phase of the European operation to study the radio interference problem. The committee was also charged with making recommendations as to organization and procedures for the elimination of actual cases of interference. Most of the committee's work proved to be in connection with this latter requirement.

b. A well planned and supervised system of frequency allocation proved to be a prime requisite in minimizing interference. Experience demonstrated that, beyond this, little could be done other than to require strict observance of the following rules which were established by The Combined Signal Board, Supreme Headquarters, Allied Expeditionary Force:

(1) The number of nets set up should be held to a minimum; to accomplish this, maximum use must be made of other signal communication means.

(2) No frequency other than an authorized frequency should be employed.

(3) The exact assigned frequency should be maintained.

c. The last of the above rules is one which deserves special attention. Frequent checking of the frequency of the radiated wave of all non-crystal-controlled transmitters of any appreciable power is essential to detect the characteristic frequency drift to bring transmitters back into line.

15. Organization to Eliminate Cases of Interference. a. Prior to "D" Day the Mutual Interference Sub-Committee arranged for and observed a series of exercises and tests involving both British and American radio and radar transmitters and receivers. As a result of recommendations based on these exercises and tests, the Combined Signal Board established the following organizations whose purpose was either to render advice in connection with frequency interference problems or to supervise the use of the radio spectrum with a view to locating and reporting cases of interference:

(1) Combined Counter Measures Advisory Staff.
(2) Interference Advisory Staffs.
(3) Radio Monitoring Terminal.

b. A detailed discussion of the functions of these organizations is contained in Technical and Training Instructions II/5/1, "Methods to be Adopted for Control of Radio Countermeasures and Clearance of Interference Experienced by Radio Communications and Radar", published by the Signal Division, Supreme Headquarters, Allied Expeditionary Force, 2 June 1944.

16. Interference Clearance Procedures. a. The policy of Supreme Headquarters, Allied Expeditionary Force, directed that cases of interference would be reported through technical (Signal) channels, while action to clear a case of interference would be handled as an operational matter through command channels. Clearance action was to be initiated by the lowest superior headquarters competent to take action in the case.

b. Implied in the above policy was the principle that only those cases of interference in which the source of interference could not be identified or in which the offended station did not feel competent to take action, or was unable to obtain satisfactory action, were to be reported through technical channels (together with all information which might be of value to the ultimate clearing authority). In all other cases, direct contact was to be made with the (assumed) offender, with the object of eliminating the interference at the earliest possible moment.

c. The provision of both "direct contact" and "channels" procedures proved to be highly satisfactory. It is estimated that better than ninety percent of interference cases were handled by direct contact. Interference reporting agencies soon became adept at selecting the appropriate headquarters in the chain of command to which to submit interference reports. Such reports were sent by direct electrical means and followed up by the required written report through technical channels. This resulted in a great saving of time. Similar action in the case of interference from an unidentified station was taken with an immediate report by electrical means being made direct to the Signal Division, Supreme Headquarters, Allied Expeditionary Force.

17. Conclusions. a. The procedures established by Supreme Headquarters, Allied Expeditionary Force, for clearing friendly radio interference proved sound.

b. The time factor dictates the use of direct contact rather than military channels procedure whenever possible. Where the latter must be used, the nearest approach to direct contact procedure possible should be employed; immediately thereafter a "follow up", adhering strictly to military channel procedure and including a statement of action taken and current status of the case, should be initiated.

c. Organizations established to assist in clearing friendly radio interference were satisfactory. They contributed greatly to the clearance of "channel report" type cases of interference as well as to cases reported by the Radio Monitoring Terminal, and furnished valuable advice on interference problems on numerous occasions.

d. The problems of clearance of friendly radio interference can be greatly ameliorated by attacking them at their source: by holding frequency requirements to a minimum, by providing a frequency allocation system designed to best meet the situation, and by insuring that all transmitters stay within designated minimum tolerance of their assigned frequencies.

18. Recommendations. It is recommended that: a. The employment of procedures and organizations for the clearance of friendly interference similar to those employed in the European Theater of Operations be seriously considered for use in any future operations of sufficient magnitude to warrant their use.

b. In any future major operations, friendly radio interference (and associated clearance) problems be held to a minimum by strict application of the principles enumerated in subparagraph 17d, above.

NOTE:

1. See also Chapter XI, Signal Instruction, Part 1, Operation "OVERLORD" and Annexure "E" to "Report of Signal Division, Supreme Headquarters, Allied Expeditionary Forces."

SECTION 3

SECURITY MONITORING[1]

19. Types of Monitoring. a. The term "monitoring", as used herein, is limited to the interception of recording of radio transmissions. Direction finding (that is, the location of a radio transmitter by bearings taken from two or more locations on the source of wave emanation) is a form of monitoring and furnishes additional information to that obtained from monitoring by interception. However, the personnel and equipment necessary to carry on direction finding activities can only be justified for the purpose of obtaining radio intelligence from enemy transmissions. In the case of friendly transmissions, the physical location of the transmitter is of no great importance; information as to the location of the headquarters such transmitter serve can, if not already known, be readily obtained by other means.

b. Monitoring of military radio channels is done for one of three purposes:

(1) To obtain information from enemy transmissions, both from a quality (content) and quantity (volume and direction of flow) standpoint.

(2) To obtain information as to the existing tactical situation from the transmissions of our own radio stations, usually those of subordinate or immediately adjacent units.

(3) To obtain information as to security violations committed by our own transmitting operators, in order that corrective action may be taken.

20. Monitoring Specialization. a. Operations in the European Theater demonstrated the fact that any given monitoring installation could, over a limited period of time, successfully concentrate on only one of the three types of monitoring above indicated and further, that each such installation would produce the best results if it continually specialized in only one type. This, of course, does not void the basic rule that a receiving operator will promptly report to his immediate superior any violation of radio transmission security coming to his attention.

b. The Signal Radio Intelligence Company is charged with the secondary mission, among other duties, of "intercepting friendly signal communication for the purpose of discovering violations of signal security or other regulations" (FM 11-5). Neither the regularly organized company, which was employed at theater, army group and army level, nor the companies especially authorized for corps' use, devoted any considerable amount of time or effort to fulfilling this particular part of their mission. They were all fully occupied in striving to accomplish their primary mission, that of intercepting enemy transmissions.

c. Staff Information and Monitoring Companies[2] (SIAN Companies) were a British institution adopted by American forces in the Mediterranean Theater and subsequently authorized for employment in the European Theater on the basis of one company per army. Their primary radio intelligence mission was the monitoring of friendly radio transmissions for the purpose of obtaining information as to the current tactical situation with the secondary mission of monitoring friendly transmissions to detect security violations. While the Seventh United States Army was the only army to have extensive experience in their employment in the

European Theater, enough was learned of their use to definitely indicate that their secondary security monitoring mission will be neglected in an effort to accomplish their primary mission.

21. Radio Security Responsibility. Each unit commander whose organization is equipped with one or more radio transmitters is responsible for training his operators in transmission discipline and radio security, and for any violation of signal security chargeable to a transmitting operator under his command. This basic principle of command, while fully applicable from a training standpoint, can only reasonably be applied from an operational standpoint to the extent that the commander is furnished, directly or indirectly, with the necessary means of supervision, i.e., monitoring equipment and personnel.

22. Value of Security Monitoring. a. While the detection of signal security violations by means of security monitoring would appear at first glance to be retroactively effective only, the direct value of such monitoring is the speedy location and reporting of violations in order that future violations will not occur. Of indirect, but much greater, value is the fact that a belief on the part of radio operators that their transmissions are being monitored reduces signal security violations to a minimum. Carelessness and indifference are engendered by lack of supervision.

b. The above was clearly demonstrated in operations in the European Theater. It is believed that the whole problem of radio security received less attention prior to and during the campaign than it warranted, and that the provision of adequate means for security monitoring would have greatly improved the radio security situation.

23. Current Security Monitoring Facilities. a. Disregarding certain facilities and equipment incorporated in the Signal Radio Intelligence Company and the Staff Information and Monitoring Company for the reasons given in paragraph 20, it would appear that no units equipped with radio transmitters (or not so equipped) are provided with personnel or equipment intended for the specific purpose of security monitoring.

b. A limited amount of security monitoring was possible during operations at times when the situation was static and wire communication facilities had been built up to the point where certain radio operators and equipment could be diverted to this purpose. However, the value of security monitoring is much less under these conditions than it is at times when all available radio channels are in operation and carrying a heavy traffic load.

c. Only limited security monitoring facilities were available in the European Theater and these were used for spot checking purposes; a particular net being monitored for a period of time and reports of the results obtained made to the unit commander concerned. The limited value of such monitoring was further reduced by the fact that the reports were in general routed through command channels and often required several weeks to reach the interested commanders. This delay made it difficult to investigate any security violation charges involved. To be of value, a security violation must be brought to the attention of the offending operator immediately.

24. Conclusions. a. Inadequate provision was made for security monitoring in the European Theater of Operations.

b. A definite need exists in the ground forces for units or teams whose primary mission is the monitoring of

friendly radio transmissions for security purposes. To provide such units or teams on the basis of twenty-four hour coverage of every frequency in use by our own forces is impossible and unnecessary. Coverage should be sufficient to make operators strongly conscious of the possibility of monitoring of their transmissions at any and all times.

c. Reports of security violations must be placed in the interested unit commander's hands in the minimum possible time.

25. Recommendations. It is recommended that:

a. A Radio Security Monitoring Company be authorized on the basis of one per field army, whose sole mission is the monitoring of frequencies in use within the army to which assigned.

b. That such a company have sufficient personnel and equipment to permit the simultaneous monitoring of at least five percent of all frequencies in use within a type field army.

c. That similar provision, on a theater basis, be made to provide for security monitoring of nets or links whose net control stations are located at headquarters senior to army headquarters.

d. That a procedure be established for placing security monitoring reports involving security violations in the hands of interested unit commanders and others concerned with minimum delay.

NOTE:

1. See also Appendix 2.

2. For information regarding the Staff Information and Monitoring Company, and recommendations as to the future Army Information Service, attention is invited to report submitted by Committee Number 34 on this subject, published by The General Board, United States Forces, European Theater.

SECTION 4

RADIO TELETYPE AND HIGH SPEED AUTOMATIC KEYING EQUIPMENT IN MILITARY COMMUNICATIONS

26. Use in European Theater. a. Neither radio teletype nor high speed automatic equipment was extensively employed in the European Theater of Operations, due solely in the case of radio teletype, to the limited quantities of equipment available.

b. Such radio teletype equipment as was available was of the fixed plant type and was not designed to withstand field usage. Hence it was in demand only by higher or semi-static headquarters. Radio teletype equipment was not stocked or cataloged as a unit but was an assemblage of a number of separate items serving as components of a workable equipment. Various combinations were possible to meet any particular fixed plant need.

c. The use of automatic keying equipment was limited to Supreme Headquarters, Allied Expeditionary Force, where both Creed and Boehme equipment was used, and to Headquarters Communications Zone, European Theater of Operations and three or four of the major headquarters. It was not generally used at any headquarters below Army Group level.

27. Radio Teletype. a. Among other high headquarters, radio teletype of the fixed plant type was employed by

Supreme Headquarters, Allied Expeditionary Force, Headquarters, Communications Zone, Headquarters, European Theater of Operations, and Headquarters, Sixth Army Group. In all using headquarters its' performance was adjudged very satisfactory.

b. At some lower headquarters, such as Headquarters Third United States Army, Headquarters XX Corps and Headquarters 3d Infantry Division, radio teletype equipment was improvised with results considered by the users to be eminently satisfactory. Improvisations were generally accomplished by the use of radio set SCR-399 in conjunction with carrier equipment CF-2.

c. A need was expressed throughout the European Theater for radio teletype equipment suitable for mobile field use. It was felt that if such equipment could be made compact enough and of sufficiently light weight, it would be of value down as far as battalions. The inclusion of security features which would permit the operator to type in clear text and have clear text copy appear on the receiving machine, while presenting enemy intercept only unintelligible material of a high degree of security, would greatly enhance the value of such equipment.

28. High Speed Automatic Keying Equipment. a. While experience with automatic keying equipment was limited in the European Theater, the following inherent disadvantages were recognized:

(1) Extra personnel for cutting tapes and transcribing recordings are necessary if the traffic handling capabilities of the equipment are to be realized.

(2) It is difficult to check back on transmission errors.

(3) It cannot pass relay traffic to, nor accept it from, a tape relay net station or a wire or radio teletype station, without a new transmitting tape being cut.

(4) It cannot relay traffic in its own system without a transmitting tape being cut.

29. Comparison. Radio teletype has several advantages over automatic keying equipment for widespread military communication use. It requires less operating personnel, is generally more flexible, is capable of handling more traffic, and can be better integrated in the overall communication system. On the other hand cases may arise where sufficient point-to-point traffic exists to warrant the use of high speed automatic keying equipment in preference to radio teletype.

30. Conclusions. a. Radio teletype is more suitable for general military communication use than high speed automatic keying equipment.

b. High speed automatic keying equipment may better meet a requirement for point-to-point service under a particular set of conditions.

c. Standard radio teletype equipment suitable for mobile field use by corps and lower headquarters was not available for operations in the European Theater.

d. An integrated cryptographic-radio teletype equipment of high security rating would greatly speed up delivery time traffic.

31. Recommendations. It is recommended that:

a. The development of radio teletype equipment suitable for general mobile field use as far forward as battalions be given a high priority.

b. Investigation of the possibility of integrating a security device of high security with a standard field teletype machine be undertaken if not already started.

c. Study of high speed automatic keying equipment to meet special needs be continued.

SECTION 5

APPLICATION OF RADIO RELAY SYSTEMS IN MILITARY COMMUNICATIONS[1]

32. General. a. The term radio relay system as used herein is defined as a radio circuit consisting of two terminal stations, with or without one or more repeater (relay) stations in tandem between them, operating in the "line of sight" frequency band and with the radiated energy beamed in the desired direction. Radio relay equipment is equipment which comprises a radio relay system to include, if a multi-channel system, equipment necessary to multi-channel operation, but excluding terminal telephone and/or telegraph operating equipment in all cases.

b. Present principle uses of a radio relay system are:

(1) As a point-to-point circuit providing one or more telephone and/or telegraph channels between two headquarters.

(2) To provide a section of a wire-radio relay communication route in a rapidly moving situation. In such instances it is used to fill gaps in the wire plant. A river crossing might exemplify such use. In this case, the radio relay section would be integrated with the adjacent wire sections.

(3) As an integral part of a theater's wire radio relay system. In this case, telephone and/or telegraph channels terminate on headquarters's switchboards and at other switching centrals in the same manner as do wire channels.

33. Systems Considered. a. Experience with standardized equipment in the European Theater of Operatons was limited to radio set AN/TRC-1 and radio set AN/TRC-6.

b. (1) Radio sets AN/TRC-1 were available in limited quantity on "1"-Day and were initially used to establish linking channels between the Allied Expeditionary Force wire system on the Continent and the United Kingdom military wire system. The AN/TRC-1 systems became available in increasing quantity throughout the campaign. Unfortunately, however, the supply never was sufficient to meet requirements, and adequate personnel trained in the operation of the equipment was never available.

(2) The AN/TRC-1 operates in the lower third of the very high frequency band, using frequency modulation. Similar to the AN/TRC-1, but having different quantities of basic components are terminal set AN/TRC-3 and the relay (or repeater) set AN/TRC-4. Four voice channels are obtained by the addition, at terminals, of carrier equipment CF-1 and 1,000 cycle ringing equipment (EE-101). A voice channel can be converted into four telegraph channels by the addition, at terminals, of carrier equipment CF-2. Multi-channel operation was normal procedure in the European Theater, giving two voice and four telegraph channels, plus one engineering voice channel per system.

c. (1) Radio sets AN/TRC-6 did not become available for field use until the closing months of the campaign and then only in very limited quantity.

(2) The AN/TRC-6 operates in the lower portion of the super-high frequency band, using pulse modulation.

Multi-channel voice frequency facilities are included as an integral part of the set. Eight voice channels are provided. A voice channel can be converted into four telegraph channels as in the case of the AN/TRC-1. Normal procedure in the European Theater was to reserve one voice channel as an engineering circuit.

34. Comparison of Systems. a. Relatively few officers in the European Theater had an opportunity to observe the operation of both systems under consideration. The concensus of opinions of those officers who did witness the operation of both systems is that the AN/TRC-6 was far superior to the AN/TRC-1. This opinion was based upon the greater number of voice channels available, the integration of multi-channel voice facilities and the increased security offered by pulse modulation operation in the super-high frequency band.

b. For use below army headquarters, it was the general opinion that the facilities offered by the AN/TRC-6 were in excess of requirements and that the weight and complexity of the equipment rendered its use between these lower headquarters less desirable than the use of the AN/TRC-1. For these same reasons, plus the difficulty of concealment, the AN/TRC-1 was not considered suitable for use below division headquarters.

35. Value of Radio Relay Systems. As a means of radio communication which can be integrated with the wire plant, radio relay systems demonstrated their adaptability in many communication problems encountered in the European Theater. They were employed principally to fill gaps in land lines which were frequently encountered in the rapidly moving situations which characterized the campaign. In many instances, their use as part of the wire-radio relay communication system extended down to include division headquarters. In some cases they constituted the sole means of telephone communication to certain units and in every circumstance demonstrated their reliability.[2]

36. Radio Relay System Security. a. There is no evidence available in the European Theater from which to determine the degree of security of the radio relay systems considered in this section, or of such systems in general. They can be intercepted; however, interception is not easy and presupposes the existence of many conditions which will rarely obtain concurrently. Nevertheless, in the interest of security, it must be assumed that interception can, and sometimes will, occur. The same problem exists, but to a lesser degree, in wire communication security.

b. Inasmuch as in a wire-radio relay system the radio relay sections are the weaker links from a security standpoint, the overall security of the system is lower than that of the radio relay sections considered alone. Before radio relay systems can be considered as being capable of one hundred percent integration with the wire sections of a wire-radio relay system, their security must be as great as, or greater than, that of the wire sections of the system.

37. Conclusions. a. AN/TRC-1 and AN/TRC-6 equipments demonstrated their value as a part of the theater communications system in the European Theater.

b. Much further development work can and should be done in this field.

c. A need exists for a radio relay system suitable for use within the division.

d. The security of radio relay systems should be the same as, or higher than, that of an associated wire system if the two types of systems are to be considered capable of

full integration.

38. Recommendations. It is recommended that development work on radio relay systems be given high priority, with special emphasis on the possible use of the higher frequency bands, and stressing:

a. The need for a system, or systems, suitable for use within the division.

b. The need for a security level equal to, or greater than, than of a wire system.

NOTE:

1. See also Appendix 3 for comments.
2. From "After Action Reports", 12th Army Group,

SECTION 6

ADEQUACY OF PERSONNEL AND EQUIPMENT AUTHORIZED UNITS FOR RADIO OPERATIONS

39. General. It is believed that insufficient radio personnel and equipment were authorized units engaged in operations in The European Theater to properly accomplish their radio operations mission. (See Appendix 4). The major causes of these deficiencies are covered in the succeeding paragraphs.

40. Equipment. a. Radio equipment authorized by War Department Tables was in some cases unsuitable for the type of operation which developed in the European Theater.

b. The supply of sufficiently powerful mobile radio sets was not adequate to meet the needs.

c. The sole use made of radio facsimile equipment within the European Theater (disregarding short-lived experimental usages) was by the air forces for transmission of weather maps. Although no shortages of equipment existed, technological faults and lack of familiarity with the sets were the primary reasons for limited use.

41. Expansion of Major Commands. Radio equipment and personnel are set up in War Department Tables to meet the estimated normal or "type" requirements. When a major command such as corps has assigned or attached to it units in excess of those considered in the preparation of the associated table, a shortage of radio equipment and personnel results with no authorized source available from which to meet the added requirements. In the European Theater, the expansion of all major commands to an abnormally large size was a common occurrence. This practice created shortages in radio personnel and equipment which were difficult to adjust.

42. Introduction of New Types of Equipment. With the introduction of new types of equipment in the European Theater, it was rare indeed for personnel familiar with its operation to be phased in at the same times. Generally the equipment was received first and its prompt use urgently indicated. To accomplish this, other activities would be stripped of personnel and transportation and emergency training of the "borrowed" personnel undertaken. This resulted in a necessary later reshuffling of personnel and transportation with attendant hardship throughout the period of disruption on all activities involved.

43. Physical Security Personnel. In many cases, radio installations had to be made in isolated locations with resulting physical security requirements greatly in excess of those which are called for in the case of installations

near a command post. Available operating personnel was always insufficient to provide adequate physical security in addition to carrying out their primary mission but they frequently had to be so employed. During operations, this need was met in some cases by the tactical commander responsible for operation of the installation, in others by the commander of the area in which the installation was located. This lack of uniformity of procedure resulted at times in a certain wastage of personnel. Since responsibility was not fixed, the problem of security details was a continuing one throughout the campaign.

44. Conclusions. Radio personnel and equipment authorized units in the European Theater of Operations were in general insufficient to exploit the full possibilities of radio or to adequately cater for those demands which were imposed.

45. Recommendations. It is recommended that pertinent Tables of Organization and Equipment be reviewed in light of experience in the European Theater of Operations and appropriate increases in both radio personnel and equipment be provided in amounts consistent with responsibilities imposed.

CHAPTER 2

WIRE

46. General. The provision of wire communication facilities for the United States air and ground components of the Allied Expeditionary Force presented a major Signal Corps problem in operation "OVERLORD". Telephone traffic volume was on a scale hitherto unencountered in a military campaign. Of messages transmitted by electrical means, other than air-ground traffic and traffic between highly mobile forward tactical units, perhaps ninety-eight percent was handled over wire circuits. To meet these requirements, a large part of the total Signal Corps tonnage allocation from the Zone of the Interior was devoted to the movement of pole line material, field wires and cables, and wire terminal equipment. Wire construction and operating personnel accounted for a major portion of the combined Communications Zone, air forces and ground forces Signal Corps personnel allocated to the Theater.

SECTION 1

OUTSIDE PLANT CONSTRUCTION, REHABILITATION AND MAINTENANCE

47. Planning. a. The provision of an adequate outside plant was the principal factor in planning the wire system for the European Theater. Work on plans for the continental wire network was started in early 1942 prior to the availability of either strategical or tactical plans for the coming operation. Assistance in preparing these plans was given by representatives of the air, ground, and service forces. During the initial planning phase insufficient information was available as to new communication equipment developments in the Zone of Interior and supplementary projects incorporating the new equipment into the plans were submitted to meet contingencies as they arose. All plans for major wire projects were submitted to the War Department for approval by the summer of 1943. When the basic tactical plan for the invasion was released in the fall of 1943 it was found th t most of the assumptions made in the preparation of the wire communication plan were sound.

b. Requirements for Signal Corps units and miscellaneous personnel together with supporting data were prepared concurrently with those for equipment and supplies. These were submitted to the Theater General Staff in the fall of 1942 for approval and forwarding to the War Department. The Theater General Staff considered these personnel requirements excessive and returned the requisition for reconsideration and revision. So much time was lost in arriving at a theater decision that when the War Department troop basis for the European Theater was finally released it was found that a further cut in the allocation of Signal Corps troops had been made necessary by prior War Department commitments to other theaters. It was obvious that either the planned scale of signal communication would have to be reduced or an increase in the Signal Corps troop basis be obtained. Because of the established War Department policy of permitting changes in a theater's troop basis only by adjustment and balancing of

the requirements of one arm or service against that of another, it was necessary to present the personnel problem direct to the senior theater air, ground and service force commanders. As a result some adjustments in the troop basis were made which improved the Signal Corps personnel situation. However, due to prior War Department commitments of Signal Corps units, long delays in filling the personnel requisitions were experienced.

THE MAIN LINE WIRE SYSTEM

48. Basis for the Main Line Wire System.

Basic instructions for a combined main line wire system were promulgated by Supreme Headquarters Allied Expeditionary Force. A map showing all major underground and overhead cable routes and open wire routes was the most important portion of the instructions. Construction boundaries defining the respective areas of responsibility of United States and British Forces for wire construction and rehabilitation were indicated. Also shown were tentative initial and subsequent locations of all major headquarters involved. The selected headquarters locations were always in or near civil signal communication centers and consequently those portions of the long distance cable network selected for operational use were considered the backbone of the main line wire system. Although fairly complete data was available on this civil long distance cable plant and the equipment installed at associated signal communication centers, little was known of its current condition. No action had been initiated to effect the production of suitable types of cable or terminal and repeater equipment which could be readily integrated with this system to assure its satisfactory rehabilitation. Hence use of the civil plant was discounted one hundred percent for planning purposes and adequate open wire routes parallelling the civil routes together with the requisite terminal and repeater equipment were planned. Experience proved that this plan was sound in that circuits over newly constructed open wire routes were in service on an average of several weeks prior to the availability of those in the rehabilitated cables. It was also found that the rehabilitated cables were subject to service interruptions for long periods after being rehabilitated usually because of sheath damage due to near misses from bombing operations. Although the civil cable routes were utilized as soon as possible, the newly constructed open wire lines were the real backbone of the system.

49. Development of the System. a. The 21st Army Group, charged with the responsibility for the initial assault and ensuing operations, directed 12th Army Group to establish a Joint Wire Group to plan initial requirements for the main line wire system in the United States Zone. The Signal Officers of 12th Army Group, First U. S. Army, Third U. S. Army, Advance Section Communications Zone, Forward Echelon Headquarters Communications Zone and Ninth Air Force were represented in this group. Also the Chief Signal Officer, 21st Army Group Lines of Communication sat with the group in an advisory capacity. The Joint Wire Group was charged with coordinating plans for the United States main line wire system with the British and with allocating construction and rehabilitation responsibilities. It also allocated wire circuits or channels to interested agencies.

b. The two basic policies immediately agreed upon by the Joint Wire Group were, namely (1) to pool circuits in the main line build, and (2) to place all construction personnel not required for specific missions in a pool under the control of the Signal Officer, 12th Army Group. It was recognized that the available wire plant material and equipment was not adequate to permit parallel builds by the air, ground and service forces. Also the shortage of wire construction and operating troops made it necessary to use those available for expansion and maintenance of the highest priority lines.

c. Unfortunately it was difficult to arrive at a complete agreement on detailed plans, responsibilities and allocations in an organization such as the Joint Wire Group. In many instances only the tactful advice of the Chief Signal Officer, 21st Army Group, Lines of Communication, and a knowledge on the part of the members of the Group of the basis for its existence permitted a decision to be reached and accepted. The need for the presence of someone empowered through his position in the theater organization to speak with command authority was apparent. The Joint Wire Group ceased to exist upon the assumption of an operational role by Headquarters, 12th Army Group in August 1944.

d. Extension of the main line system eastward, as the invasion progressed, became the responsibility of Headquarters, 12th Army Group, which was the most forward headquarters having construction and rehabilitation troops available for the purpose. Plans for expansion of the system were coordinated by the Signal Officer, 12th Army Group, with the Chief Signal Officers of Supreme Headquarters and of Communications Zone. A similar procedure was followed by 6th Army Group upon its juncture with "Overlord" forces. The rapid tactical advance made it necessary for Communications Zone to complete missing sections in the system and to augment facilities in completed sections. Communications Zone also added new lateral sections at points where needed to provide maximum benefit for alternate routings or to meet additional requirements of its own.

50. Development Problems.

a. As operations progressed and the combat zone moved forward the rear areas were divided into base sections, each with its own headquarters command. The Signal Officer in each of these base sections was responsible to the base section commander rather than to the Theater Chief Signal Officer. The original decision of the Joint Wire Group was made difficult to execute by this organizational arrangement. Although cooperation among the several agencies remained excellent, planning was decentralized to Supreme Headquarters, Headquarters Communications Zone, Advance Section Communications Zone, the army groups and the armies. Some uncoordinated construction or rehabilitation was undertaken by Advance Section Communications Zone and by certain of the armies. Because of the decentralization of control to the several base commanders, the achievement of a unified communication system was based upon cooperation rather than command action. It was almost impossible to obtain necessary personnel to accomplish a particular high priority mission within the desired time despite the sincere spirit of cooperation existing among all concerned. The same difficulty existed in allocation of materials and equipment required for the system.

b. Centralized control was also lacking initially for the allocation of circuits or channels in the main line

system. The air forces made particularly heavy demands for point-to-point "operational" circuits. These demands were contrary to the agreed common user policy and were difficult to reconcile. When Paris, the focal point of the French long distance cable system, was established as a headquarters location, Supreme Headquarters instituted a Long Line Control Group. This Group was charged with making recommendations as to allocations in new or overloaded portions of the system and with enforcing decisions as to allocations. It had the further mission of recommending augmentation of or changes in the system to increase its efficiency. Unfortunately the staff of the Long Lines Control Group was not adequate to function smoothly. The undue delays in meeting requests for circuits or channels made it necessary that moves of major headquarters be planned many weeks in advance if adequate communications were to be assured. In many instances such early planning was impossible.

c. Despite the adoption of the basic policy of making maximum use of common user facilities, a tendency developed to connect major headquarters and installations by long direct circuits rather than to an area switching central forming a part of the main line system. Such a procedure reduced the efficiency of the system as a whole.

d. Lack of matching types of cable and repeater and terminal equipment greatly delayed rehabilitation of the underground long distance cable plant. Also, shortage of competent toll cable splicers and of installation and other specialist personnel aggravated the problem. The net result was an inability to rapidly replace tactical with fixed plant types of equipment. This delayed the release of tactical equipment urgently needed in more advanced portions of the system.

e. The extreme shortage of transportation to move materials forward to construction dumps was another problem in connection with construction and rehabilitation of the wire communication system. Organic transportation of construction units was barely adequate for hauling the materials from the construction dumps to the place where they were to be used. Within the army areas it was sometimes possible to obtain assistance of army Quartermaster truck companies but at army groups and communications zone no such solution was found to be practicable.

51. Special Systems Within the Main Line System.

a. To assure prompt completion of incoming and outgoing telephone calls for key officers Supreme Headquarters instituted a "red line" system. It consisted of circuits on the main line system to all major headquarters. These were terminated on a separate switchboard in the main echelon of Supreme Headquarters. Local circuits connected this special switchboard to the local switchboard at Supreme Headquarters Allied Expeditionary Forces Headquarters and to the desks of officers concerned with this service.

b. During the Ardennes operations a similar system was established to permit the 12th Army Group Commander and his army commanders to converse by telephone with a minimum of delay.

c. The value of such special systems is questionable because of the reduction required in the available common-user facilities. The priority system used for handling trunk calls presumably provided the same rapid service.

52. Tactical Wire Plant.

a. Tactical wire plant is defined as the wire plant forward of and including the repeater stations serving an army group headquarters. As such, it involved the portion of the main line wire system which extends down to include army and tactical air command headquarters. This discussion will not consider in detail the army wire systems which on the whole were adequate and satisfactory despite troop and supply shortages common to all signal communication activities in the theater.

b. The 6th Army Group made much greater and more successful use of rehabilitated open wire lines and of long distance spiral-four cable systems than did 12th Army Group. This was probably due to the lesser requirements of the 6th Army Group, whose area was not as extensive as that of the 12th Army Group, and the fact that its construction personnel acquired experience in the Mediterranean Theater with similar open wire rehabilitation and with the installation and operation of spiral-four systems.

c. Many of the spiral four installations in rear of army headquarters installed to meet pressing needs for wire communication were replaced shortly thereafter with standard open wire construction. Little more time would have been required to install open wire initially if proper foresight had been used.

d. Considerable quantities of rapid pole line construction materials were shipped to the Theater for local construction use in army wire systems. Its use was found to be impracticable as it would not stand up under service conditions. Spiral four was found to be much more satisfactory for this purpose.

e. First US Army experimented with British Multi-Air-Line construction while in the United Kingdom, and requisitioned several thousand miles of build for use in operations. Spiral-four installations were found to be more satisfactory and little of the Multi-Air-Line construction material was used.

f. Standards of construction and installations of the armies varied greatly. Those with low standards quite naturally experienced a high rate of trouble and increased maintenance requirements. Open wire leads constructed under low standards, if later incorporated in the main line wire plant, usually required complete re-working to make them suitable for such use.

g. Use by forward troops of civil wire facilities, particularly underground cable plant, resulted in much needless work and long delays when it was later desired to incorporate the plant into the permanent system. The random splices and unmatched cable patches installed by these troops were major causes of difficulty in underground long distance cable. Occasions also arose when lower headquarters were reluctant to release civil wire facilities required for incorporation in the main line system or to meet some other major need.

53. Rear Area Short Haul Wire Plant.

a. The Communications Zone was broken down into a number of base, intermediate and advance sections, each of which was a special command and had assigned to it a proportionate share of the SignalCorps troops initially allocated to the Communications Zone. Base and intermediate sections were assigned control over fixed areas, whereas advance sections moved forward with the armies and maintained control over the area immediately in rear of army

boundaries.

b. Short haul wire plant was set up in base and intermediate sections to connect the various depots, hospitals, etc., to the area headquarters and to provide an area network. The area system was tied into the main line system at its section headquarters or at some major civil signal communications center located in or close to the area.

c. An area Signal Officer naturally felt that his primary wire mission was to provide a satisfactory area communication network. His interest therefore in assisting in the installation of and in maintaining portions of the main line wire system which crossed the area in question was of a secondary nature. He likewise showed little interest in meeting theater requirements for furnishing a portion of his wire personnel for work outside of his area. Experience demonstrated that action taken through technical channels by the Chief Signal Officer, Communications Zone, seldom produced the desired cooperation. It was therefore necessary to resort to command channel procedure, with its attendant delays in headquarters staff coordination and in routing methods, to accomplish such simple matters as the movement of a Communications Zone cable splicing team from work in one area to a new task in another. Where any major action was called for, the concurrence of two or more area commanders was often required. If an area commander did not concur in the proposed action, there were further lengthy delays in getting the project under way.

54. Maintenance.

a. Maintenance of main line and local open wire plant and also local cable plant was a responsibility of the base section commanders within the Communications Zone and of the senior headquarters commander within the army areas. Plant controlled by Advance Sections of Communications Zone within army areas, by mutual agreement was sometimes maintained by the army or army group concerned. Communications Zone assumed responsibility for maintenance of main line underground cable plant in rear of headquarters of army group. The plant forward of repeater stations serving army group headquarters was normally maintained by the pooled resources of Advance Sections of Communications Zone and the army groups.

b. Modern Equipment for continuity and transmission testing of toll lines was lacking during the actual operation. A variety of both open wire and cable toll testing boards were improvised. Throughout the entire operation there was a continued shortage of personnel adequately trained in the proper method of toll testing. Initially there was a lack of uniformity in toll testing procedure. However standard procedures for testing long lines and the location of faults were later made applicable throughout the United States zone.

c. The major maintenance problem for overhead plant arose from the fact that the same troops had to be sub-allocated by area or tactical unit signal officers on missions of construction, rehabilitation and maintenance. As there was a continuous shortage of such troops one or more of these missions had to suffer and since construction or rehabilitation when completed resulted in positive physical gains to the plant, they were universally favored at the expense of proper maintenance.

d. Construction battalions and companies were not a proper source of personnel and equipment for the performance

of maintenance missions. Only a small portion of the personnel and equipment of such units were suitable for employment on this work. While this small portion was so engaged, the balance of the personnel and equipment of the unit was usually idle.

55. Personnel.

a. The inadequacy of trained Signal Corps personnel is discussed at length in chapter one of Study 112 of The General Board. The shortage of trained toll cable splicers was particularly acute and materially retarded the rehabilitation of civil long haul cables and the establishment of the theater main line communication system. As an expedient to overcome this shortage of skilled specialists it was common practice among the army groups and the Advance Section of Communications Zone to form provisional cable splicing companies of splicers taken from available construction battalions or any other source where they could be obtained. It was possible with the splicing teams thus formed to make surveys and test main line cables over long distances and to undertake rehabilitation of such cables in their entirety instead of piecemeal.

b. Shortage of personnel, equipment and transportation hampered the recovery of abandoned field wire and spiral-four cable. Nor was adequate personnel or equipment available for its reconditioning.

56. Equipment and Supplies.

a. Open wire construction was frequently delayed because of shortages of pole line hardware, such as pins, brackets, bolts, lag-screws, splicing sleeves, transposition brackets etc. Expedients, which were necessary because of material shortages, such as the use of inverted pins and insulators and non-standard splices resulted in maintenance difficulties and low transmission quality.

b. The supply of several types of line wire, i.e. copper, copper-weld and iron, all of which were available in more than one gauge, complicated the construction of open wire lines with inexperienced construction crews. It was not uncommon for several types of wire to be used in the construction of a single line. This lack of uniformity made balancing of circuits almost impossible and caused transmission deficiencies. Experience in this Theater indicated that #104 copper-weld wire was a satisfactory line wire for use under the varying operational conditions.

c. Within the Zone of the Interior construction teams were taught to leave wire and cable reels at the point where emptied so that they might be readily available for use in recovery of circuits when no longer required. This practice was carried over into the European Theater of Operations and resulted in a severe shortage of reels, because the quantity of both wire and cable recovered represented a very small percentage of that installed. No additional transportation would have been required to haul the empty reels back to the construction dump where they would have been available for reuse as needed.

57. Conclusions.

a. Planning of wire communication for operations in the European Theater was in general sound, although the basic tactical plan was not available prior to completion of the long range signal plans.

b. Reduction of the Theater Chief Signal Officer's personnel requirements by both the Theater General Staff and the War Department made difficult the realization of the wire communication plan.

c. Lack of centralized control of Signal Corps troops and materials in the Communications Zone appreciably retarded developments of the Theater wire system.

d. Uncoordinated builds of standard open wire lines and improper use of civil underground cable were made by troops in forward areas.

e. Need for standard Army procedure for long lines fault control and for thorough training of toll test personnel was apparent throughout the operation.

f. The use of a section of a standard construction unit to perform rehabilitation and maintenance work immobilized the remainder of the unit and is therefore unsound.

g. There was a continuous shortage of cable splicers in the European Theater of Operations and those available were usually assigned to organizations where maximum benefit could not be obtained from their specialty.

h. An effective wire recovery program was not possible within the Theater because of the lack of personnel, equipment and transportation for this purpose.

i. The failure to standardize on a single type of line wire hindered the fulfillment of the line construction program.

58. Recommendations. It is recommended that:

a. The Chief Signal Officer of the United States Army and the Theater Chief Signal Officer be instrumental in arriving at the final decision as to the requirements for Signal Corps troops for operations in any specific theater.

b. In any future active theater of operations a signal communication service be established under the direct control of the theater chief signal officer. This service should control:

(1) All construction units not specifically allocated to a headquarters.

(2) All fixed plant installations and all operating and maintenance teams or units employed therein.

(3) All permanent outside plant materials and fixed plant terminal and repeater equipment.

(4) The development, operation and maintenance of the main line wire system.

(5) The allocation or reallocation of facilities available in the main line system.

(6) Changes to the main line build.

c. Standard Army procedure for long lines fault control and toll testing be adopted and applied.

d. Teams suitably organized and equipped to perform open wire rehabilitation and maintenance work be included in Tables of Organization and Equipment of both heavy construction companies and cellular type units.

e. Tables of Organization be reviewed for the purpose of removing personnel of highly specialized skill such as cable splicers, where not ordinarily required for normal operations. This personnel should be pooled and made available to the theater chief signal officer.

f. Special cellular teams be organized and equipped to handle the recovery and rehabilitation of wire and cable as abandoned.

g. One type of wire be adopted as standard for open wire builds.

SECTION 2

TERMINAL AND INTERMEDIATE FACILITIES

59. General. This section constitutes a limited review of wire communication equipment from an operational standpoint. It consists of significant opinion and conclusions arrived at from observations of the use of wire communication equipment in the European Theater. Recommendations have been made periodically during operations by those responsible for the use of this equipment to correct deficiencies noted. Many of these suggested changes are being studied at the present time in the Signal Corps laboratories in the Zone of the Interior. Comments and recommendations presented in this section will therefore be of a general nature.

60. Telephone Switchboards. a. Switchboards made available to the various echelons of command generally were found to be inadequate for communication needs. For example the TC-10 central office set has a capacity of only one hundred and eighty common battery and ninety magneto lines, whereas a much larger capacity is required at headquarters normally authorized this equipment. Since no specific toll switchboard, as distinct from the local common battery type, was available in the European Theater, standard switchboards were usually employed for this purpose. However such adaptations were not entirely satisfactory due to inherent design limitations of the available boards. Switchboard BD-110, which is a component part of central office set TC-10, is designed for use with not more than six positions in multiple. When additional central office sets of this type were used in parallel, adequate electrical supervision was not possible resulting in frequent interruptions of telephone conversations. It was also necessary to use local trunking to complete calls to a subscriber whose line did not appear in the multiple of the board which answered the incoming call.

b. In the European Theater a large portion of the tactical type common battery central office sets such as the TC-10 (or commercial substitutes) were being utilized by non-tactical headquarters or else were frozen as a part of the Theater reserve.

c. There were not sufficient toll test boards available for adequate fault control on cable and open wire circuits. Much of the testing equipment was improvised from whatever resources were available.

61. Carrier Equipment. Tactical carrier equipment played an important part in Theater wire and radio relay communication. Its electrical design was satisfactory. However mechanical weaknesses developed when it was used under field conditions. When the equipment was transported with the carrying cases in the horizontal position, the panels had a tendency to sag.

62. Repeaters. Repeaters are essential for satisfactory communication over most long circuits. The supply of such equipment was never entirely adequate to meet demands even though both liberated French and Belgian repeaters and captured German equipment were pressed into service. The supply of this type of equipment from the Zone of the Interior was never satisfactory.

63. Teletypewriters. The traffic handled through teletype communication channels played an extremely important part in operations in the European Theater. Without

this equipment and associated tape relay equipment the message center traffic could not have been handled. This type of equipment was never available in sufficient quantities to meet all demands despite its augmentation by captured machines. In the larger headquarters the teletypewriter switchboard BD-100 was found to be inadequate in capacity. Captured boards of 50-line capacity were found to more nearly approximate the needs of army headquarters and higher.

64. Facsimile Equipment. Little use was made of facsimile equipment in the European Theater except by the air forces for the transmission of weather maps. The circuit time required for transmission of pictures and documents was felt to be too great for practical purposes particularly when the shortage of high-grade circuits in the Theater was considered.

65. Radio Relay Equipment. Radio relay equipment proved to be extremely important in the European Theater. The speed with which long circuits could be made available with this equipment made it so much in demand by the armies that the available supply was never entirely adequate. (Attention is invited to Chapter 1, "Radio", where the subject of radio relay equipment is covered in greater detail.)

66. Conclusions. The various intermediate and terminal wire facilities operated in a generally satisfactory manner during the European campaign. Aside from over present supply shortages, shortcomings were noted chiefly in telephone switchboards which were insufficient in size and adaptability.

67. Recommendations. It is recommended that study and development of Signal Corps wire communications equipment be continued with particular emphasis placed on switching facilities and radio relay apparatus.

SECTION 3

OPERATIONS

68. Personnel.

a. Telephone Operators. Throughout the European campaign telephone service generally suffered through lack of properly trained operators. Military telephone traffic in the European Theater of Operations greatly exceeded that anticipated and prepared for by authorized tables of organization and equipment. To meet the telephone load from an equipment standpoint it was necessary in most of the major headquarters to install more and larger telephone switchboards than had been used during the preparatory training and maneuver periods and to use available long haul circuits to greater capacity than had been the practice. It was found that the authorized operators were generally unprepared to work on the larger and more complicated switchboards and that heavy traffic loads were being bottle-necked by inefficient traffic handling. An attempt was made to remedy these operating deficiencies by on-the-job training. However a truth long recognized by commercial telephone companies again became evident; i.e., that men do not have the finger dexterity nor are they temperamentally adapted for efficient operation of large switchboards. As female operators from the Woman's Army Corps became available, they took over the switchboard operation in some of the larger headquarters installations and released the male operators for use in forward areas. Many of the women had been trained by the commercial telephone companies and were much better

prepared for their assignment than their predecessors had been. The service of the female operators proved to be very satisfactory and in general superior to that of male operators.

b. Teletypewriter Operators. Teletypewriters were used almost exclusively by the United States forces in the European Theater of Operations for handling telegraphic wire communications. While the use of such equipment greatly speeded the handling of a large volume of traffic, one of the weaknesses in the system was the quality of the operators. Training within the Zone of the Interior did not adequately prepare the operators for the work load encountered and little practical experience had been afforded them in the use of tape relay equipment, the employment of which became essential in the handling of large volumes of traffic. The teletypewriter network was expanded to meet operational needs as the armies moved across France and into Germany. With this expansion there was an ever-increasing need for additional operators. In most instances, this demand was met by training typists in teletypewriter operation. It should be noted, however, that while typewriting ability is an important asset for a potential teletypewriter operator, such training within itself is not sufficient. Development of a rhythmically uniform finger movement adjusted to the mechanical speed of the equipment was necessary for maximum efficiency in the use of teletypewriters. This desirable degree of proficiency in training was not generally reached although improvements were apparent as experience was gained.

c. Carrier and Repeater Technicians. The enlarging of the Theater of Operations as the campaign progressed lengthened telephone lines beyond the limit of unamplified transmission of voice currents. Equipment required for this repeatering process exceeded available supply of American repeaters and required extensive use of French, Belgian and German equipment. Signal Corps technicians had received training only in the operation of American type equipment and frequently had difficulty in integrating foreign repeaters into the wire network. Inasmuch as the transmission quality of long haul circuits is dependent to a large degree on the adjustment and operation of repeater equipment, the proficiency of the technicians was reflected in the quality of the long distance telephone circuits.

d. Supervision. Experience has shown that supervisory personnel are of great importance in establishing and maintaining the efficiency of switchboard and teletypewriter operators. Many of the supervisors were not greatly superior in training or ability to the operators they were attempting to direct and consequently were incapable of making appreciable improvements in the service. Supervisors should be thoroughly conversant with the mechanics of operation and procedures, have a good knowledge of various circuit routings and be capable of efficiently directing the efforts of operators under them. The full effort of a supervisor is normally required in the efficient discharge of his duty. However, there were instances in which supervisors in signal centers were given assignments in addition to that of supervision. The fluctuating traffic conditions and the possible alternate routings required by a fluid wire situation necessitates full-time competent supervision of operators if maximum exploitation of the communication system is to obtain.

69. Procedure. A uniform operating procedure is an important contributing factor to the high quality of commercial telephone communication in the United States. A comparable

emphasis was not placed on establishing and enforcing suitable uniform procedures in tactical communication within the European Theater and there was a consequent lack of uniformity in handling calls at different headquarters. The divergences in locally devised procedures made the completion of long distance connections a tedious process.

70. Conclusions.

a. Training given switchboard operators, teletypewriter operators and repeatermen did not adequately fit them for the job to be done in the European Theater of Operations.

b. Telephone service was greatly improved when female operators from the Women's Army Corps were utilized.

c. Competent supervisory personnel are essential for efficient service.

d. Lack of uniform operating procedures was detrimental to the communication service.

71. Recommendations. It is recommended that:

a. Telephone operators, teletypewriter operators and repeatermen be selected on the basis of their adaptability and that they complete a comprehensive training program to include practical experience on all types of equipment that they will be expected to operate.

b. American female operators be used at all large telephone installations other than those within the combat zone.

c. Qualified supervisory personnel be amply provided at all communication installations.

SECTION 4

SPECIAL PROBLEMS

72. Railway Signal Communication Systems. a. Applicable regulations during the planning phase of operation "Overlord" were not clear as to the division of responsibility between the Corps of Engineers and the Signal Corps in the matter of installation, operation and maintenance of railway signal communication facilities. The problem was further complicated by the activation of the Transportation Corps and of the Military Railway Service, European Theater of Operations, during the planning period.

b. The Corps of Engineers accepted responsibility for the installation and maintenance of block signalling systems. The Table of Organization for the maintenance of way company of the Engineer Railway Operating Battalion included personnel for the operation and maintenance of telephone and teletype train dispatching circuits. It was therefore initially decided that the Signal Corps would construct or rehabilitate the required train dispatching circuits. It was therefore initially decided that the Signal Corps would construct or rehabilitate the required train dispatching circuits and would obtain and turn over the necessary telephone and telegraph terminal equipment to the Corps of Engineers for installation. Assistance on installation would be given whenever possible. Based on this decision, a project covering estimated requirements for outside plant materials and for terminal equipment was initiated and approval thereof obtained from the War Department.

c. Immediately after the break-through from Normandy Peninsula, the Theater Military Railway Service took over responsibility for the construction and rehabilitation of train dispatching circuits. This experiment proved unsuccessful. Ten days after its initiation, responsibility reverted to the

Theater Chief Signal Officer who then redelegated it to the Signal Officer, Advance Section, Communications Zone. The latter retained this responsibility throughout the balance of the campaign.

d. Train dispatching circuits were provided on the basis of two per military railway line in the liberated countries and four per line in Germany. From "D" Day to 30 August 1944, a total of 1782 wire miles of these circuits was constructed or rehabilitated, and in the ensuing month, 9354 additional wire miles were added, making a total of 11,136 wire miles completed in what amounted to a two month's period, since little or no work of this type was done during June and July. Due to sudden changes in both the tactical and administrative situations, approximately twenty percent of this work proved to be unnecessary from a military standpoint.

e. In the European Theater, the provision of railway signal communication systems was largely a matter of rehabilitation rather than of new construction. Such rehabilitation was open to the same criticism as was normal open-wire rehabilitation or maintenance work in the Theater. A large part of the personnel and equipment of standard signal construction units, which were the principal source of personnel and equipment to accomplish the task, was immobilized as being unsuited to the mission while such work was being carried on. Teams of three or four trained specialists with light equipment and a small vehicle would appear to have been the proper solution.

73. Pipe-line Signal Communication Systems. a. The problem of supplying the air and ground forces of the Allied Expeditionary Force with adequate quantities of gasoline during operations was one that received early attention in planning. Briefly, the basic solution adopted was the construction of pipe-lines across the English Channel to storage tanks located near the French coast and the extension of these lines to outlets well forward as rapidly as speed of construction and tactical considerations permitted. The pipe-line system referred to ran from Normandy to Coubert, a town south of Paris, and eventally to Mainz, Germany, and was a most important system from the supply standpoint. Other lines were constructed from Marseilles northward in rear of the 6th Army Group and from Antwerp, Belgium in a north-easterly direction into Holland.

b. Successful operation of these pipe-line systems required the installation of pumping stations spaced approximately eight miles apart throughout the length of the system and the construction of storage tanks every forty or fifty miles along the pipe-line. Each installation of storage tanks was called a "tank farm". Crews to repair breaks or leaks in the system had to be maintained at the tank farms, and telephonic communication throughout the length of the system for flow control and plant maintenance purposes was essential.

c. It was initially believed that a satisfactory pipe-line telephone system could be installed, maintained and operated by the Engineer troops engaged on the project using signal communication equipment organic to these units. The Signal Corps was therefore not called upon for assistance durint the planning phase nor the initial operational phases of these pipe-line projects. It was soon found that the organizational field signal equipment in use, and the outside plant engineering and construction methods employed, were not producing satisfactory results. In the latter part of August 1944, responsibility for the development and installation of the pipe-line telephone system was transferred from the Theater

Engineer to the Theater Chief Signal Officer. A standard type of plant capable of meeting not only current but future needs was designed and adopted. Replacement of the unsatisfactory old plant and construction of new plant was started and Engineer personnel trained in maintenance and operating procedures applicable to the new system.

d. The standard type of plant adopted involved the use of "rapid pole line" construction methods utilizing an eight-pin crossarm and using existing poles wherever possible. A BD-71 switchboard was installed at each tank farm and a long distance circuit of 128 copper wire run between adjacent switchboards. In addition, "party line" service was provided from the switchboard at each tank farm to all pumping stations controlled by that farm, utilizing a circuit of 080 copperweld wire for the purpose. By switching it was possible to establish telephone communication between any two telephones forming a part of the system.

e. Since requirements for Signal Corps equipment, materials and construction units for installation of the pipeline telephone system did not develop until after operation "Overlord" had been initiated, they had to be met at the expense of existing projected requirements. This necessary diversion was unfortunate, particularly in the case of construction units, the current needs for which were being only partially met at the time. Since the pipe line traversed several base and intermediate sections of the Communications Zone, difficulty was further experienced in allocating and shifting men and equipment between those sections. This difficulty was occasioned by the organizational structure of the Communications Zone and methods of operation which delegated complete area responsibility to section commanders. It therefore was necessary to secure official command channel concurrence for inter-section activity, which activity, in most cases, was of no concern to the area commanders involved.

74. Signal Communication Facilities for the Press.

a. It was not until late in the planning phase of operation "Overlord" that any proper appreciation of the magnitude of proposed signal communication requirements for the Press was obtained. These proposed requirements were such as to clearly indicate that their provision would require either a full time allocation of a considerable number of radio frequencies and wire channels, or a sharing of a still greater number of both, to the serious detriment of foreseen operational needs. Associated with this problem was the problem of press censorship.

b. It was decided to establish censorship facilities at army and higher levels and to prohibit filing of press traffic for transmission by electrical means below army headquarters. A minimum number of radio frequencies was allocated for press use, and full time teletypewriter channels included in plans on the basis of one channel from each army to army group with a more generous scale from army groups to the rear. Provision was also made for handling a fixed maximum of press traffic over operational circuits when circumstances permitted. The provision of all the preceding facilities was subject to non-interference with operational needs. Stress was laid in all plans on making the maximum use of motor and air messenger facilities by the Press in order to decrease the load on electrical facilities.

c. During operations, there were many periods when it was impossible to provide press wire facilities on the planned scale due to the limited number of wire channels available and urgent operational need therefor. Continued

pressure was placed on the Signal Officers at all echelons of command from Supreme Headquarters down to armies by Public Relations Officers and others for an increase in press wire facilities and in allocated radio frequencies. Such increases were granted whenever possible; however, to have acceded to every demand would have meant jeopardizing the success of the operation.

d. From a signal communication viewpoint, it would appear that all-inclusive plans for the Press were not given early enough consideration and that the possible effect of press requirements on the tactical electrical communication system was not fully understood by the planners. The only reasonable solution to the problem would appear to be a reduction in the authorized number of war correspondents, consolidation of press dispatches into a "pool" dispatch at the various levels of command from army headquarters rearward, and acceptance of only such "pool" dispatches for transmission by electrical means. Electrical transmission of other than "pool" dispatches could be undertaken at the lowest headquarters in the chain of command at which solid and adequate facilities to the rear could be depended upon, such dispatches being routed thereto by air or motor messenger. However, to have such procedure adopted in any future major operation in which we may become involved will require indoctrination not only of the major press associations and news agencies but of the Press as a whole.

e. In operation "Overlord", certain press ratio terminals were equipped and manned by personnel of commercial radio operating companies, while Signal Corps personnel was set up in Public Relations operating units to man army radio and wire terminals handling purely press traffic. All of the personnel referred to above was under the operational control of the Public Relations Officer of the headquarters concerned, who in turn called upon the Signal Officer for additional help when the need arose. The split responsibility of such an arrangement is believed to be organizationally unsound. Experience demonstrated that only military personnel should be concerned with signal communication in an active theater (with the possible exception of major rear signal communication centers such as London and Paris in the European Theater of Operations), and that the Signal Officer of a headquarters must have operational control over all signal communication personnel and means associated with the headquarters.

75. Control of Civil Signal Communication Systems in Liberated and in Captured Enemy Territory. a. As mentioned earlier in this chapter (Section 1), signal communication plans for operation "Overlord" contemplated the use of the civil long distance underground cable plant of enemy-occupied countries and of Germany, together with associated repeater stations and terminal installations, as the backbone of the "Overlord" main line wire system. Plans also contemplated the use of such other indigenous telephone plant as would assist in the development of the Theater wire system, and of indigenous fixed radio installations.

b. Inasmuch as wire plant located in enemy-occupied countries was government-owned and prior to the war had been government-operated, it was necessary to reach an agreement with the government-in-exile of each enemy-occupied country with respect to the use of these facilities for allied military purposes. Certain of these agreements, insofar as they covered operational points, appear as appendices to Part I, Signal Instruction, Operation "Overlord". In general, they permitted full rehabilitation and use of civil plant and

assured all possible assistance by the government concerned in the form of the loan of available administrative, engineering and operating staffs. On the other hand, minimum civil local and trunk needs were to be met as rapidly as operational requirements would permit and use of the civil plant for military purposes was to be accounted for in detail for purposes of reimbursement.

c. Full use of such portions of the government telephone and telegraph staffs as were available was made in all cases. Qualifed officers from these staffs were assigned for liaison purposes to Supreme Headquarters, Headquarters Communications Zone, army groups, and in some cases, armies. They were of great value in the surveying of facilities in newly liberated areas, and rounding up of bureau personnel in all areas, and the obtaining of plant and engineering information not otherwise available.

d. Difficulty was encountered throughout the operation in turning back to civilian agencies trunk facilites required to meet minimum civil needs. This was due to the fact that the trunk circuits involved often ran through one or more base or intermediate sections of the Communications Zone and through one or more army zones, and that the procedure and channels for requesting release of circuits and for the clearance of such a request were never clearly understood by either the civil or military agencies concerned. In many cases, obtaining the release of a circuit whose release should have required a matter of days took several weeks of correspondence, telephoning and personel visits on the part of those interested. The submission of requests for release written in bulk form, that is, covering a large number of non-associate circuits spread over a wide area, inevitably resulted in no final action being taken on any included item.

e. The requirement for a detailed accounting of the use of civil plant for military purposes was impossible to meet in full, and required many man-hours of work during operations which the various headquarters concerned could ill afford for such a purpose. From a bookkeeping standpoint, other factors such as proportionate amount of time put in by civilian employees in meeting military as compared to civilian needs, rehabilitation and augmentation of plant by the use of allied military personnel and materials, etc., must also be considered. It is felt that some simpler initial solution could have been arrived at which would have obviated this unnecessary and non-productive feature.

f. No problems similar to the preceding arose in Germany prior to "V-E" day. Reichspost telephone and telegraph personnel found "on the job" (usually in limited numbers) were, after screening, willing and in most cases anxious to assist in getting both local and trunk plant back in operation. Military supervision was provided at all installations. No civil trunk facilities were authorized nor circuit-use accounting required.

76. Conclusions. a. Where a project may involve requirements for signal communication, the arm, service or agency responsible for such planning cannot be counted upon in all cases to undertake early coordination of its plans with the Signal Corps. This is often due to a lack of knowledge of the capabilities and limitations of signal communication means.

b. Personnel, equipment and materials required to meet a signal communication requirement which has not been covered in plans can only be furnished at the expense of planne

and approved projects. In such cases the planned and approved projects suffer.

c. The provision of special signal communication facilities such as those covered in this section was not economically effected due to lack of centralized control over the planning and implementation agencies concerned.

d. Demands for signal communication facilities for the Press during operation "Overlord" were excessively heavy. To have met them in full would, in all probability, have so reduced and interfered with tactical facilities as to have placed the success of the operation in jeopardy.

e. Agreements with foreign governments covering the use of their civil signal communication plants for military purposes prescribed an accounting too detailed in nature. Procedures for requesting and obtaining release of portions of such plants for use in connection with civil administration needs were not effective.

77. Recommendations. It is recommended that:

a. The Signal Corps be advised, at an early date in the planning stage, of those projects for which they may later be called upon to provide signal communication facilities.

b. In any future theater of operations, the theater signal communication service be charged with responsibility for the provision of special signal communication systems such as those required by railways, pipe-lines and the Press.

c. A further and more detailed study be made of the problem of press coverage of an active theater of operations and of signal communication requirements incident thereto, with a view to establishing a yardstick for use in future planning for this service.

d. Any future agreement with a foreign government covering the use by United States forces of its civil signal communication plant in an active theater of operations avoid any strict requirement for detailed accounting incident to the use of such plant.

CHAPTER 3

THE SIGNAL CENTER

78. Definition and Mission. A signal center is a terminal communications agency charged with the receipt, transmission and delivery of all messages sent by telegraph, cable, radio, teletype and other special means. Signal centers are located at and are part of a headquarters. The installation consists of a message center, a cryptographic section, if necessary, and the terminal means for transmission of messages such as telephone, teletype, radio or messengers, together with the necessary operating personnel.

79. Organization and Personnel. a. In the European Theater, the operating nucleus of signal centers, located at Army or Army Group levels, was usually a Signal Operation Battalion. When the traffic load at a headquarters became so large that the Signal Battalion could no longer handle it, separate Signal Companies and specialists teams from Table of Organization and Equipment 11-500 were assigned in addition thereto. The result was sometimes a rather loosely organized pool of personnel which not only lacked military homogeneity but likewise lacked the operating perfection of a cohesive team.

b. The demand for additional personnel usually exceeded training capacities and as a result such personnel came poorly trained to perform the duties for which they were required. Experience also demonstrated that many of the supposedly trained specialists had little conception of the job to be done; personnel in supervisory positions were often inadequately prepared to direct their subordinates; so called cryptographic technicians (Military Occupational Specialty 805) reported for duty knowing little more than the operation of the Converter K-209; teletype operators (Military Occupational Specialty 237) frequently knew little about duplex teletype or tape relay operational procedures. The value of this personnel would have been greatly enhanced if they had first been oriented in the center signal center problems and procedures before being assigned to a busy operating signal center.

c. Normally the commanding officer of the Signal Operation Battalion was appointed Signal Center Officer in addition to his other duties as battalion commander. This placed him at a disadvantage in that he had two full time jobs to do neither of which could be given proper attention. In the signal center, he was responsible for the work of personnel from organizations other than his own battalion over whom he had no administrative control and too frequently only a loose operational control. He did not have a team. He was at a further disadvantage in that while he was responsible for the operation of the signal center, he was not a member of the Signal Officer's staff. His duties as a battalion commander frequently made him unavailable for consultation when signal operations plans were being formulated. Twelfth Army Group corrected this situation by assigning a member of the Signal Officer's staff as Signal Center Officer.

80. Communication Procedure. Although teletype

proved to be the most accurate and rapid means of electrical transmission of traffic in the European Theater of Operations, the efficiency in handling this traffic in signal centers was lowered by the lack of uniform procedure practices. The loose organization of the Signal Communications system throughout the theater did not provide the coordination and standardization of policies and procedures requisite to efficient operation. The preparation of suitable procedures presents no great problem; however, their uniform application requires a well-knit organization and firm direction.

81. Staff Message Control. The preparation, editing and local distribution of messages is not a responsibility of the signal center. Normally a Staff Message Control or Adjutant General Cable Section was established at the larger headquarters for this purpose. This office also maintained the files of all cable correspondence. Close coordination is to the mutual advantage of both the Signal Center and the Staff Message Control to avoid security violations and abuses of precedence classifications. The Cryptographic Security Officer can be of material aid to the Staff Message Control Officer in preventing security violations and should work very closely with him.

82. Mobility. World War II is without precedent in rapidity of movement. The more rapid the movement the greater are the demands made on signal communications. There is a need for standardized installations of our communications equipment which will make it as mobile and flexible as the headquarters it serves.

83. Conclusions. a. The Signal Operations Battalion when augmented by separate Signal Companies and cellular teams usually lacked homogeneity as an operating team.

b. Personnel assigned for signal center operation were poorly trained in general and were not oriented as to theater communications problems and procedures.

c. The Signal Center Officer should be a member of the Signal Officer's staff and his duties should be limited to the operation of the signal center. The commanding officer of the Signal Operations Battalion should not be used for this assignment.

d. For efficient signal communications, standardized procedures should be enforced throughout the Armed Forces.

e. Close coordination between the signal center and the Staff Message Control is essential.

f. The development of more efficient and mobile signal center installations is needed.

84. Recommendations. It is recommended that:

a. Administrative control of units providing personnel for signal center operations be exercised by group headquarters to be set up for that purpose.

b. The training program be expanded to include specialized instructions for operating and supervisory personnel for signal centers at high level headquarters.

c. A Theater Signal Specialist Training Pool be organized at Theater Headquarters to provide trained supplementary and/or replacement personnel for Theater and lower command signal centers.

d. The Signal Center Officer be a member of the staff of the Signal Officer with responsibilities limited to the operational control of the signal center.

e. Uniform signal operations procedures be established and enforced throughout the Armed Forces of the United States.

f. Mobile signal centers be designed and authorized to incorporate appropriate modern communications equipment in an installation as mobile as the headquarters which it serves.

CHAPTER 4.

MESSENGER SERVICE

85. Messenger Service, General: a. Requirement. There is a requirement for messenger service at all headquarters, from the lowest to the highest. Usually the most rapid available means of transportation is employed, consistent with the security of the messenger and the traffic he is carrying. In the lowest echelons the messenger usually travels on foot. Messengers serving higher echelons may use pursuit aircraft, motor vehicles, boats or any other mechanical means of transport that best fits the purpose.

b. System Necessary. In lower echelons, divisions and corps, the provision of messenger service presents no difficult problems. At higher headquarters, such as army, army group, theater, etc., the problem is complicated by the long distances separating headquarters, amount of message traffic to be handled and lack of uniformity in both system and methods employed by the several headquarters concerned.[1] In the European Theater of Operations, the magnitude of the problem and its inherent difficulties were not visualized initially and as a consequence the service grew and expanded in a manner which, in many instances, was dictated by expediency rather than logical, efficient planning.[2] That the system operated as well as it did is a tribute in the main to the resourcefulness of many junior officers, the physical stamina of many enlisted men and the durability of the jeep.

c. Organization. The organization of an efficient theater wide messenger service presents no great problems if the several basic factors affecting such service are recognized in the beginning and catered for in planning.

86. Factors Influencing a Theater Messenger Service:

a. In the European Theater of Operations the messenger service covered many thousands of square miles of territory. It operated under many adverse conditions such as icy roads, poor roads, roads crowded with troops and supply transport, all possible conditions of weather and in some instances subject to attention from enemy aircraft. As with any organization which follows an unplanned growth, many deficiencies became evident. These were corrected as they arose, provided they were susceptible of correction without interfering with or halting operations. Unfortunately, however, many reforms, the need for which was apparent, could not be placed in operation because of this latter factor.[3] As the service continued, the basic requirements for an efficient theater messenger service became apparent,[4] but these were never fully met in actual operation due to the dislocations their institution would have caused.

b. Experience in the European Theater of Operations indicates that the following essential factors should be considered and catered for well in advance of the actual installation of a large messenger service.

(1) Messenger service breaks down logically into two categories, i.e. Trunk Service and Local Service. All trunk Service routes should be under the control of the Theater Signal Officer while Local Service

Routes should be under control of the local Signal Officers concerned.

(2) It is essential that there be a uniform method of regulating both Trunk and Local Messenger Service. A general Standing Operating Procedure covering points common to all messenger service is a necessity.

(3) A master locator system should be established at the highest headquarters and such parts of it as are necessary distributed to lower echelons.

(4) Adequate personnel and transport should be provided.

87. Trunk Service and Local Service:

a. In the interest of economy of personnel and equipment, as well as efficiency of operation, experience demonstrated in this theater that behind Army Rear area boundaries there should be a "Trunk Messenger Service". Briefly, Trunk Messenger Service may be described as "through" service between large areas or concentrations, conducted in a manner similar to "trunk switching" in the telephone service. "Local Messenger Service" may be described as that service which provides messenger delivery for a given area or concentration of units.

b. In the rear area where the situation is relatively stable for significant periods of time, the most efficient and economical method of effecting physical message delivery is to establish throughout the area a series of fixed locations between which messenger runs are maintained. Each such fixed location should be so placed as to conveniently serve the maximum number of organizations at or near such locations. Scheduled service between these fixed locations should be determined by the amount and urgency of message traffic handled. These units providing local messenger service within an area served by a trunk system would deliver inter-area traffic to such stations for delivery. Such a system would, for example, eliminate the duplication of messenger runs such as were established in this theater by the Advance Section, Communications Zone, Twelfth Army Group, Air Force units and others, all of which traversed the same area. For proper administration and coordination this Trunk Messenger Service should be made a responsibility of the Theater Signal Officer. The establishment of such a system would not preclude the use of special messengers for inter-area service by any unit provided the urgency warranted. Within a given area, and particularly in the combat zone, the messenger service should be a responsibility of the local Signal Officer concerned, as speed of delivery in such areas, as opposed to volume handled, is usually the predominant factor.

88. Uniformity in Procedure: a. Since several services were operating independent messenger systems, and since no overall procedure for the operation of such systems had ever been drawn up, it naturally followed that differences in operational procedure existed.[5] Where it was necessary to route traffic over systems operated by more than one agency, delays were frequently incurred due to a divergence in method of terminal handling.

b. Lack of uniform system was attributable also to difference in working agreements between the Adjutant General and the Signal Officer at the several headquarters concerned.[6] These local adjustments and division of duties and responsibilities were based mainly upon the personalities of the individuals concerned and the amount of personnel available to each to perform the duties involved. It might be parenthetically added here that neither one had

sufficient T/O personnel to adequately discharge the duties imposed. Since the problem of terminal handling, and other incidental items is not immediately involved, it is neither necessary nor desirable to prescribe a "system" at this time since any reasonable system will work satisfactorily. The point which is emphasized, however, is the necessity for prescribing a system and having this system observed uniformly throughout the service. The system should be prescribed at Theater level, based upon factors common throughout the area. All those parts of the system common to every headquarters should be published in a Standing Operating Procedure.

89. Master Locator System: a. In combat, units are frequently moved. For security purposes the exact geographical location of units is guarded. If a messenger is to deliver a message to a unit he must know where the unit is located. These factors point to the necessity for an overall locator system.

b. Here again, as in other phrases of the uncoordinated messenger service built up in this Theater, each headquarters attempted to work out its own solution. These attempts ranged from the sketchiest, ineffectual efforts of some units to elaborate and cumbersome systems used by some other units. The desirable solution lies somewhere between these extremes. With an integrated theater messenger service the responsibility for maintaining a master locator file should devolve upon the Theater Signal Officer. Methods of gathering the necessary information to keep the file accurate and current will be dictated by the exigencies of the moment and any system adopted should be sufficiently flexible to provide for adjustments.

c. Such parts of this Master Locator File as are necessary for unit Signal Officers to operate should be regularly distributed to them. Signal Officers at echelons below Theater level should be relieved of all responsibility incident to locating units other than those composing their own force.

90. Personnel and Transport: a. The necessity for providing adequate personnel and transport to support the required messenger service is axiomatic. This personnel should include sufficient administrative specialists to provide housekeeping overhead. In this Theater, the requirements for personnel and transport were underestimated by at least 50 percent. This phase of the situation is made a matter of record in passing only to indicate the difficulties of estimating messenger service requirements, and to warn against the tendency to underestimate in the absence of factual supporting data.

91. Conclusions:

The most efficient and economical messenger service can only be provided on a Theater basis. The system should be made a responsibility of the Theater Signal Officer and all details of operation incident to Trunk Service determined at Theater level, together with those details incident to local service which are necessary for coordination. Operation of local messenger service should be made a responsibility of the local Signal Officer concerned.

92. Recommendations: a. The Theater Signal Officer should be responsible for:

(1) The installation, operation and maintenance of an integrated messenger service operating trunk routes

down to Army level. This service should be augmented by the local messenger service by local commanders.

(2) The establishment of a Master Locator System, the keeping of such system current, and the distribution of such parts thereof, as are necessary to lower echelons.

(3) The preparation and distribution of a Standing Operating Procedure to regulate all messenger service in the Theater.

b. Tables of Organization and Equipment for larger headquarters should be revised upward to provide adequate personnel and transport to support the necessary messenger service.

NOTES:

1. After Action Reports, Signal Section, Twelfth Army Group, August 1944 - May 1945.

2. "Analysis of Signal Problems", prepared by Colonel P. A. Wakeman, Signal Officer, Advance Section, Communications Zone, European Theater of Operations.

3. Daily Journal of the Chief Signal Officer, European Theater of Operations, dated 26 July 1944.

4. Daily Journal of the Chief Signal Officer, European Theater of Operations, dated 16 October 1944

5. Daily Journal of the Chief Signal Officer, European Theater of Operations, dated 12 January 1945.

6. Daily Journal of the Chief Signal Officer, European Theater of Operations, dated 26 July 1944 and 28 July 1944.

CHAPTER 5

PHOTOGRAPHY

93. General. For the purpose of arriving at an analysis of Signal Corps photographic coverage of the European War, a number of conferences were held with those in charge of this activity in the European Theater. Officers and enlisted men concerned have been interviewed and records have been examined.[1] Despite the lack of unanimity of opinion among those interviewed, the Signal Corps photographic personnel queried had many thoughts that would contribute to a more efficient and logical photographic organization. Much of their disagreement is a natural result of the technical and artistic aspect of their profession. Allowances have been made for these factors, and the following discussion represents what is thought to be a composite of the ideas expressed.

94. Signal Corps Photographic Organization. The Army Pictorial Service is the section of the Signal Corps charged with photography. It has headquarters in Washington, D. C. where its chief is a member of the staff of the Chief Signal Officer. It operates a photographic school and equipment development laboratory at Astoria, Long Island, New York. Within the European Theater of Operations, the staff photographic organiaztion consisted of a Photographic Officer with an appropriate staff section at Supreme Headquarters Allied Expeditionary Force, each army group and army. At each of these levels, the Photographic Officer was on the staff of the Signal Officer of that echelon. Signal Corps photographic units at each of the echelons were directed by the Photographic Officers in the accomplishment of their mission. Within the individual armies, an officer from the photographic company was normally attached to each corps headquarters to serve as photographic officer to guide the activities of the photographic teams attached to the organizations within the corps.

95. Pre-invasion Plans.

a. Prior to "D-Day", plans[2] were made for Signal Corps photographic units to secure ground photographic coverage by still and/or motion picture of all important events special operations and incidents of a military nature that took place within the assigned zones. It was planned that the pictorial coverage should:

(1) Convey military information to commanders and to the War Department

(2) Provide news photographs of publicity or psychological warfare value;

(3) Provide a historical record of the war;

(4) Provide photographic identification Service.

96. Assignment of Photographic Companies.

a. Signal Corps Photographic Companies were assigned to the armies as follows:

(1) 165th Signal Photographic Company assigned to First Army.

(2) 166th Signal Photographic Company assigned to Third Army.

(3) 163rd Signal Photographic Company assigned to Seventh Army.

(4) 168th Signal Photographic Company assigned to Ninth Army.

(5) 198th Signal Photographic Company assigned to Fifteenth Army.

b. The 167th Signal Photographic Company and the 3264th Signal Service Company (Photographic) were assigned to Twelfth Army Group. Teams from these two companies assisted the several army photographic companies whenever assistance was required within the army areas.

97. Organization and Employment of a Photographic Company.

a. The Signal Photographic Company is organized as a headquarters platoon, a laboratory platoon and an assignment platoon. The headquarters platoon contains a supply and maintenance section whose duty is to furnish and maintain equipment and supplies for the company. The laboratory platoon operates a photographic laboratory for the processing and printing of all still picture negatives exposed by the various units of the company. It is equipped to perform copy work, make enlargements, produce lantern slides and other kindred types of work normally performed by a photographic laboratory. The assignment platoon was originally designed[3] to be broken down into three corps assignment units, nine division assignment units, two general assignment units and two identification units. However, it was found in actual operations in the European Theater that this number of units was often insufficient to meet all needs and that a more flexible arrangement was desirable. Therefore the original unit arrangement was often changed to fit local requirements. Combat photographic teams of from two to four men were most commonly used. The four man team, consisting of two motion picture photographers, one still picture photographer and a chauffeur, was considered the best arrangement. A change in Table of Organization 11-37 removed a large number of chauffeurs from the company authorization. This required the use of a photographer for a driver, which reduced to some extent the photographic efficiency of the company. It meant that the driver-photographer, upon reaching the most forward point that the team could go with the vehicle, either remained with the vehicle at the expense of the photographic mission or left the vehicle unattended. The latter action was generally in violation of standing orders.

b. The normal procedure was to attach combat photographic teams to the various divisions and other major combat organizations of the army for operational coverage. Processing of film and replenishment of supplies was done by the photographic company usually located near army headquarters. Other than this, the photographic team operated independently of its parent company and became more a part of the unit to which it was attached. Teamwork between the several combat photographic teams of the photographic company was seldom necessary or present.

c. Experience seemed to indicate that the photographic company was not the best organization to accomplish the combat photographic mission. There appeared to be no logical reason, from an operational standpoint, for grouping photographers into a single organization since their activities were not such as to require teamwork or coordinated action between the individuals of the organization. From an administrative standpoint, many other arrangements other than the company organization would have worked as well. As a matter of fact, experience would appear to indicate that grouping photographers into one organization was perhaps one of the most difficult structures within which to operate as far as control was concerned. For example, in the movement of divisions from sector to sector, there was

a constant necessity for changing photographic teams to retain the integrity of the several photographic companies within their respective army areas. In many instances, after the combat photographic team had worked with a given organization for a period of time, they became members of the family of this organization, assumed some of its esprit and were considered members of the team by men of the organization itself. Neither the photographers nor the organization to which they were attached looked with favor upon changes thus made necessary. Combat photographic teams were of necessity separated by thirty to forty miles from their parent organization where laboratory facilities for developing were normally located. A significant period of time elapsed between the time the photographer took his pictures and the time the finished prints reached the hands of those who were interested. The photographers themselves were often uncertain as to whether they were taking proper pictures or correctly exposing their negatives since no formal arrangements were made for them to see the results of their work and make adjustments which might be needed. (In most instances prints of pictures were furnished Division Signal Officers and photographers could view their work in his office. This, however, was a local arrangement in each case.)

d. The reaction of the photographic company commander, as well as the photographic teams which constituted his organizztion, appeared to be that they lacked direction. No one told them specifically what photographic coverage was required. The general practice of assigning photographic teams to divisions resulted in these teams being shuttled forward by the usual line of command through which they passed until they finally found themselves in the forward combat areas. From this point on the team was generally left to its own initiative as to what pictures it should take. By the rather informal arrangement that attached combat photographic teams to divisions, it was not unusual for commanders to have no knowledge of the presence of such teams. Commanders were in general, unfamiliar with the possibilities of photography as a tactical aid. Since combat photographic teams were commanded by a lieutenant or a senior non-commissioned officer, and since they operated well forward, these possibilities were often not brought to the attention of commanders. The photographers themselves felt that they might have been more gainfully employed if someone in authority had been interested in their work and had an understanding of the nature and possibilities thereof. As mentioned above, the lapse of time between the taking of pictures and the time prints could be viewed created in some instances a feeling of futility. The processing of motion picture film required extensive laboratory facilities and was done in the Paris area some three or four hundred miles in the rear of the final combat zone. Motion picture photographers therefore never saw the film they exposed without special arrangements being made to send them to Paris for this purpose.

e. The photographic company as organized under Table of Organization 11-37 lacked personnel and equipment for portrait work. In headquarters the size of an army or larger, there will always be a demand for photographic portraiture. Nowhere does it appear that provisions were made in tables of organization for personnel or equipment to furnish this service at any echelon. The task was adequately performed but at the expense of both photographers

and equipment diverted from other purposes.

f. The editing of motion picture film likewise required the full time of a large number of people. As in the case of portrait pictures, no personnel was specifically provided in Theater photographic organizations for this work. Its performance also was accomplished by personnel diverted from other duties.

98. Employment of Photographic Personnel in Rear Areas.

a. The 3908th Signal Service Battalion (Photographic GHQ) was assigned to handle photographic needs in the rear areas of the European Theater. It operated in London and Paris. At these two localities large laboratories were established to process all motion picture film exposed by Signal Corps photographic personnel in the Theater and to handle quantity reproduction of still pictures. The demands for portrait work at the Theater Headquarters was on a large scale and required the assembly of a considerable amount of special equipment.

b. The Photographic Officer, on the staff of the Theater Signal Officer, headed the Theater Army Pictorial Service. His organization handled the administrative matters incident to assuring an adequate flow of photographic supplies and equipment and certain personnel matters. The Photographic Officer was charged with the fulfillment of the Signal Corps' photographic responsibility. From conferences and discussions with personnel who composed the photographic staff, it would appear that too much emphasis was placed upon the taking of pictures for public release purposes with a consequent lack of attention to performing the Signal Corps' primary photographic mission of exploiting those things photography could contribute to the immediate prosecution of the war from a tactical viewpoint. A clear delineation of the Signal Corps' responsibilities incident to photographic coverage for public release needs to be made. While it has always been understood that the Signal Corps would make available for public release such pictures as were appropriate, it would appear that the large demand for original photography incident thereto was not anticipated in planning nor was adequate personnel and equipment provided for the purpose. In some cases there was a duplication of effort in securing of pictures for public release purposes when certain events were covered not only by Signal Corps photographers but photographers from the press as well. Closer coordination on the part of the Public Relations Division could have obviated this duplication to a large extent.

99. Photographic Equipment and Supply.

a. The Signal Corps is charged with the research, development, procurement and distribution of photographic supplies for the Army. Research and development is carried on at the Signal Corps Laboratories located at Astoria, Long Island, New York. Procurement and distribution of photographic supplies and equipment is effected through the normal channels employed to procure and distribute all other Signal Corps equipment. Nothing about the supplies under consideration is considered to be of such uniqueness as to warrant special handling beyond such as was accorded Signal Corps equipment spare parts.

b. The personnel immediately concerned with photographic activities in this theater state that the principal definite things or improvements manifest in equipment emanating from the Signal Corps Laboratories in Astoria were:

(1) Blueprints describing the methods of mounting a tripod on a 1/4-ton 4 X 4 vehicle; and

(2) A special Simmons camera which arrived in this Theater a few weeks before termination of the war. This camera required special film not available in the Theater, and an insufficient supply of the subject film was furnished to effect an adequate test.

c. The handling of photographic supplies in the European Theater of Operations presented several difficulties that were never entirely overcome.

(1) Expendable supplies such as film, paper and chemicals were frequently in greater demand than available stocks would satisfy. Some of the shortages were due to a number of considerations beyond the immediate control of those concerned. While many organizations such as Engineer units, Military Police companies, Criminal Investigation Sections of Military Police Service Organizations, Cavalry Reconnaissance Troops, etc., have photographers and photographic equipment as organic authorizations, many others procured unauthorized photographic equipment for which supplies were requisitioned. It became difficult, if not impossible, to differentiate between those requisitions for which proper authorization existed and those for supplies for unauthorized photographic activities. There was no sound basis for editing requisitions even of the legitimate users of photographic supplies since requirements vary directly with the activities being covered and the photographic coverage being made.

(2) Another supply difficulty was the frequent lack of familiarity of depot personnel with the interchangeability of the various commercial photographic products. In some instances, both in the United Kingdom and on the continent, certain British or other non-American photographic supplies were procured. It immediately became apparent that unless personnel handling these supplies had some knowledge of their use and interchangeability, appropriate substitutions could not be made.

(3) The problem of spare parts for cameras and other photographic equipment was a repetition of that found in maintenance of other Signal Corps items of equipment; i.e., spare parts were not available in sufficient quantities. Several shutters or synchronizers may be worn out before the camera body is ready for discarding, but these parts were often not available and the whole camera was deadlined. Spare parts should be procured concurrently with the complete items for maintenance and maximum economy of equipment.

100. Training. Signal Corps photographic units were organized in the Zone of the Interior in several of the Signal Corps training centers. The personnel for these units was obtained generally by examination of the individual soldier's qualification card to determine if he was experienced in photographic work, or by selecting personnel who were interested in photography and wanted this type of assignment. Schools for the training of the individual soldier-photographer were conducted at Astoria, Long Island, New York. In many other instances, the soldier received his photographic training within his organization. Since combat photographers operate in the forward areas, it was essential that all members of photographic companies be given thorough basic training in addition to

specialty training in order to fit them properly to protect themselves and to accomplish their mission in a combat area. Experience in this Theater indicates that this desirable degree of training both in specialty and as soldiers was not always accomplished. For example, some of the photographic units reaching this Theater were found to contain personnel well trained as soldiers but poorly trained as photographers. In other instances, the converse of this proved to be the case. In at least one known case, lack of training in the basic knowledge that all soldiers should possess before entering a combat zone resulted in the death and capture of Signal Corps photographic personnel. In order for a combat photographer adequately and efficiently to discharge his responsibilities, it is essential that he also have a reasonable knowledge of the fighting tactics of the unit to which he is attached. If the photographer does not have this knowledge, it is only by the merest chance that he will secure pictures of real value. In addition to the training which the photographer receives in his specialty and in basic military training, he should be given every opportunity to participate in maneuvers in the Zone of the Interior. He should be attached during such maneuvers to a unit similar to the one that he is likely to be assigned to in a combat area. In this way he will receive a certain amount of combat indoctrination and feel less unfamiliar in his surroundings than he would were he thrown into a combat area without such maneuver experience. It is unreasonable to expect a combat photographer to do good work when, as is presently the case, he is required to spend protracted periods in the comparative safety of rear areas before being moved to the combat area. The combat photographer, if he performs his mission in a manner in which it is visualized he should, assumes practically the same risk as the combat infantry soldier does. It is the unusual person who can adjust himself to new and dangerous surroundings at a moment's notice. Combat indoctrination is considered to be just as important an item in his training as that of his ability to take pictures. Without the one, he cannot efficiently perform the other.

101. Conclusions.

a. The Signal Photographic Company does not afford the best distribution of photographic personnel for the accomplishment of the combat photographic mission.

b. The decentralization of responsibility for still and motion picture photography to the interested units, (including the Signal Corps) together with the personnel and equipment necessary for implementation appears desirable.

c. Since the processing of motion picture film requires extensive laboratory facilities it appears desirable to leave this activity a responsibility of the Signal Corps together with the responsibility for such other activities as; portrait photography, the production of photographic prints in bulk, etc.

d. The responsibility for research, development, design, production and distribution of photographic equipment and supplies now rests with the Signal Corps and might well remain so.

102. Recommendations. It is recommended that:

a. Further study be made to effect the decentralization of all still and motion picture photography (other

than that covered in recommendation "b" below) to the services concerned (including the Signal Corps), with the Signal Corps continuing to be charged with the development of photographic equipment, photographic supplies and the processing of motion picture film.

b. Plans be formulated for a Signal Corps photographic organization for use at theater headquarters level to be charged with:

(1) Processing and editing all motion picture film for the theater;

(2) Portraiture;

(3) Production of still picture prints required in large quantities;

(4) Special feature coverage.

Notes:

1. See list of principal consultants included as a part of this study.

2. See Change Number 2, Paragraph 17, Annex 7 (Signal) to Joint Plan "Overlord".

3. See Field Manual 11-20, paragraphs 54, 55 and 56.

APPENDIX 1

FREQUENCY ALLOCATION

Statement by Major Everett O. Bundy, formerly of Signal Section, Headquarters 12th Army Group:

"The frequency allocation method as published in Supreme Headquarters Allied Expeditionary Force Signal Instructions has been an extremely satisfactory method as evidenced by the lack of criticism. Practically everyone concerned with frequency allocation has agreed that this was the best possible solution to an extremely complex problem.

"The greatest difficulty encountered was the lack of sufficient frequencies between two (2) and six (6) megacycles. This was caused by the distances involved and the authorized and available types of equipment, which necessitated the repeated sharing of frequencies and consequent interference between nets. Weakness in the method of frequency allocation used was that no mandatory provision was made for daily changing of frequencies at the time the call sign was changed."

Statement by Officers of Radio Branch, Communications Division, Office of the Theater Chief Signal Officer, Theater Service Forces, European Theater:

"The method of frequency allocation used by Supreme Headquarters Allied Expeditionary Force was very satisfactory. For such an operation as was carried out in the European Theater, all frequencies must be controlled by one agency."

From Report on Operations, First United States Army, 20 October 1943 to 1 August 1944:

"Frequency system developed by the British and used by our forces under supervision of Supreme Headquarters Allied Expeditionary Force is good."

APPENDIX 2

SECURITY MONITORING

Statement of Signal Officer, Seventh United States Army:

"In the Staff Information and Monitoring Company, Seventh Army was provided some personnel and equipment for radio security monitoring, but there are two reasons why the arrangement was not completely satisfactory.

a. The Staff Information and Monitoring Company had a dual mission: Obtaining tactical information, and checking radio security. Whatever the original intent in setting up the organization, in actual operation the obtaining of tactical information was treated as the primary mission, and the efforts applied to its accomplishment did not contribute materially to the security mission. Consequently, the personnel available for security monitoring was rarely first rate.

b. The only individual in Seventh Army who had the effective services of radio monitoring personnel was the Army Commander himself, since all such personnel were in the Staff Information and Monitoring Company and the services of this company were required by Army. Commanders of subordinate units were benefited by the Staff Information and Monitoring service only insofar as they could make constructive use of the security violation notices which had to come to them through command channels, and, after careful analysis of the monitoring logs there was an unfortunate delay between any breach of radio discipline and the possibility of corrective action. Every unit commander whose responsibility it is to establish and maintain radio nets should be provided the means to monitor them."

Statement of Signal Officer, XXIII Corps:

"Monitoring of friendly radio nets was never adequate due to unavailability of sufficient personnel. A solution would be the employment of monitoring teams not a part of the unit operating the net."

Statement of Signal Officer, XXI Corps:

"Personnel available for monitoring our own nets was inadequate except for spot checking. The employment of a security monitoring detachment is recommended."

APPENDIX 3

RADIO RELAY EQUIPMENT

Statement of Major Eugene P. Halpin, formerly of Signal Section, Headquarters 12th Army Group:

"The following modifications and improvements should be made in Very High Frequency equipment:

a. Improvement of antennas to provide a better match to transmission lines, greater directivity, and increased strength to resist high winds.

b. Improvement of limiters to eliminate amplitude modulation, thus decreasing noise and interference.

c. Redesign of crystal circuits to provide stronger and more stable oscillations.

d. Improvement of plate tuning condenser in the transmitter to reduce arcing. This improvement should include dust-proofing.

e. Improvement of interconnecting cables to reduce noise.

f. Provision of power supplies that are suitable for continuous operation. The present PE-75 is not suitable for this purpose. A multichannel set such as the AN/TRC-6 is more suitable than the AN/TRC 3 and 4 for use from the main echelon of Army Groups and Communications Zone to Army Headquarters. An improved AN/TRC 3 and 4 should be used for Army Group Tactical Headquarters to Army Headquarters, from Army Headquarters to Corps Headquarters, and from Corps Headquarters to Division Headquarters. Mobile light weight equipment providing two telephone channels and one teletype channel should be developed for use from Division Headquarters to Regimental or comparable headquarters. This should be on a different, probably lower frequency range, than the present AN/TRC 3 and 4. The Very High Frequency radio link equipment itself stood up well under mobile situations where moves were frequent, but great difficulty was experienced in providing transportation, messing and administration for crews. The Very High Frequency team should be so equipped as to enable it to function as a self sufficient unit."

Statement of Major Oliver C. Dunbar, formerly of Signal Section, Headquarters 12th Army Group:

"The fact that Very High Frequency Equipment has been used so extensively by all echelons from corps back to Communications Zone, and by the Ninth Air Force, throughout all phases of the campaign appears to be sufficient proof that Very High Frequency is already considered an integral part of the communications system. However, in the past, the subscriber has almost always been informed that he is talking over a non-secret radio link, thus implying that there is less security in a Very High Frequency circuit than there is in a wire circuit. But Field Manual 24-5 stipulates that no material higher than "Restricted" may be discussed over a wire circuit. Furthermore, interrogation of many German radio intelligence men indicates no case of successful enemy interception of Very High Frequency transmissions. If it can be assumed from this that Very High Frequency circuits are as secure as wire circuits, then the users need never know whether they are talking over wire or radio. This fact can assure complete integration of Very High Frequency into the overall communications system. The necessity

for extending the use of radio link equipment from division to regiments and battalions was first brought out by First Army last December (1944). The Signal Officer, First United States Army, in conjunction with the Technical Liaison Section, Communications Zone and the LMT Laboratories, Paris, constructed a model using SCR-300's. It is not known what success resulted from the use of the set."

Statement of Signal Officer, XX Corps:

"I should say, based on our experience in XX Corps, that the VHF radio link equipment issued to us was suitable for integration with the overall communication system, but I would like to qualify that by saying that there is plenty of room for improvement.

"Our experience with VHF radio link in XX Corps was as follows: We got the equipment essentially on loan from Third US Army, one or two systems at a time, and never had as many systems as we wanted. Our serious difficulty was that our corps signal battalion, being organized under the April, 1942 Table, was already short of transportation. We received no additional transportation with the VHF systems and had to appropriate already scarce 2 1/2 ton 6x6's in which to mount the VHF and associated equipment. This caused a serious transportation problem with us and the only reason we got by was that the corps signal battalion had appropriated a great deal of captured transportation, all of which was put to use hauling equipment or impediments. The action was so rapid that there was not time for shuttling and we had to use this additional transportation. I enlarge upon this because it was our biggest problem in connection with VHF. I think the VHF and associated equipment was more bulky than necessary. I would suggest a definite program running throughout the years to develop smaller and lighter VHF radio link equipment because I am certainly convinced that there is a definite need for this communication equipment. It "saved our necks" a number of times when the action was to rapid for the installation and/or maintenance of wire to divisions. VHF radio link communication equipment should be employed to and including combat command headquarters in armored divisions and combat team headquarters in infantry divisions. If smaller and lighter equipment can be developed, I should recommend its use at even lower echelons.

"Although bulky, the VHF equipment we had lent itself quite readily to mobile situations. Of course, this equipment has to be spotted on high ground and at times there was some little difficulty in getting it to such high ground. However, the 2 1/2 tons 6x6 was able to negotiate almost any kind of trail or road so most of the time it was possible to get this equipment on suitable high ground in the vicinity of the CP. The biggest hurdle from the view point of consumption of time was the construction of satisfactory wire circuits from the VHF station to the switchboard. Another weakness was the shortage of VHF radio link equipment. Generally speaking, we did not have sufficient sets to afford installation at a new location before tearing down the old location. I should say that with duplicate equipment for "leap frogging" and with smaller and lighter equipment, the portability would be satisfactory for fast moving situations."

Statement of Signal Officer, XV Corps:

In answer to the question - "Is the present type of Very High Frequency radio equipment suitable for integration with overall communications systems?"

"Yes, it provides a rapidly installed and reliable communication channel and, at times, the only feasible means of electrical communication.

"Improvements are suggested as follows:

a. An antenna system that is more rapidly erected and, in the dark, more easily erected than the present antenna system.

b. Single dial tuning control, or, in any event, reduction in the present number of controls.

c. Provision for use of 110 or 220 V, AC, with more fluctuation tolerance than the present equipment.

d. A channel equalizer to correct gain of individual channels when several (more than three) relay stations are in a circuit.

e. Lighter and more compact carrier equipment.

f. A PE-95 to be substituted for PE-75's at higher headquarters (corps) terminal station.

g. A wider frequency range is required as interference from other VHF constituted a serious problem. Part of the interference was from nearby VHF and could not always be predicted due to interaction of several sets in one small physical area.

h. Develop light weight power supply and carrier equipment for use of small units and the airborne troops. Weight of the present VHF equipment except antenna and carrier equipment is satisfactory for subject troops."

In answer to question "What is the lowest echelon at which Very High Frequency link equipment should be employed?"

"Present equipment to include division headquarters. Lightweight VHF and carrier equipment to include infantry regiments."

Statement of Signal Officer, Seventh US Army:

"The present type of VHF equipment such as AN/TRC-3, AN/TRC-4, and AN/TRC-6, are considered ideal for integration with overall communication systems. Although this equipment is believed ideal, the following suggestions and criticisms are offered:

a. For AN/TRC-3 and 4 equipment, the power equipment is unsatisfactory. The PE-75 used in pairs when supplying current to an installation has a running period of three and one half hours. This means at any one installation an interruption of service every three and one half hours lasting from one to five seconds. The multiplication of these interruptions in the several installations in any system (to include remote carrier and repeater equipment providing a circuit) makes that circuit unsatisfactory especially for teletype. Other objections to PE-75 are high incidence of maintenance, voltage instability, and hand cranking.

b. The following changes in power equipment are recommended:

(1) That two power units be furnished per station, each capable of delivering three kilowatts.

(2) That the power units be trailer mounted.

(3) That a switching panel be provided for instantaneous cut over.

(4) That the gasoline tank have sufficient capacity to provide for eight hours continuous running.

(5) That the units be self-starting.

c. It is also suggested that where six or more terminals are in use, as at army group or army headquarters, provisions be made to separate the transmitters from the receivers to eliminate interference between the two. This can be accomplished with the present equipment but difficulty is experienced in control and engineering."

Statement of Signal Officer, VI Corps:

"It is suggested that VHF radio link equipment and the carrier equipment used with it be permanently mounted in a vehicle of high mobility and of such type as to permit comfortable conditions for its operation. Such a vehicle should contain the necessary equipment to serve either as a terminal station of a system or as a relay station within the system. It is recommended that the complete combination terminal-relay station be designated and issued as the unit of VHF. This suggestion is based entirely upon the experience gained from the tactical use VI Corps made of VHF equipment during the period 15 March 1945 to 9 May 1945. Technically the AN/TRC-1 and CF-1 used between corps and division was extremely satisfactory. Two terminal stations, one at corps, and one at division, were sufficient in nearly all cases to provide two talking circuits and one teletype circuit, which were sufficient to meet the communications needs until land lines were installed. It was necessary to equip each station as both a terminal station and as a relay station in order to provide relay stations that were used on occasions. The present type of VHF radio link equipment has been proven to be suitable for integration with overall communications systems. It was first used between First US Army Headquarters on the Normandy beachhead, and First US Army Rear Echelon on the English coast, permitting teletype traffic to any British or American headquarters in England. With VI Corps, at one time during the Battle of Germany, it was possible to talk to Paris, France, from division headquarters, using four echelons of radio link equipment: division to corps, corps to army, army to army group, and army group to Paris. The alternative use of land links and radio circuits between any of the intermediate headquarters seemed to be just as practical, except that radio link was more dependable on all occassions.

"A practical employment of the present type VHF radio link equipment can be made as far down the chain of command as division headquarters. The number of frequencies now available would not permit the use of the same models at army group, army, corps and division. A VHF radio link set designed for similar operation to the AN/TRC-1, that is to provide at least two talking circuits, small enough for operation in a forward regimental command post, and operated on frequencies that would not interfere with the VHF radio link equipment being used by higher echelons would be the answer to a Division Signal Officer's problem of maintaining continuous voice communication with regiments. Unless an entirely different type of equipment is used within the division, VHF radio link equipment is recommended for employment only to division level.

"The VHF radio link equipment used in VI Corps was installed in mobile vans similar to the Ordnance Small Arms

Repair Truck and did therefore lend itself to the very rapid situations that occurred. When carefully planned and executed, the moves of division command posts were made without interruption to telephone communication between corps and division commanders. It proved to be dependable enough for the corps commander to speed up the advance of the corps without jeopardizing communications beyond a reasonable risk. This is a fact. However, it is pointed out that very, very close liaison and understanding must exist between the signal officers and the commanders of corps and divisions in order to make the maximum use of additional mobility through VHF radio link equipment."

Statement of Officers of the Radio Branch, Communications Division OCSigO, TSFET, regarding the integration of Very High Frequency radio link equipment with the overall communications system:

"Integration with the AN/TRC-6 type equipment is far superior to that possible with the AN/TRC-3 and AN/TRC-8 types. Equipment should be reduced in size and weight, operation should be simplified and power units should be improved. Recommend variable frequency control similar to method used in AN/TRC-8 be employed in preference to crystal control used in AN/TRC-3. Continuously variable frequency control would enable operating personnel to avoid interference that often renders VHF circuits unusable due to lack of proper crystals at the various installations. In the European Theater it has proved virtually impossible to provide sufficient crystals at the relays and terminals to insure continuous operation devoid of interference."

In reference to VHF equipment and fast moving situations:

"Many mobile installations were made and these often proved very satisfactory. However, a kit for making mobile installations, miniaturization of equipment, utilization of a four wheel 1 1/2 or 2 ton trailer for mounting, and the development of a suitable antenna would greatly enhance the value of the radio link for fast moving situations. Mobility was limited to a certain degree by inability of staff officers to adequately plan and engineer their circuits. More training in this work is needed, for better engineering standards must be adopted by all VHF staff planners."

APPENDIX 4

PERSONNEL AND EQUIPMENT

Statements given below were in answer to the question - "Were personnel and equipment furnished you on T/O and E basis adequate for the successful performance of your mission as far as radio communication was concerned? Please cite some specific examples."

Statement by Signal Officer, XXIII Corps:

"Existing T/O and E were adequate for operating under normal conditions. Very often the situation was abnormal and there was insufficient personnel and equipment to handle the job. Example: In April, 1945, XXIII Corps was operating with six divisions. This necessitated the use of two command nets. It was also necessary to send radios and operating teams to two engineer groups. Twelve hours of continuous radio operation for one operator was the rule rather than the exception. This materially decreased the effectiveness of the entire radio operations.

"KP and guard duty was required for highly trained radio operators further reducing their strength. A solution would be the use of a service platoon for such duties.

"No provision was made in the Signal Battalion T/O for VHF operators. Personnel required was taken from other sections. Training provided for the work was very brief and inadequate. Personnel for this work should be added to the T/O."

Statement by Signal Officer, VI Corps:

"No. In both the 1st Armored and the 2d Armored Division, the radio section of the division signal company was inadequate to perform the mission. Three additional SCR-399 radio sets with crews were added to the 142d Armored Signal Company of the 2d Armored Division prior to the invasion of Normandy, France, under the First US Army. Additional operator personnel and CW sets were added to combat command headquarters, and in several other places in the division. Recommendations for these changes have been submitted several times and should be available at the Office of the Chief Signal Officer, Washington, D. C., Hq, 1st Armored Division, and Hq, 2d Armored Division. The T/O and T/E basis, even though inadequate in the cases mentioned, is preferred to any other type basis of authority and issue.

Statement by Signal Officer, XX Corps:

"No. Generally speaking for the signal battalion, they had sufficient radio sets if there were no regard for type and physical characteristics of sets but in actual application the supply of mobile and sufficiently powerful radio sets was inadequate. Third US Army furnished us several extra SCR-399 sets for example, and during the rapid movement of August, 1944, and again in March and April of 1945, excellent use was made of these extra and above T/O and E radio sets. There were on the T/E for the corps signal battalion some four SCR-177 radio sets. They were used very little and were in effect excess baggage because they do not lend themselves well as installed vehicular radio sets. I would say that the SCR-177 did not pay

for itself. On the other hand fairly good use was made of the SCR-193 which was mounted in 3/4 ton C&Rs. The difficulty with the SCR-193 is largely in the matter of battery charging. In cases where there was such use of this vehicular-installed radio, the vehicle motor had to be kept running as a means of charging the battery and this certainly was an uneconomical power plant for this purpose. I recommend continued experimentation in the matter of vehicular radios."

Statement by Radio Officer, 94th Signal Battalion:

"Adequate personnel requirements to operate the corps and division terminals of a VHF link are found in two EF and one EO teams. For the equipment to be maintained in the best operating condition, it should be issued to the link carrier platoon on an organizational basis instead of from an army pool. Several pieces of equipment were operating only 60% of their efficiency due to the fact that the same set of tubes had been in continuous use with three or four different corps and no tube operation charts had been forwarded with them. A tube checker could not show the actual condition of the tubes and they were replaced completely in III Corps to insure correct operation. Operator maintenance was also lax due to the use of "borrowed" equipment.

The T/O allowances for the radio platoon was 42 operators and nine drivers. The T/E allowance was three SCR-399s, four SCR-193s and four SCR-188s.

"The SCR-188s were unsatisfactory for our purpose mainly because they lacked mobility. The SCR-399 proved to be the only radio set that was completely dependable. During the Ardennes operation, several armored division were employed. Their unexpected move into that sector didn't allow time to reassign frequencies and as a result station interference was at a maximum. It was impossible to operate any set dependably during this time except the SCR-399.

"After the crossing of the Rhine River the III Corps advance was so rapid that AM radio was at times the only means of communication. The radio platoon and equipment was split into two parts. One half for the III Corps Tactical Headquarters and the other for III Corps Main. This caused the operators to work as high as fifteen to eighteen hours a day while we were advancing.

"We found that it was necessary to maintain a centrally located point for coordinating all radio traffic. The personnel and equipment required for each echelon was six radio operators, one SCR-342 receiver, one BD-72 switchboard and one teletype machine. The SCR-342 receiver was used for monitoring the tactical air nets to provide information for G-2 Air.

"Two trunk lines to the corps switchboard and local lines to all dispersed radio sets were connected to the BD-72. We had direct TT communication with message center so that traffic could be immediately handled between the two means. This installation was called the Radio Center and had complete control of the radio situation.

"During III Corps' advance into central Germany, it was found that one net control station could not handle all traffic to the divisions. Therefore a point to point net was established with each division. All stations were required to be in continuous operation. There were times when the divisions were out of range of our SCR-399s. We had

to alternate our SCR-399s from one net to another in order to maintain continuous communication. The situation could have been greatly alleviated had we been allowed ten SCR-399s; two SCR-193's would be beneficial for reconnaissance work."

Statement by Signal Officer, XXI Corps:

"Radio communication personnel as allowed by T/O were adequate. The substitution of four SCR-399 radios for the four SCR-188 radios allowed by T/O & E 11-18, 19 December 1943 is recommended. As an alternative, two SCR-193 and two SCR-399 radio sets could be substituted. This recommendation is based on the lack of portability and loss of security due to the antenna of the SCR-188.

"Some difficulty was experienced in receiving signals of subordinate headquarters using radio set SCR-177."

Statement by Signal Officer, XVI Corps:

"The T/O & E was inadequate. We used two extra sets SCR-399, one extra set SCR-499, one extra set SCR-506 and five extra sets SCR-193. The SCR-399's and the SCR-499 were invaluable when displacing corps CP. The SCR-506 and the SCR-193's were used by corps liaison officers to send information from front line units to Corps CP."

Statement by Colonel T. H. Maddocks, formerly Chief, Communications Branch, Signal Section, Hq. 12th Army Group:

"This is a long story, involving unexpected demands, such as the G-3 (air) and the G-2 (air) nets, "T" force, etc. With our 12 SCR-399, T/E sets, plus 46 eventually obtained from the 3187th (originally used for the G-3 (air)-6; balance for US-BR links where we were to handle both ends), we would have been about right. The 3103d helped out prior to receipt of the 3187th's last 20. An argument develops as to whether senior headquarters should man both ends of a link or all stations in a net (higher headquarters level). This applies also to radio relay. I personally think that each headquarters should have personnel and equipment to do entire job at headquarters and any relay stations to lower echelons. However, this means, to conserve personnel and equipment, a Theater pool with personnel (and equipment) attached to lower headquarters for duration of need."

Statement by Major Bundy, formerly member of Radio and Radar Group, Signal Section, Headquarters, 12th Army Group:

"No T/O and E organization is set up for army group headquarters' radio operations and no T/O and E organization exists that is suitable for the purpose. Two signal operations battalions were originally assigned to Headquarters 12th Army Group, but these were totally inadequate, containing only manual Morse operators and twelve radio sets SCR-399. Radio sets SCR-193 and SCR-177-B furnished these two battalions were little or no use due to the distances involved and necessity for remote control operation. No VHF personnel were initially available to Headquarters 12th Army Group, though in August, 1944,

one-half EF team and two EO teams were secured. These were supplemented by personnel from replacement battalions as an overstrength to the Signal Section, Headquarters 12th Army Group. This latter personnel were radio repairmen, who however, were not trained on VHF equipment. The arrival of the 3187th Signal Service Battalion in January 1945 partially alleviated the HF shortage, but no RTT personnel or equipment, which was badly needed, were ever available to the headquarters. The 3186th Signal Service Battalion arrived in March 1945 to operate VHF equipment and Detachment A, 3190th Signal Service Company arrived in June 1945 to operate SHF equipment. If these units had been available prior to the invasion, much of the difficulty encountered in radio communication would have been eliminated."

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Statement by Signal Officer, XII Corps:

"No! More transportation for equipment and personnel in both HF and VHF radios is needed. In addition, there is a shortage in personnel and equipment for VHF in operation such as were carried out in this theater."

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Statement by Signal Officer, XV Corps:

"No! This Headquarters was issued 5 SCR-399, 4 SCR-193, and 4 SCR-177. The latter sets were almost useless and two or more of them were always dead-lined. This Headquarters operated 6 nets, which necessitated use of 12 sets when the CP and advance CP were in operation. The failure of the SCR-177 often upset the radio picture and forced changes at awkward moments.

"It is suggested that Corps' T/E be changed to include 10 SCR-399 plus 4 SCR-193 or SCR-188. Preceding would permit 6 nets plus advance CP to operate and leave 2 spares or sets for special jobs as relay stations, liaison, etc.

"Preceding problem should be studied and standard remote control unit devised. Suggested is a van type vehicle equipped with operating desks and separate AC power supply such as PE 95 plus storage battery supply to permit BC-312 to be utilized in lieu of BC-342. At least 3 receiving positions should be equipped with a built-in loop antenna to help minimize interference. Balance of receiver positions should have a good all-wave or universal antenna with suitable distribution system. The van should have built-in teletype and telephone positions.

"Transmitters should be designed to work on remote control without immediate operator supervision for periods of 6 hours or more.

"Keying units should be designed to work up to five miles on W-100B, or longer on lines of lower resistance (Spiral Four) and should be simple, and fool proof.

"A van similar to the one at the receiving location should be available at the transmitting location to be used in event the keying lines fail."

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Statement by Signal Officer, Third United States Army:

"Personnel provided by the T/O for the operation of CW radio were adequate. This headquarters operated as many as 8 SCR-399's at the forward echelon, with one set at the rear echelon. Personnel were sufficient for the operation of the above, with the same number of personnel standing by for displacement of the headquarters.

a. Personnel for the operation of radio link, had they

been provided as complete EF and EO teams in the number specified by T/O 11-500, would have been sufficient. However, the number of personnel furnished this headquarters for radio link operation was grossly inadequate.

b. Examples: (On radio)

(1) On 1 January 1945, circuits terminating at the Headquarters, Third US Army were as follows: Headquarters, Third US Army to -

(a) III Corps, VIII Corps, XXI Corps and XX Corps,
(b) 12th Army Group (TAC)
(c) Headquarters, 12th Army Group
(d) Headquarters, 12th Army Group
(e) Seventh US Army and First French Army
(f) First US Army, Ninth US Army and Communications Zone.
(g) Eight Air Force
(h) Third US Army (Rear Echelon)

(2) On 12 March, 1945, circuits terminating at the Headquarters, Third US Army were as follows: Headquarters, Third US Army to --

(a) XII Corps, VIII Corps and XX Corps
(b) 12th Army Group (TAC)
(c) 12th Army Group (Parallel Circuits)
(d) 12th Army Group (Parallel Circuits)
(e) First US Army, Ninth US Army, Advance Section, Communications Zone.
(f) Seventh US Army, First French Army.
(g) 65th Medical Group, 66th Medical Group, 92d Gas Treatment Battalion.

(Note: T/O personnel from the Signal Operations Battalion were operating all stations serving Medical Units.)

(3) On 6 May, 1945, circuits terminating at Headquarters, Third US Army were as follows: Headquarters, Third US Army to --

(a) III Corps, V Corps, XII Corps and XX Corps.
(b) 4th Inf Div, 70th Inf Div, and 36th AAA Brigade.
(c) Seventh US Army and First French Army
(d) 12th Army Group (Tac)
(e) Twelfth Army Group (Parallel Circuits)
(f) Twelfth Army Group (Parallel Circuits)
(g) Advance Section Com Z, and 24th Regulating Station
(h) Third US Army, (Rear Echelon), 65th Med Gp, 66th Med Gp, 92d Gas Treatment Battalion.

(Note: T/O personnel from the Signal OperationsBattalion were operating all stations serving Medical Units)

In each of the above examples, adequate personnel was available to displace all circuits should the headquarters move.

c. Personnel furnished this headquarters for the operation of VHF radio link equipment was grossly inadequate. On the other hand, it is believed that had personnel been provided as complete EF and EO teams (T/O & E 11-500) operating personnel would have been sufficient.

(1) On 23 August, 1944, radio link circuits were being operated from Headquarters, Third US Army as follows: Headquarters US Army to --

(a) XXII Corps
(b) XII Corps
(c) XV Corps
(d) Rear Echelon, Headquarters Third US Army.

These circuits embodied a total of eight (8) terminals and three (3) repeater stations.

Personnel required to operate above	66
Personnel furnished	22
Shortage	44

(2) On 19 April, 1945, radio link circuits were being operated from Headquarters, Third US Army as follows: Headquarters, Third US Army to --

(a) First US Army
(b) Rear Echelon, Headquarters Third US Army
(c) III Corps
(d) VIII Corps
(e) XII Corps
(f) XX Corps

These circuits embodied a total of eleven (11) terminals and five (5) repeater stations.

Personnel required to operate above	96
Personnel furnished	30
Shortage	66

(3) Those circuits in c (1) above, according to T/O and E 11-500, should require a total of 66 radio operators alone, while those in c (2) above should require a total of 96 radio operators. A total of 5 EO teams, or 30 operators, were made available to, and employed by, this headquarters. Any additional personnel employed were recruited from diverse sources such as the organic Signal Operation Battalion, Repair Company, and Depot Company, thereby causing such organizations to be short personnel considered necessary to fulfillment of their primary missions.

d. It is realized that the employment of 6 EO teams to operate 6 terminal stations at our headquarters in no way approaches the maximum in efficient use of personnel; however, where personnel are made available according to T/O & E 11-500, sufficient personnel are at hand to displace circuits, repair and maintain equipment, and attend to all administration and supply functions pertinent to the operation of such circuits."

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From "After Action Report", Third US Army:
August Operations - "A shortage of radio equipment and personnel made it necessary to put more stations in nets than was considered desirable. Personnel from repair company used to operate and maintain radio links."
September Operations - "Rapid movements caused shortages in VHF personnel."
Conclusions - "Pools of certain personnel should be available."

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From "After Action Report", 12th Army Group:
September, 1944 - "It is believed that the personnel shortage encountered at this time, of which VHF personnel constitute an important group, could have been averted by the more prompt shipment of signal personnel from the United States. Shipments were behind schedule."
October, 1944 - "The shortage of VHF personnel is still critical. There is more equipment available than there is personnel to operate the equipment."
November, 1944 - "The problem of obtaining sufficient VHF personnel remains a major problem."
December, 1944 - "The VHF personnel problem has been under intensive study. Critical situation has been temporarily relieved by the borrowing of personnel from Signal Units. No operators were available from GFRS."

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From "Analysis of Signal Problems" - ABSEC Signal Officer:

"EB or field radio teams proved to contain inadequate personnel to perform the function for which they were intended. Actual operating conditions often required a field radio team that was capable of operating independently. Therefore, the EB radio team should have been revised to meet those standards. This revision was accomplished by reforming the team to include four operators, trained in the use and rules of the M-209, one repairman and one powerman."

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From AGF Report No. 1109 - Monthly Report Signal Corps Activities, 28 July 1945:

Lt. Col. Brickson, Asst. Sig O, Third US Army:

"Two signal operations Battalions are necessary, one at each echelon."

Lt. Col. Nagel, 301st Sig Opns Bn:

"There should be at least two operations battalions with an Army of this size."