

RESTRICTED

FM 1-45

WAR DEPARTMENT

**AIR CORPS
FIELD MANUAL**



SIGNAL COMMUNICATION

RESTRICTED

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SIGNAL COMMUNICATION

**PREPARED UNDER THE DIRECTION OF THE
CHIEF OF THE AIR CORPS**



**UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON: 1940**

WAR DEPARTMENT,
WASHINGTON, *September 5, 1940.*

FM 1-45, Air Corps Field Manual, Signal Communication,
is published for the information and guidance of all con-
cerned.

[A. G. 062.11 (5-29-40).]

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RESTRICTED**AIR CORPS FIELD MANUAL****SIGNAL COMMUNICATION****CHAPTER 1****CHARACTERISTICS**

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SECTION I**GENERAL**

■ **1. SCOPE.**—This manual prescribes the requirements of a signal communication system for the Air Corps, the policies governing the use of such a system, and the means and methods to be employed.

■ **2. REFERENCES.**—FM 24-5, covering signal communication of all arms, is in general applicable to Air Corps signal communication and contains much pertinent data, particularly with reference to telephone and telegraph installations and radio operation.

■ **3. MEANS AND METHODS.**—Signal communication for the Air Corps comprises all the means and methods employed to transmit orders, instructions, and information between command posts on the ground, aircraft in flight and ground stations, aircraft in flight, for liaison with other arms and services, and during joint action with the Navy. An adequate and efficient system of signal communication for aviation forces will comprise message centers, wire circuits, radio, messenger service, visual and sound signaling.

■ **4. POLICIES.**—The basic policies for the employment of signal communication are as follows:

a. Wire is the primary means of signal communication for point to point communication on the ground.

b. Radio is the primary means of signal communication between aircraft in flight and between air and ground.

c. Radio will be used for point to point communication on the ground only when time has not permitted the installation of wire facilities or when wire facilities fail.

■ 5. FUNDAMENTAL CONSIDERATIONS.—The following fundamental considerations must be recognized in planning signal communication for aviation forces:

a. An adequate and efficient system of signal communication and sufficient trained personnel for the operation and maintenance thereof are essential to the efficient tactical employment of an aviation force, either in wartime operations or in field exercises.

b. The effective protection of an aviation force and its installations against air attack demands an adequate and efficient system of signal communication.

c. Full advantage of the capabilities of aircraft as combat weapons is realized only when adequate and efficient signal communication is provided.

■ 6. REQUIREMENTS.—a. Wire communication must be provided for communication within the following headquarters and between these headquarters and subordinate units:

- (1) GHQ (or THQ).
- (2) Air force.
- (3) Next subordinate headquarters.
- (4) Wing.
- (5) Group.
- (6) Squadron.
- (7) Base.
- (8) Auxiliary Air Corps units.
- (9) Army and its aviation.
- (10) Corps and its aviation.
- (11) Division and its aviation.
- (12) Air Corps fields.
- (13) Airdromes.
- (14) Balloon squadrons.
- (15) Weather stations.

b. Radio equipment and competent personnel to install, maintain, and operate it must be provided for—

- (1) Aircraft.
- (2) Ground stations.

■ 7. COOPERATION AND COORDINATION.—In groups and larger Air Corps organizations the entire communication system consists of all the subordinate communication systems, each installed, maintained, and operated by personnel of the separate organizations. Each subordinate system is operated so as to form a part of the general system so that messages may be transmitted rapidly and efficiently from one station to any other station in the system. Cooperation among all signal communication personnel as well as coordination of methods of construction, operation, and procedure is mandatory if the systems are to furnish maximum service.

SECTION II

ORGANIZATION

■ 8. CHARACTERISTICS.—*a.* A basic requirement of the system of signal communication for aviation forces is that it provides adequate and efficient communication service when the elements of the forces are operating from dispersed air-dromes.

b. A standard arrangement of signal communication for aviation forces in all field operating conditions cannot be prescribed because of the possible variations in dispersion of units. The lay-out adopted must fit the condition that exists in the particular area in which the aviation forces operate. The availability of existing commercial and private wire and radio facilities will determine the amount of new construction required.

c. While the signal communication equipment for the ground establishments of aviation organizations is, in general, the same as that employed by the ground arms, the greater dispersion essential for the combat elements of an air force may require longer wire lines.

d. The varied requirements for radio communication by aircraft in flight and by ground stations necessitate numerous different types of radio equipment. Their characteristics will vary with the purpose for which each is intended.

e. Signal communication for the Air Corps should be flexible and simple and be available when and where needed. Communication should be available to an air commander as

soon as his command post opens. Alternate means is provided as soon as possible.

■ 9. APPLICATIONS.—A system of signal communication for the Air Corps must provide facilities for—

Intercommand post or point to point ground communication.

Interstation communication within aircraft.

Liaison.

Air command.

Radio aids to air navigation.

a. Intercommand post or point to point communication comprises the various means of signal communication employed for communication between the command posts of the various Air Corps units.

b. Interstation (interphone) communication comprises the means employed for communication between the personnel of the individual aircraft crew.

c. Liaison communication comprises the various means employed for liaison between—

(1) Commanders in the air and their own or other headquarters on the ground.

(2) Commanders of units in flight.

(3) Observation and liaison aircraft in flight and ground stations.

(4) Reconnaissance aircraft to other aircraft and to ground stations.

(5) Rescue and retriever boats and aircraft in flight and ground stations.

d. Air command communication comprises the means employed for control of units in flight by the flight commander.

e. Radio aids to navigation comprise the radio facilities employed in air navigation.

SECTION III

RESPONSIBILITY AND AGENCIES

■ 10. RESPONSIBILITY.—The responsibility for signal communication is a command function. Each commander is provided with a signal or communication officer who is trained as a specialist in signal communication.

■ 11. CONTROL.—Two channels are utilized in securing control over signal communication.

a. All orders affecting the tactical employment of agencies of signal communication are issued through the normal channels of command and are coordinated with orders issued to other tactical or technical agencies by the appropriate staff section prior to issue.

b. Orders which are issued for the technical control of an agency of signal communication in routine matters, which do not need coordination with orders issued to other elements of the command, may be issued in the name of the commander, direct by the communication officer of the superior unit to the communication officers of subordinate units. The extent of employment of the direct channel by communication officers depends upon the relation existing between the individual commander and his communication officer. The unit communication officer must secure approval by his commander of all plans for signal communication prior to their issue in the form of orders. Plans for furnishing signal communication which affect other staff sections are coordinated with those sections prior to issue.

■ 12. DUTIES OF UNIT COMMUNICATION OFFICER.—The general duties of the unit communication officer are divided as follows:

a. During *training periods* the unit communication officer—

(1) Prepares the training programs for signal communication troops of his unit and subordinate units under the general policies laid down by his commander and by higher authority.

(2) Organizes and supervises such specialists' schools as prescribed by his commander or required by higher authority.

(3) Makes such inspections of the signal communication personnel and equipment of his own and subordinate units as his commander may direct, and submits recommendations to the latter concerning action that should be taken to correct deficiencies that may exist or to improve training methods or doctrines.

(4) Takes steps to secure and supply ample training and organization signal equipment throughout the command.

(5) Prepares such orders, regulations, and signal operation instructions as may be needed for the efficient training of the signal communication personnel of the command.

(6) Personally conducts the training and secures the training and organization equipment for the signal communication troops of his unit.

b. During actual or simulated combat conditions he—

(1) Prepares or secures from higher authority such orders and signal operation instructions as may be needed to insure the technical and tactical control of the signal communication systems of his unit. He insures the proper distribution of such orders and signal operation instructions throughout his unit.

(2) Acts as adviser to the commander and his staff on all matters pertaining to signal communication.

(3) Prepares the plans for the employment of the signal communication agencies of his own and subordinate units so as to insure the most efficient employment of these agencies at his own command post and the necessary coordination and technical control of the agencies of the subordinate units, subject to orders received from higher authority. He submits these plans to his commander or to the appropriate staff officers for approval.

(4) Prepares all signal orders based upon the approved plan of signal communication, transmits these orders to the proper issuing agency, and checks on the issue of these orders.

(5) Supervises the signal communication systems employed by his own and subordinate units to correct deficiencies and secure coordination between systems.

(6) Takes steps to insure replacement of signal equipment and personnel of his own and subordinate units.

■ 13. PERSONNEL EMPLOYED.—*a.* Signal Corps troops are charged with the installation and maintenance of all wire lines between all Air Corps headquarters, units, agencies, and installations except between groups and/or squadrons when they are immediately adjacent to each other.

b. Groups and squadrons are charged with the installation, maintenance, and operation of their internal wire communi-

cation facilities and for external wire communication under the exception noted in *a* above.

c. Wire communication and radio used solely for administrative purposes at air force, next subordinate headquarters, wing, and base headquarters are handled by Signal Corps personnel of the headquarters or base squadron concerned. All other communication facilities are handled by Air Corps personnel at the stations mentioned.

■ 14. AGENCIES.—*a.* The primary means of communication between ground headquarters and other establishments of the air force is by telegraph printer. Such communication is supplemented by—

(1) Telephone service, particularly where it is necessary to effect immediate personal contact between two or more individuals.

(2) Radio, when traffic is greater than can be handled by telegraph or when telegraph is not available.

(3) Airplane messenger, particularly for the transmission of documents, maps, etc., which cannot be electrically transmitted, and other messages such as routine requisitions, reports, etc., where rapidity of transmission is of secondary importance. This will free the electrical system for handling communications of higher priority.

(4) Automotive messengers and runners, normally used over relatively short distances.

b. The primary means of communication between airplanes in flight and between airplanes in flight and ground stations is radio. Because of the possibility of radio interception at various distances, indoctrination of personnel in the use of visual or other means of signaling between airplanes for routine command purposes is essential.

c. Exclusive reliance must not be placed on telegraph printer service for communication because special circumstances may make this means inoperative when communication is urgently needed.

CHAPTER 2

WIRE COMMUNICATION

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| SECTION I. General..... | 15-17 |
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SECTION I

GENERAL

■ 15. SYSTEMS.—*a.* Wire lines, together with their associated equipment, constitute the *wire system* and are the principal means of a signal communication between points on the ground.

b. The wire system consists of the *telephone and telegraph* systems. The telegraph system may be subdivided according to the type of equipment used into—

- (1) Telegraph printer.
- (2) Tone telegraph

c. For communication within individual airplanes an inter-phone system is provided.

■ 16. EMPLOYMENT.—*a.* The wire system is employed for the following purposes:

- (1) Intercommand post or point to point communication.
- (2) Communication within the organizations.
- (3) Communication within the airplane.

b. The telegraph printer and tone telegraph are employed for point to point communication.

c. The telephone is employed for person to person communication; between personnel of the various headquarters, within organizations, and to supplement telegraph printer service when additional channels are required.

■ 17. POWERS AND LIMITATIONS.—*a.* (1) The telegraph printer possesses many characteristics not found in other types of equipment. Some of these are relative secrecy, rapidity, accuracy of transmission and reception, and the capacity to

handle a great volume of traffic. Also skilled telegraph operators are not required for operation of telegraph printers, as messages are sent by operating a typewriter and are received in printed form. Its greatest disadvantages are that considerable time is required for the installation of such equipment, a factor which may prevent its use during the initial phase of a concentration, and that highly skilled personnel are required for maintenance.

(2) Two types of installations are possible, the fixed or loop and the exchange. With the fixed or loop installation, only one message can be transmitted at a time, but it will be reproduced at all stations on the loop. The TWX or exchange installation, whereby all establishments having two or more machines are provided with switchboards, affords greater flexibility than the loop installation. It permits of connecting machines to provide for the transmission of long messages without relay.

b. Tone telegraph is intended primarily for use when telegraph printer service is not available. It is an excellent means of communication and, while slower than the telegraph printer, is capable of handling large quantities of traffic. Its main advantages are the simplicity and dependability of the operating equipment, the short time required for initial installations, and the fact that by using tone telegraph, satisfactory operation can be secured over wire lines which are too poor for telegraph printer operation. Its disadvantage is that trained operators are required.

c. The *telephone* provides a very satisfactory means for direct communication between individuals. It can be installed relatively easily and permits of the direct interchange of ideas between the speakers. For this purpose it is both quick and effective. However, the telephone is not suited for the transmission of long messages or the transmission of large quantities of general information, and is a particularly poor means of transmitting messages in cryptographic form. For these latter purposes it should be regarded as a supplementary means to be used only when the telegraph channels available are insufficient to meet traffic requirements.

SECTION II

CIRCUITS

■ 18. TELEGRAPH.—The following minimum telegraph circuits are required between—

| | <i>Circuit</i> |
|--|----------------|
| GHQ and each air force headquarters..... | 2 |
| Air force headquarters and next subordinate headquarters..... | 2 |
| Wings and next higher headquarters..... | 2 |
| Wing headquarters and subordinate groups..... | 2 |
| Group headquarters and subordinate squadrons... | 2 |
| Air base and subbase headquarters and each group | 1 |

(See fig. 1.)

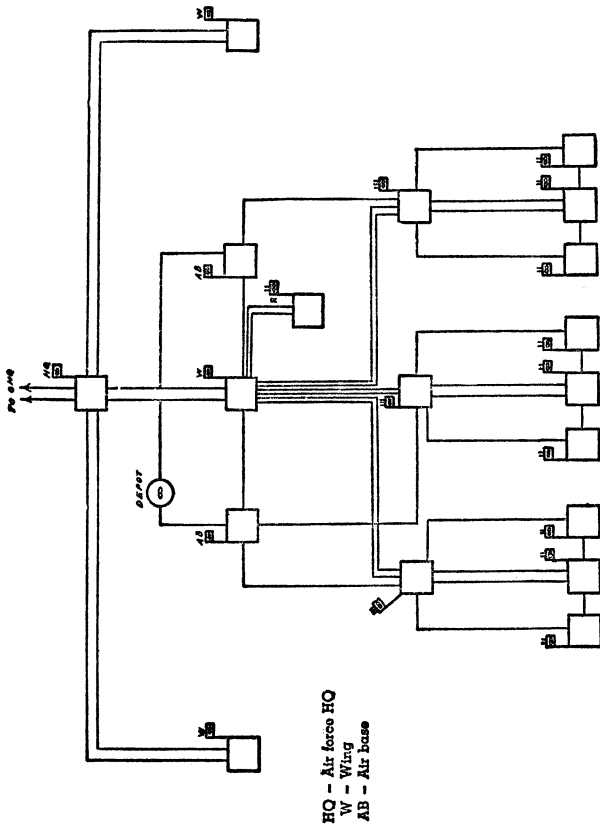
■ 19. TELEPHONE.—*a.* The following minimum telephone circuits are required between—

| | <i>Direct circuit</i> |
|---|-----------------------|
| GHQ and each air force headquarters..... | 1 |
| Air force headquarters and next subordinate headquarters..... | 1 |
| Each tactical air headquarters and air base headquarters..... | 1 |
| Each headquarters and each next subordinate headquarters | 1 |
| Each tactical unit and its railhead..... | 1 |
| Air base and subbase headquarters and each group | 1 |
| Air base and subbase headquarters and their railheads | 1 |

b. The local circuits are as required.

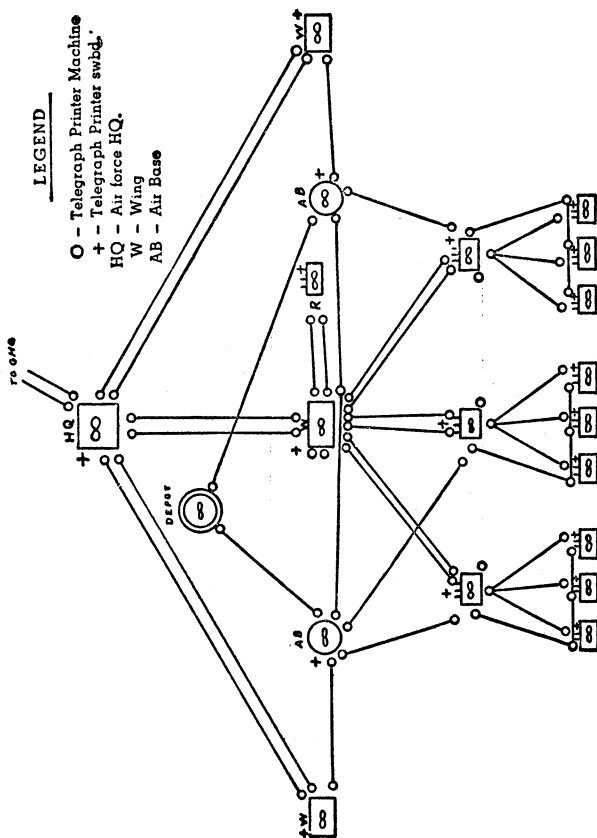
■ 20. COMMERCIAL CIRCUITS.—*a.* Telephone circuits are supplemented by long distance toll circuits, when needed, whenever commercial facilities are available.

b. Where available, telephone trunk circuits and telegraph printer circuits are leased from commercial communication companies.



① Circuit diagram; three wing type air force. FIGURE 1.—Telegraph printer.

HQ - Air force HQ
 W - Wing
 AB - Air base



④ Traffic diagram.
 FIGURE 1.—Telegraph printer—Continued.

■ 21. **ADDITIONAL CIRCUITS.**—Where commercial circuits are not available or are inadequate they are supplemented by additional construction by Signal Corps units, normally operating directly under the signal officer of the headquarters to which the Air Corps unit is assigned or attached. In special cases these construction units are attached to the Air Corps unit.

■ 22. **REQUIREMENTS.**—The Air Corps wire system is not ordinarily an independent system. Generally, it will form a part of the wire system of higher headquarters, such as GHQ or the headquarters of lower echelons of command with which the Air Corps unit is cooperating or to which it is attached or assigned. Initial requirements for wire circuits must be furnished the communication officer concerned to permit their lease or construction. Similarly increased circuit or new circuit requirements must be furnished the communication officer concerned as early as possible. Advance planning is indicated and communication officers must at all times keep in close contact with the operating division of the headquarters so as to obtain necessary information on future requirements. Requests for wire circuits and changes therein follow normal command channels.

■ 23. **CONSTRUCTION.**—Wire lines constructed for aviation units operating in direct support of ground forces are maintained by signal communication units of the supported forces. Wire lines constructed for aviation forces not so assigned or attached are maintained by signal communication units of those forces.

CHAPTER 3

RADIO COMMUNICATION

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SECTION I

GENERAL

■ 24. **EMPLOYMENT.**—Radio is the principal means of signal communication employed by aircraft in flight for interaircraft and air-ground communication. It is the principal means through which information as to hostile naval and aerial activity will be transmitted by aircraft.

■ 25. **EQUIPMENT.**—Radio sets fall into two general classes, those installed in aircraft and those used in ground stations.

a. Sets installed in aircraft include—

(1) Command sets.

(2) Navigation sets.

(3) Liaison sets of short, medium, and long range.

b. Radio sets installed in ground stations include fixed and mobile sets of medium and long range.

■ 26. **PURPOSES.**—Radio is employed for the following purposes:

a. By an air commander in flight for the purpose of command and for navigation.

b. For liaison between—

(1) Air units in coordinated action.

(2) Commanders of air units and their supporting reconnaissance.

(3) Aircraft in flight and an Air Corps or other ground station.

(4) Reconnaissance and observation and liaison aviation and the headquarters of the units to which attached.

c. For use in rescue and retriever boats.

d. For Army and Navy intercommunication.

e. For communication between command posts or point to point on the ground in emergencies or when wire is not available.

■ **27. RADIOTELEGRAPHY.**—Radiotelegraphy is the normal means of radio communication for ground point to point, air-ground, and air-air liaison between Air Corps units. For these functions the use of telegraphy is dictated by the need for accuracy of transmission.

■ **28. RADIOTELEPHONY.**—Radiotelephony is the normal means of radio communication for air-air command, navigational purposes, and for airdrome control. These require a speed of transmission that precludes use of telegraphy.

■ **29. POWERS AND LIMITATIONS.**—*a.* The range of radio communication is, in general, dependent upon the power of the transmitter, the frequency used for the transmission, and the electrical noise level at the receiving station. The range will be adversely affected by atmospheric and man made electrical interference.

b. Radio communication is not secret. This disadvantage necessitates the habitual use of cryptograms in transmitting messages by radio telegraph. For the same reason the radiotelephone should be used as little as possible. (See par. 42*b.*)

c. The approximate location of radio stations, either ground or those in aircraft, can be determined by hostile radio direction finder stations. Such information will permit the enemy to determine the approximate location of airdromes being used if radio ground stations are being operated thereat. Two or more radio fixes on airplanes in flight will permit the enemy to approximate the course and speed of the aircraft and from such information deduce the possible mission and objective. This disadvantage can be minimized by reducing the use of radio to a minimum and making all transmissions as short as possible.

d. Hostile stations can interfere deliberately with radio communication. Such a practice, however, ordinarily interferes with their own radio stations as much as with ours and is, therefore, not generally employed, except in those cases

where the force on a mission is dependent upon radio communication for the successful completion of its mission.

■ 30. RADIO NETS.—*a. Ground point to point nets.*—(1) In order that radio communication may follow the proper channels of tactical command, the radio stations of a superior unit and the radio stations of the next subordinate units are grouped into one net. Each net is designated by the name of the superior unit. A wing net includes the wing headquarters station, the group headquarters stations, and the stations at the headquarters of auxiliary or attached troops under direct wing control.

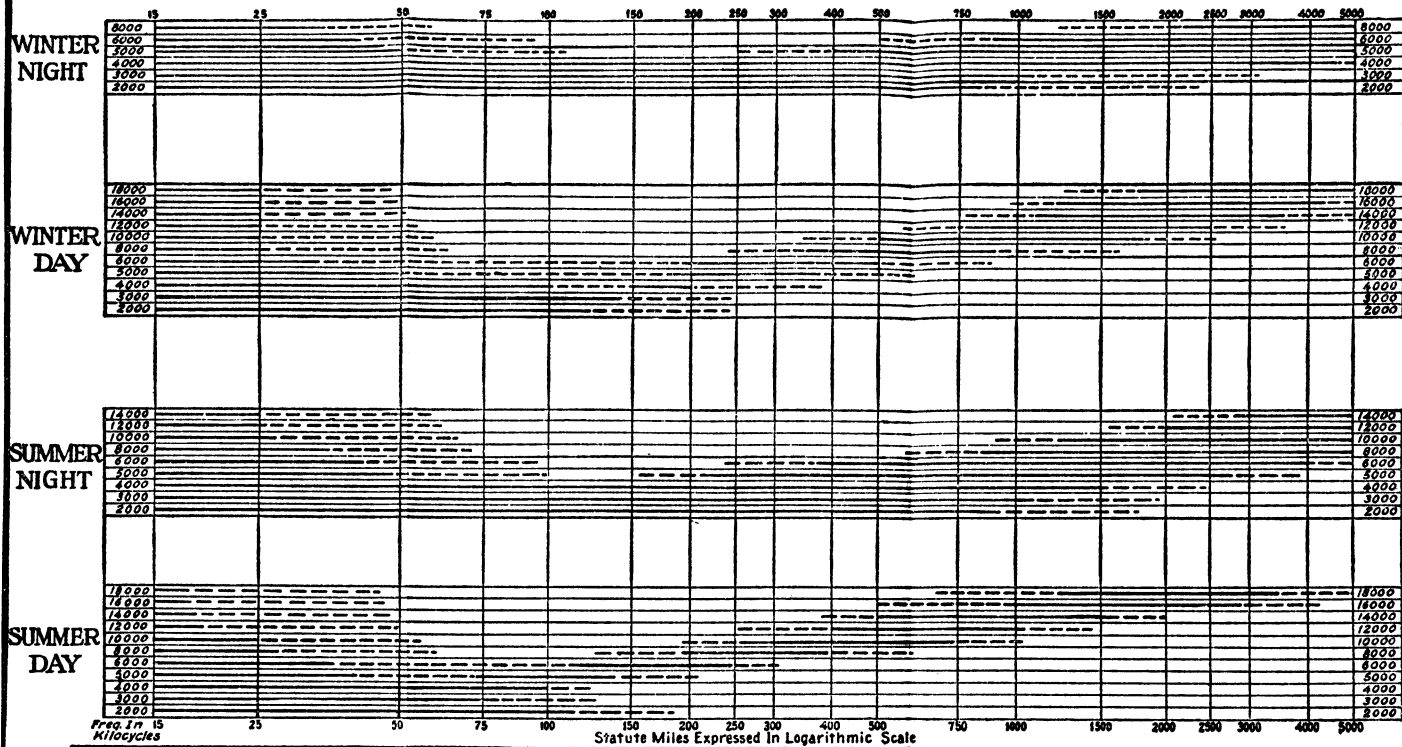
(2) The radio station at an air base is not generally included in any radio net. However, it is capable of direct communication with the radio station of any unit which it serves and in emergency may join any net.

(3) Radio communication between ground establishments will be kept to a minimum in order to leave communication channels free for air-ground communication, to prevent an enemy from intercepting transmissions, and to prevent revealing the location of headquarters and airdromes.

b. Air-ground and air-air liaison nets.—(1) In air force units the ground station employed in air-ground liaison communication is located at higher air headquarters, wing, or group headquarters. The radio stations located at these headquarters communicate with the command airplanes in flight of their subordinate units.

(2) In reconnaissance and observation and liaison units the ground stations employed for communication with airplanes in flight are at the unit headquarters or the headquarters of the supported ground force.

(3) Prior to take-off on a mission, the air commander is furnished with all available data for the completion of his mission, and radio communication with that commander is only required when the mission must be changed or important additional data have been received since take-off, or to provide continuous information of a moving or changing objective. The latter information is normally obtained by reconnaissance aircraft and transmitted to the ground sta-



Effective Range —————
 Variation Reported by
 Different Observers - - - - -

Skip Distance And Range
 Graph: 2000 to 18000 Kilocycles
For use as a guide only

FIGURE 2.—Useful range of high frequencies.

tion of the headquarters directing the reconnaissance mission and thence through command channels to the air commander.

c. Air command nets.—All airplanes of a group are included in the group air command net. The airplanes of separate squadrons are included in a squadron air command net. Exceptionally, a squadron of a group may have its individual air command net. Only in exceptional cases will a wing or higher commander require air command communication. Independent units which frequently operate together are assigned a common alternate command frequency to permit joint operations. Necessary instructions are issued in each case for the organization of air command nets.

■ 31. FREQUENCIES AND CALL SIGNS.—*a.* Frequencies and call signs are allotted by higher air headquarters and are assigned subordinate units by their next higher headquarters. Frequencies for air-ground use for cooperating missions are assigned by the unit with which aviation is cooperating.

b. Figure 2 indicates the useful range of high frequencies from 2,000 to 18,000 kilocycles, which will be used as a *guide* only and not as a definite rule as to usefulness of frequencies. Only through experience can signal personnel select the proper frequency under varying conditions and distances. As frequently more than one of the available frequencies is usable over the distance involved, it may be possible to select a frequency that will permit the transmission to skip enemy intercept stations, when the approximate location of those stations is known.

c. In order to provide the necessary channels for radio communication, each unit should ordinarily be assigned the approximate number of frequencies listed below:

| | <i>Frequency</i> |
|--|------------------|
| Higher air headquarters..... | 5 |
| Next subordinate headquarters..... | 5 |
| Wing headquarters..... | 5 |
| Bombardment group, heavy..... | 5 |
| Reconnaissance squadron, long range..... | 5 |

| | <i>Frequency</i> |
|---|------------------|
| Bombardment group, medium----- | 4 |
| Pursuit group, fighter----- | 4 |
| Reconnaissance squadron, medium range-- | 4 |
| Bombardment group, light----- | 3 |
| Pursuit group, SE and INT----- | 2 |
| Army, corps, and division reconnaissance and observation and liaison squadrons (for training only)----- | 2 |

d. It must not be inferred that multiple frequency assignments are made for the purpose of allowing separate frequencies for units subordinate to those listed. All components of a group or smaller separate unit will normally be operated on the same frequency. The frequencies assigned within a unit, as indicated above, should vary as to transmission characteristics to provide day, night, short, and long range communication and should be compatible with the assignments of other units operating in the same area.

SECTION II

GROUND RADIO COMMUNICATION

■ 32. GENERAL.—*a.* Radio is supplementary to wire for ground communication. Radio equipment designed for the Air Corps possesses a mobility which permits its use during the movement of command posts and during such movements it may become the primary means of ground communication.

b. Radio telegraphy (CW) is normally used between ground radio stations.

c. In the planning of a system of ground communication, the use of radio means should be considered as a means of last resort. Since units are provided with one radio transmitter for each ground net in which they operate and the same transmitter must be used for air-ground operations, only one type of radio communication is available at a specific time.

d. Since the radio transmitter is to be used primarily for air-ground liaison work, the radio station should normally be established in the location most desirable for its operation

as an air-ground station. In all installations the actual location of the transmitting equipment should be as far removed from the operating position as facilities permit. By remotely controlling the transmitter equipment, added security from goniometric stations can be gained.

■ 33. GROUND RADIO EQUIPMENT.—Two types of ground radio equipment are provided Air Corps units. A medium range type for combat squadrons and a long range type for reconnaissance and transport squadrons and for group and higher headquarters. These sets are normally operated from commercial power sources but have auxiliary power generators with gasoline engine for use when this is not available.

■ 34. GROUND RADIO NETS.—In general, ground radio nets should be established between units as follows:

| | <i>Net</i> |
|--|------------|
| Higher air headquarters and next subordinate headquarters..... | 1 |
| Wing headquarters and next higher headquarters.. | 1 |
| Wing headquarters and group headquarters.... | 1 |
| Group headquarters and squadrons..... | 1 |

Attached units operate in the net of the unit to which they are attached.

■ 35. FREQUENCIES.—Frequencies are assigned for Air Corps units which will enable the ground radio nets to operate over the approximate distances shown below:

| | <i>Miles</i> |
|--|--------------|
| Higher air headquarters..... | 3,000 |
| Wings | 1,000 |
| Bombardment groups..... | 500 |
| Pursuit groups, fighter, nets..... | 500 |
| Pursuit groups, SE and INT, nets..... | 100 |
| Reconnaissance, observation, and liaison squadrons working in army, corps, and division nets.. | 200 |

SECTION III

AIR-GROUND LIAISON AND AIR-AIR LIAISON COMMUNICATION

■ 36. GENERAL.—a. In an air force the ground station employed in air-ground liaison communication is located at

higher air headquarters, and at each air headquarters down to and including group headquarters. Likewise, the ground radio stations of units of reconnaissance observation, and liaison aviation and other air units serving with ground organizations are located at the command post of the army, corps, or division to which the aviation unit is attached.

b. Radiotelegraphy (CW) is the normal means of radio communication for air-ground and air-air liaison by air force units. MCW or voice transmissions may be used under exceptional circumstances.

■ 37. AIR-GROUND LIAISON RADIO EQUIPMENT.—*a. Ground equipment.*—See paragraph 33.

b. Airplane liaison radio equipment.—Each bombardment and reconnaissance airplane and three airplanes of each transport squadron are equipped with a radio set similar to the ground radio set which is provided for squadrons. These sets are capable of operating on CW, MCW, and voice.

■ 38. AIR-GROUND LIAISON NETS.—Air-ground liaison nets are established normally as follows:

a. Higher air headquarters and airplanes of—

(1) Headquarters squadron, higher air headquarters.

(2) Commanders of next subordinate units.

(3) Units operating under direct control of the higher headquarters.

b. Wing headquarters and airplanes of—

(1) Headquarters squadron, wing headquarters.

(2) Group commanders.

(3) Units operating under direct control of wing headquarters.

c. Group headquarters and airplanes of all assigned and attached units.

d. A squadron may establish its own air-ground net. Except in the case of units operating alone, this will be done only to meet special situations and upon authority of group headquarters.

■ 39. FREQUENCIES.—Whenever possible, frequencies are assigned air units which will enable the ground and air stations

to maintain continuous communication over the approximate distances shown below:

| | <i>Miles</i> |
|---|--------------|
| Higher air headquarters and all airplanes operating with it..... | 3, 000 |
| Wing headquarters and all airplanes operating with it | 3, 000 |
| Bombardment group, heavy, headquarters, and all airplanes operating with it..... | 2, 000 |
| Bombardment group, medium, headquarters, and all airplanes operating with it..... | 1, 500 |
| Bombardment group, light, headquarters, and all airplanes operating with it..... | 750 |
| Pursuit group, fighter, headquarters, and all airplanes operating with it..... | 1, 000 |
| Pursuit group, SE and INT, headquarters, and all airplanes operating with it.....(voice) .. | 75 |
| Reconnaissance, long range, airplanes..... | 2, 000 |
| Reconnaissance, medium range, airplanes..... | 1, 500 |
| Army, corps, and division reconnaissance airplanes..... | 300 |
| Army, corps, and division observation and liaison airplanes | 150 |

These frequencies may be used as an alternative means of fulfilling the requirements of paragraph 35.

■ 40. AIR-AIR LIAISON NETS.—Air-air liaison nets are ordinarily established for specific missions. They are used to permit the direct transmission of information between units in the air over considerable distances. Such a net could be established by a wing when two groups are proceeding from different bases to a common target which is under surveillance of a reconnaissance unit. In this case the net would be composed of the two group commanders' airplanes and the reconnaissance airplane. The net thus established would be terminated upon return of the units to their respective bases.

■ 41. AIR-AIR LIAISON FREQUENCIES.—The frequencies for air-air liaison nets are assigned by the headquarters which issues

the orders establishing the net and may be one of those assigned that unit or any of those assigned the groups concerned.

SECTION IV

AIR COMMAND COMMUNICATION

■ 42. AIR COMMAND NETS.—*a.* The air command net is an agency of communication established to provide control of formations in flight. Normally, the group is the basic unit which establishes an air command net. Units other than groups will establish air command nets for specific missions as ordered.

b. For purposes of secrecy it is essential that command radio communication be restricted to a minimum, and that visual signals be used for command purposes whenever possible. It is important that operating personnel realize that anything broadcast by radio is available to any enemy forces within radio range, and that under favorable conditions command radio transmitters may be heard over great distances. Simple prearranged codes may be used for voice transmission, but they are generally unreliable due to the practical difficulties encountered in their use.

■ 43. AIR COMMAND RADIO EQUIPMENT.—*a.* All airplanes, except primary trainers and observation and liaison airplanes, are equipped with a low powered radio transmitter and a receiver for command purposes. There are several different types of these sets, but all possess the common characteristics of comparatively short range, low power, light weight, and in most instances restricted frequency range. They are generally pilot operated, and although means are provided for operating them on tone telegraph, they are primarily designed for voice operation.

b. Observation and liaison airplanes are provided with a radio installation similar to that of the above category, but which is designed for operation with units of the ground arms. They differ materially only in the frequency range covered, and in that they are higher powered.

■ 44. FREQUENCIES.—Units should be provided with air command frequencies which will permit operation by voice over these approximate distances:

| | <i>Miles</i> |
|---|--------------|
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SECTION V

OTHER TYPES OF RADIO COMMUNICATION

■ 45. RADIO AIDS TO NAVIGATION.—*a.* Radio aids to navigation include the following:

Control towers.

Instrument landing systems.

Radio ranges.

Radio broadcast stations.

Radio compasses and direction finders.

Radio marker beacons.

b. Control towers are established at airdromes to facilitate the movements of aircraft on and in the vicinity of the airdrome, and to acquaint pilots with the changing conditions incident to operation from the airdrome. They are normally established as permanent installations of prepared airdromes. When the establishment of control towers is indicated in the field they are prepared and operated by the senior unit using the airdrome. The ground equipment issued the unit concerned is utilized to set up the control tower.

c. With the exception of control towers, the functions and uses of other radio aids are covered in FM 1-30.

■ 46. RESCUE BOAT COMMUNICATION.—*a.* Air Corps bases located on or near large bodies of water over which operations are being conducted are provided with rescue boats. These boats are equipped with radio in some instances. In general, such boats are required to operate in the air-ground radio net of the unit they serve and are capable of operation on CW, MCW, or voice.

b. Rescue boats are equipped with radio installations as follows:

(1) Boats under 20 feet in length—No installation.

(2) Boats 20 to 40 feet in length—Radio receiver only.

(3) Boats above 40 feet in length—Radio set similar in characteristics to the SCR 187.

c. The radio sets furnished for rescue boats are special units prepared to withstand the extra dampness incident to operation on the water. Although standard aircraft types of radio equipment may be installed and operated on rescue boats, such installations should not be made except by direction of higher authority. Aircraft radio equipment, when installed on boats, deteriorates rapidly and requires a high degree of maintenance.

CHAPTER 4

VISUAL COMMUNICATION

■ 47. GENERAL.—Visual and acoustical means of communication supplement air command and air-ground radio communication. Visual means of communication may be used for controlling formations in flight, coordinating and controlling take-offs and landings. Both visual and acoustical means may be used in air-ground communication between aircraft and ground troops.

■ 48. VISUAL MEANS.—Visual communication is provided by the following means:

Signal lamps.

Flags.

Pyrotechnics.

Panels.

Hand and arm

Airplane.

■ 49. SIGNAL LAMPS AND FLAGS.—*a.* Signal lamps and flags for sending messages in International Code are not employed by the Air Corps at present. However, some signaling has been done by the blinking of navigation or landing lights in accordance with prearranged codes. In certain situations, particularly at night, command radio may be replaced by the blinking of lights. Likewise, ground troops may use lights to signal to observation airplanes.

b. Airdrome control towers are provided with a signal lamp which is designed to show lights of two different colors. The colors employed are red and green. These lamps are used by tower operators to signal aircraft not equipped with radio, or whose radio may not be functioning, during landing and take-off operations. The following standard

light signals are prescribed for communication between control towers and aircraft:

(1) *From control tower to aircraft.*

| Signal | Meaning | | |
|----------------------|---|-------------------|--------------------------------|
| Tower | Airplane in flight | Airplane taxiing | Airplane in take-off position |
| Green light..... | Clear to land..... | Continue taxiing. | Clear for take-off. |
| Flashing red light.. | None..... | ----- | Return to line when on ground. |
| Red light..... | Do not land. Stay clear of field and continue circling. | Stop immediately. | Do not take off; wait. |

(2) *From aircraft in flight to control tower.*

| Signal | Meaning |
|--------------------------------------|---|
| Landing light on..... | Desire to land. (Note this signal should be acknowledged by control tower.) |
| One flash of landing light..... | Acknowledge visual signal from ground. |
| Series of flashes of landing light.. | If flood lights are off, turn on flood lights; if flood lights are on, turn off flood lights. |

■ 50. PYROTECHNICS.—*a.* Pyrotechnic equipment supplied by the Ordnance Department includes rockets, flares, position lights, and various kinds of pistol and rifle signaling cartridges. Pyrotechnics are employed by the Air Corps for communication between aircraft in flight and the ground arms and have a limited use for communicating between aircraft in flight.

b. Due to the difficulty involved in firing more than one signal at one time and the limited number of different signals available, communication by this method is limited to the transmission of a very few signals in accordance with simple prearranged codes.

■ 51. **PANELS.**—Panels are displayed by ground troops for signaling to airplanes. They may be used by elements of the Air Corps for special purposes but are not normally employed in this manner, and the transmission of lengthy messages is slow and cumbersome. Panels have the disadvantage of being visible to all airplanes both friendly and enemy and may reveal to the enemy important information of our troops at a time when such information should be withheld. This is particularly true where panels are used to mark front lines.

■ 52. **HAND, ARM, AND AIRPLANE SIGNALS.**—Hand, arm, or airplane signals may be used in lieu of command radio during daylight hours, particularly when radio silence is required.

a. Hand and arm signals.—Hand and arm signals are suitable for the control of small units; however, it has been found generally impracticable to control large formations in this manner. These signals are as prescribed within the unit.

b. Airplane signals.—Visual signals which comprise movements of parts of the airplane, and the movement of the airplane itself, can be used to control formations in the air. In order to secure uniformity throughout the Air Corps in these items of control, which are common to all formations in flight, the following signals are prescribed:

| Signal | Significance |
|--|---|
| <p>(1) <i>Flutter ailerons.</i> Repeated and comparatively rapid movement of ailerons.</p> | <p><i>Attention.</i> This signal will be used on the ground or in the air to attract attention of all pilots in the formation. Pilots should stand by for radio message or further signal. When on the ground and in proper position to take off, this signal will normally mean "Ready to take off."</p> |
| <p>(2) <i>Fishtail or yaw.</i> By rudder control during flight cause the tail of the airplane to move alternately and repeatedly right and left.</p> | <p><i>Open up formation.</i> Where applicable, this may be used to order a search formation.</p> |

| Signal | Significance |
|---|---|
| (3) <i>Series of small dives and/or zooms.</i> | <p><i>Prepare to land.</i></p> <p>This signal is an order to each pilot in the formation to take necessary steps preparatory to landing. In the absence of further signals the landing will be made in the normal landing formation of the unit, which should be predetermined. Any change in formation for landing will be ordered by supplemental signal or by radio.</p> |
| (4) <i>Dip right (left) wing.</i> | <p>(a) From any formation other than echelon, go into echelon of flights to the right (left).</p> <p>(b) Being in an echelon of flights to the right (left) go into echelon of individual airplanes to the same side.</p> <p>(c) Being in an echelon of individual airplanes, if wing is dipped on the side to which the airplanes are echeloned, form echelon of flights to the same side.</p> <p>(d) Being in an echelon of flights or individual airplanes, if wing is dipped on the side away from the echelonnement, form same echelon to the opposite side.</p> |
| (5) <i>Rock wings.</i> Slow, repeated, rocking motion of airplane about longitudinal axis by gradual use of ailerons. Wing movement to be slower and of greater amplitude than in "flutter of ailerons." | <p><i>Assume normal formation.</i></p> <p>From any other formation, go into the normal closed-up formation for the unit concerned. This formation is to be prescribed in each group and/or squadron.</p> |

NOTE.—These signals may be augmented as required by any group or larger unit or by any separate squadron or flight. In such case, however, care will be taken to avoid confusion of the added signals with those herein prescribed, and the number of signals added will be kept to a minimum.

■ **53. ARTILLERY FIRE CONTROL.**—In directing artillery fire when radio communication is not possible, information is conveyed by maneuvering the airplane in accordance with a prearranged code.

CHAPTER 5

OTHER MEANS OF COMMUNICATION

■ 54. **SOUND.**—*a.* Short, prearranged signals may be transmitted by aircraft in flight, using motors or machine guns. Due to the small number of different signals available, communication by this method is of necessity limited.

b. Normally airdromes will have a ground system of sound communication for air attack and fire alarms.

■ 55. **DROP AND PICK-UP MESSAGES.**—Communication by drop and pick-up messages is covered in FM 24-5.

■ 56. **HOMING PIGEONS.**—The use of homing pigeons for communication is covered in FM 24-5.

■ 57. **MESSAGE CENTER**—*a. Purpose.*—The message center is the agency at each headquarters or command post charged with the receipt, transmission, and delivery of all messages except mail, those transmitted by personal agencies, and telephone conversations. It exists primarily for service to the commander and his staff and furnishes this service by—

(1) Providing a fixed locality to which messengers and messages may be directed.

(2) Coordinating the use of all agencies of signal communication to provide for the transmission of messages by the best means available.

(3) Keeping temporary but reliable records to insure the prompt and accurate handling of all messages passing through the message center.

b. Operation.—(1) The message center for all Air Corps unit headquarters is established and operated by personnel of the communication section and operates directly under the unit communication officer. To provide for continuous operation during the movement of the unit headquarters, it is organized into two echelons—one for establishing the message center at the new location of the command post, and the

other to permit continued operation at the old location until the new command post is opened. The message center furnishes special messenger service to superior, subordinate, adjacent, or attached and supporting units as required by means of motorcycle messengers, automobile messengers, or runners.

(2) The efficient dispatch of messages is facilitated if all telegraph and radio operating positions are near the message center.

c. Personnel.—Sufficient personnel are assigned to the message center to provide for 24-hour operation. Personnel are assigned specific duties as enumerated in FM 24-5.

■ 58. WEATHER COMMUNICATION.—*a. Within continental limits.*—Within the continental limits of the United States each weather section charged with forecasting is provided with a telegraph printer machine connected to the CAA long lines. Distribution of weather information to units not provided with weather sections is by means of the communication facilities normally available to the unit. No special weather communication circuit is provided. In the event weather information other than that normally rendered in combat reports is required, special weather circuits may have to be established. Establishment of such a system will be only by direction of higher authority. The Signal Corps is charged with the procurement, construction, and installation of all weather telegraph printer facilities.

b. Outside continental limits.—During operations without the continental limits of the United States, weather sections will be provided with such connections to the existing governmental weather services as may be available and such other facilities as may be established by direction of higher headquarters.

■ 59. PANEL CODES.—The panel codes prescribed for use of ground arms for communication with supporting aircraft are—

a. Air-ground liaison code for use by the Infantry, Cavalry, Field Artillery, Coast Artillery Corps, and Air Corps.

b. Fire control code for use by the Field Artillery, Coast Artillery Corps, and Air Corps.

■ 60. SPECIAL CODES.—The Air Corps employs the following tentative codes in addition to the codes in paragraph 59:

- Liaison code.
- Weather code.
- Contact code.
- Map coordinate codes.
- Army and Navy aircraft code.
- Special codes.
- Radio call signs.

■ 61. GENERAL CODES.—Codes required by ground echelons for point to point communication are prescribed by higher authority.

■ 62. PURPOSE OF CODES.—*a.* The air-ground liaison code is intended for use in regular communication between ground units and aircraft engaged in reconnaissance and observation and liaison. It may be used for communication between ground stations in case of emergency. It is revised frequently for purposes of secrecy by rearrangement of code groups and their meanings.

b. The fire-control code is fixed and nonconfidential and is used in the adjustment of artillery fire.

c. The air force employs its own liaison code, weather code, and contact code.

d. Map coordinate codes are used to enable the transmission in coded form of such map or geographical locations as are not more conveniently referred to by means of map coordinates, to affect secrecy, and to permit brevity.

e. The Army and Navy aircraft code is intended for use only on joint missions in regular communication between Army forces and Navy aircraft, naval units afloat or ashore and Army aircraft, or between Army aircraft and Navy aircraft.

f. Special codes are issued from time to time to facilitate certain types of liaison through the special means of signal communication peculiar to the Air Corps.

g. Radio call signs for radio stations and aircraft are assigned by higher authority in signal operation instructions.

h. The codes used for point to point transmission on the

ground and for certain classes of air-ground and air-air liaison will be as prescribed by higher authority.

i. The use of codes and ciphers in signal communication is particularly important in the interests of secrecy and in certain cases may be valuable as a time saver, operating to increase the amount of traffic which can be handled over a given channel of communication.

■ 63. CRYPTOGRAPHIC MESSAGES.—Only messages which, due to the time element, could be of no value to the enemy, and other messages whose subject matter would be of no value, may be sent in the clear; and then only over the signature of the unit commander. Important messages transmitted by telegraph printer will be placed in cryptographic form if they are to pass through commercial centrals or whenever there is any possibility of enemy agents tapping the lines. Airplane commanders and operating personnel should be given definite instructions covering those circumstances in which the transmission of messages in the clear will be authorized. It is imperative that all airplane commanders and radio personnel be familiar with the instructions covering the use of codes and ciphers as given in FM 24-5.

■ 64. SIGNAL ORDERS.—*a. General.*—Signal orders are issued for the purpose of establishing and coordinating the operation of the signal system. These orders may be issued as an annex to a formal written field order, as signal operation instructions, or the necessary information may be contained in paragraph 5 of the field order. When time is limited they may be issued in fragmentary form and may be dictated or oral. In groups and lower units, signal orders will normally be contained in paragraph 5 of the field order and will usually be issued in fragmentary form either oral or dictated.

b. Paragraph 5 of the field order.—(1) For Air Corps units this paragraph is normally divided into two sublettered paragraphs, as follows:

a. Subparagraph *a* contains the plan of signal communication and refers to the signal annex or to signal operations instructions if issued.

b. Subparagraph *b* refers to the location of command posts, ground and air. When aviation units are operating in sup-

port of a ground command, the command posts of such supported units are usually given.

(2) When aviation units are changing bases, paragraph 5b will state the proposed stops of the unit commander with the time at which he will clear each point. It will also state the commander's position in the formation and the position of any air commander higher in the chain of command who is to be present in the formation.

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