

APPENDIX F

COMMUNICATIONS

Introduction

This appendix is intended for users, supervisors, and planners. It provides basic guidance on planning and employing communications assets. The development of operating procedures and doctrinal changes is an evolutionary process. The information in this appendix is modeled on an objective heavy division (L-series) TOE. Users operating under modification TOES (MTOEs) must understand that some of the procedures and methods outlined herein are a model solution and may be tailored to meet specific unit requirements.

Communications Systems

Radio is the major means of voice and digital communications within the field artillery. Separate radio nets are established for command and control, fire direction, fire support coordination, fire support planning, and administration and logistics. The execution of AirLand Battle doctrine requires the skillful use of all communications resources. Thus, close coordination and a clear understanding of radio net structure are necessary.

A communications system is the result of a plan designed to fulfill the requirements of a general heavy division mission. As a result of net standardization, units can quickly and accurately communicate in combat. Command discipline must be established so that these standard net structures and purposes are not arbitrarily changed except to tailor for a specific modified mission. This tailoring is based on the factors of METT-T. Standard net structures (net title, Purpose, users, and equipment) should be defined in SOP and should be kept current as changes in procedures and/or systems occur.

Communications system planning must include advance coordination for SOI and COMSEC materials for secure operations. Consider the fire support scheme of maneuver for planned, on-order, and anticipated missions.

Radio Net Structures

Refer to the fire support communications nets matrix on page F-6.

Forward Observer and/or Aerial Observer

A forward observer is equipped with a single radio set; however, several nets may be available for the observer. The net the observer selects is based on several factors – mission, experience level, and operational control. Whether the observer is airborne, in a tracked vehicle, or on foot, each may operate on the nets discussed below.

Maneuver Battalion Mortar Fire Direction Net VHF-FM (Digital). This net is used for battalion mortar tactical and technical fire direction within the maneuver battalion. The battalion mortar FDC is the net control station.

Maneuver Battalion Fire Support Net VHF-FM (Voice). This net is used for voice fire support coordination between maneuver and fire support elements. The battalion FS cell is the net control station.

Direct Support Battalion Fire Direction Nets 1, 2, and 3 VHF-FM (Digital). These nets are duplicates of each other. They are used for tactical and technical fire direction from the FOs through the DS battalion FDC to the battery and/or platoon FDC. The DS battalion FDC at the tactical CP is the NCS.

Division Artillery Operations/Fire Nets 1, 2, and 3 VHF-FM (Digital). These nets also are duplicates of each other. They are used for tactical fire direction and fire support planning for the div arty elements. The aerial observer may be required to operate on these nets. The div arty CP is the NCS.

Division Artillery Target Acquisition/Intelligence Net VHF-FM (Digital). This net is used for div arty target acquisition and intelligence (intel) gathering. The aerial observer may be required to operate on this net, as do other TA assets at div arty such as the Q-36 radar. The NCS is the div arty operations and processing section at the div arty CP.

Maneuver Battalion Mortar Fire Direction Center

The maneuver battalion mortar FDC operates on three nets:

Ž Maneuver battalion command/operations (cmd/ops) net VHF-FM (voice).

- Maneuver battalion fire support (FS) net VHF-FM (digital).

Ž Maneuver battalion mortar fire direction net VHF-FM (digital).

Combat Observation/Lasing Team

The COLT has three radio sets and operates in the following nets as directed by the brigade fire support officer:

- Maneuver battalion fire support net VHF-FM (voice), as required.

Ž Maneuver brigade fire support net VHF-FM (voice). This net is used for fire support coordination between the brigade FSO, his FS cell, FA elements, and the maneuver brigade. The brigade FS cell is the NCS.

- Maneuver battalion mortar fire direction net VHF-FM (digital), as required.

Ž Direct support battalion fire direction nets 1, 2, and 3 VHF-FM (digital), as required.

Fire Support Team or Company Fire Support Officer

The FIST and the company FSO have equipment configurations based on supported maneuver companies. The mechanized infantry FIST is equipped with four radio sets, and the armor or armored cavalry FIST has three radio sets. The FIST and FSO control the FOs and respond to input from both the maneuver and DS battalions on the following nets:

Direct Support Battalion Command Net VHF-FM (Voice). This net is used for command and control and for initial coordination. On reaching the maneuver element or unit, the FIST normally *drops off* this net and enters the DS battalion FD net assigned.

Direct Support Battalion Fire Direction Nets 1, 2, and 3 VHF-FM (Digital). The FIST may control FO calls for fire support on these nets.

Maneuver Battalion Mortar Fire Direction Net VHF-FM (Digital). The FIST may control FO calls for mortar fire support on this net and may use it for digital control of the FOs in the centralized mode of operation.

Maneuver Battalion Fire Support Net VHF-FM (Voice). This net is used for voice fire support coordination when the FSO is physically with the maneuver commander and calls for fire support from other than FA observers.

Maneuver Company Command/Operations Net VHF-FM (Voice). When the FSO is not physically with the maneuver commander, the FIST monitors this maneuver net to provide rapid response to the commander's intent.

Battalion FS Cell and Battalion Fire Support Officer

The battalion FS cell and the battalion FSO have five radio sets and respond to input from

both maneuver and DS battalions on the following nets:

- Maneuver battalion command/operations net VHF-FM (voice). When the FSO is not physically with the maneuver commander the FS cell monitors this maneuver net to provide rapid response to the commander's intent.
- Maneuver battalion fire support net VHF-FM (voice). The FS cell is the NCS of this net.

Ž Maneuver brigade fire support net VHF-FM (voice).

- Maneuver battalion mortar fire direction net VHF-FM (digital), as required.
- Direct support battalion fire direction nets 1, 2, and 3 VHF-FM (digital), as required.
- Direct support battalion operations/fire net VHF-FM (digital). This net is used for FA digital fire support planning and coordination calls for reinforcing fire, and mutual support operations. The DS battalion CP is the NCS.
- **Direct** support battalion command net VHF-FM (voice). This net is used for initial coordination and control of movement before arrival at the maneuver battalion. Then the FS cell drops off to the maneuver brigade fire support net VHF-FM (voice). The FSO may monitor this net as required.
- Div arty command net VHF-FM (voice). This net is used for command and control of all div arty elements. The FSO may monitor this net as required.

Battery or Platoon Fire Direction Center

The battery or platoon FDC has four radio sets to operate on the following nets:

- Battery command net VHF-FM (voice). This net is used for command and control of all battery elements and provides a voice radio net for battery use.

Ž Battery fire direction net VHF-FM (digital). This net is used for technical fire direction.

- Direct support battalion command net VHF-FM (voice).
- Direct support battalion fire direction nets 1, 2, and 3 VHF-FM (digital).

Direct Support Battalion Command Post

The DS battalion CP has two distinct entities—the FDC and the operations processing section. In addition, the DS battalion has a logistics operations center located with the brigade combat trains. This center has its own radio net, the DS battalion administrative/logistics (admin/log) net VHF-FM (voice). The CP operates on the following nets:

- Maneuver brigade command/operations net VHF-FM (voice).
- Maneuver brigade fire support net VHF-FM.
- Direct support battalion command net VHF-FM (voice).

Ž Direct support battalion fire direction nets 1, 2, and 3 VHF-FM (digital).

- Direct support battalion operations/fire net VHF-FM (digital).

Ž Div arty command net VHF-FM (voice).

Ž Div arty operations/fire nets 1, 2, and 3 VHF-FM (digital).

- Div arty command/fire (CF) net HF-AM/single sideband (SSB) (voice/facsimile). This net is used to provide a multipurpose long-distance capability for communication with its subordinate battalions, its MLRS battery, and the division FS cell. The operations/processing section is the NCS.

Brigade FS Cell and/or Brigade Fire Support Officer

The brigade FS cell and FSO have four radio sets to operate on the following nets:

- Maneuver brigade command/operations net VHF-FM (voice). The FS cell monitors this net when the FSO is not physically with the maneuver commander.
- Maneuver brigade fire support net VHF-FM (voice) (NCS).
- Direct support battalion command net VHF-FM (voice), as required.
- Direct support battalion operations/fire net VHF-FM-(digital), as required.
- Div arty command net VHF-FM (voice).
- Div arty operations/fire nets 1, 2, and 3 VHF-FM (digital), as required.
- Maneuver battalion fire support net VHF-FM (voice), as required.

Aviation Brigade FS Cell and/or Aviation Brigade Fire Support Officer

The aviation (avn) brigade FS cell and FSO have three radio sets to operate on the following nets:

- Maneuver brigade command/operations net VHF-FM (voice), as required.
- Maneuver brigade fire support net VHF-FM (voice).
- Direct support battalion command net VHF-FM (voice), as required.
- Direct support battalion operations/fire net VHF-FM (digital), as required.
- Div arty command net VHF-FM (voice).

- Div arty operations/fire nets 1, 2, and 3 VHF-FM (digital), as required.
- Maneuver battalion fire support net VHF-FM (voice), as required.

Division Fire Support Elements

The tactical and main fire support elements have similar equipment, but the tactical FSE is mounted in an armored carrier command post (M577). Both FSEs operate on the following nets:

- Division fire support net HF-AM/SSB (voice anchor facsimile [fax]). On this net, the FS cells conduct fire support planning and coordination with each other and the div arty command post. The main FS cell is the NCS.
- Corps fire support net HF-AM/SSB (voice and/or facsimile). The corps FS cells conduct fire support planning and coordination on this net. Division FS cells (tactical and main) may enter this net as required.
- Div arty command net VHF-FM (voice).
- Div arty operations/fire nets 1, 2, and 3 VHF-FM (digital).
- Div arty command/fire net HF-AM/SSB (voice and/or facsimile), as required.

Div Arty Tactical Command Post

The div arty CP is the hub of the artillery effort within the division area. Therefore, the CP plays an extremely important role within each maneuver brigade area. The CP is divided into two main sections, the FDC and the operations/processing section. An additional element, the div arty logistics operations center, has a radio net of its own, the div arty admin/log net VHF-FM (voice). The div arty CP maintains communications with division, corps artillery, direct support battalions, and the MLRS battery on the following nets:

- Division cmd/ops net VHF-FM (voice). This is a maneuver net for command and control and combat operations. The div arty CP monitors this net to respond to the maneuver commander's intent.

Ž Division fire support net HF-AM/SSB (voice and/or facsimile), as required.

- Div arty command net VHF-FM (voice) (NCS).
- Div arty operations/fire nets 1, 2, and 3 VHF-FM (digital) (NCS).

Ž Div arty target acquisition/intelligence net VHF-FM (digital) (NCS).

- Div arty command/fire net HF-AM/SSB (voice and/or facsimile) (NCS).

Ž Corps artillery command/fire net HF-AM/SSB (voice and/or facsimile). This net is a multipurpose net used for long-distance command and control and for technical and tactical fire direction to all artillery elements within the corps area. The corps artillery CP is the NCS.

Separate Maneuver Brigade Fire Support Element and Separate Brigade Fire Support Officer

The separate (sep) brigade fire support effort is multifaceted and must be able to respond to the maneuver commander at corps or division, depending on operational control and the mission assigned. The FSE and FSO may have to coordinate with corps artillery, div arty, or an FA brigade. The separate brigade FSE and FSO may have to operate in the nets described below.

When the maneuver brigade is OPCON to corps, the brigade FSE and FSO may operate in the following nets:

- Corps command/operations net VHF-FM (voice). This is a maneuver net for command

and control and for combat operations. The separate brigade FSE monitors this net to respond to the maneuver commander's intent. Corps main CP is the NCS.

- Corps fire support net HF-AM/SSB (radio teletypewriter [RATT]).

- Corps artillery command net VHF-FM (voice). This net is used for command and control of all corps artillery elements. The corps artillery CP is the NCS.

- Corps artillery operations/fire nets 1,2, and 3 VHF-FM (digital). These nets are used for fire support planning and coordination between artillery units. They also are used for tactical and technical fire direction to subordinate artillery elements. The corps artillery FDC is the NCS.

Ž Corps artillery command/fire net HF-AM/SSB (voice and/or facsimile). This

When the maneuver brigade is OPCON to corps but with a supporting FA brigade, the maneuver brigade FS cell and FSO may operate in the following nets:

- FA brigade command net VHF-FM (voice). This net is used for command and control of the FA brigade elements. The FA brigade CP is the NCS.
- FA brigade operations/fire nets 1, 2, and 3 VHF-FM (digital). These nets are used for fire support planning and coordination between artillery units and for tactical and technical fire direction to subordinate artillery elements. The FA brigade CP is the NCS.
- FA brigade command/fire net HF-AM/SSB (voice and/or facsimile). This net is a multipurpose net used for long-distance command and control and for technical and tactical fire direction to all artillery elements within the FA brigade area. The FA brigade CP is the NCS.

FIRE SUPPORT COMMUNICATIONS NETS MATRIX

	FO	AERIAL OBSERVER	BN MORTAR FDC	COLT	FIST	CO FSO	BN FS CELL	BN FSO	BTRY OR PLT FDC	DS BN CP	BDE FS CELL	BDE FSO	AVN BDE FS CELL	AVN BDE FSO	DIV FSE (TAC)	DIV FSE (MAIN)	DIV ARTY CP	SEP BDE FSE	SEP BDE FSO
Maneuver co cmd/ops net VHF-FM (V)					X ¹														
Maneuver bn cmd/ops net VHF-FM (V)			X			X ¹													
Maneuver bde cmd/ops net VHF-FM (V)										X	X ¹		X ¹						
Division cmd/ops net VHF-FM (V)																	X	X ²	X ²
Corps cmd/ops net VHF-FM (V)																		X	X
Maneuver bn FS net VHF-FM (V)	X ³	X ³	X	X ¹	X	X ¹	X	X ¹				X ¹		X ¹					
Maneuver bde FS net VHF-FM (V)				X		X ¹	X	X ¹		X	X	X ⁴	X	X ⁴					
Division FS net HF-AM/SSB (V-fax)															X	X	X ¹	X ²	
Corps FS net HF-AM/SSB (RATT)															X ¹	X ¹		X	
Maneuver bn mortar FD net VHF-FM (D)	X	X ¹	X	X ⁶	X	X ¹	X ¹												
Btry cmd net VHF-FM (V)									X										
Btry FD net VHF-FM (D)									X										
DS bn cmd net VHF-FM (V)					X ¹	X ¹		X ¹	X	X	X ¹	X ¹	X ¹	X ¹					
DS bn FD nets 1, 2, and 3 VHF-FM (D)	X ⁷	X ⁷		X ⁶	X ⁷	X ¹	X ¹		X	X									
DS bn ops/F net VHF-FM (D)							X			X	X ¹		X ¹						
Div arty cmd net VHF-FM (V)								X ¹		X	X	X ¹	X		X	X	X	X ²	
Div arty ops/F nets 1, 2, and 3 VHF-FM (D)										X	X ¹		X ¹		X	X	X	X ²	
Div arty TA/intel net VHF-FM (D)		X ¹															X		
Div arty CF net HF-AM/SSB (V-fax) ⁵										X					X ¹	X ¹	X	X ²	
FA bde cmd net VHF-FM (V)																		X ¹	
FA bde ops/F nets 1, 2, and 3 VHF-FM (D)																		X ¹	
FA bde CF net HF-AM/SSB (V-fax) ⁵																		X ¹	
Corps arty cmd net VHF-FM (V)																		X	
Corps arty ops/F nets 1, 2, and 3 VHF-FM (D)																		X	
Corps arty CF net HF-AM/SSB (V-fax) ⁵																	X	X	

¹As needed²When operating under control of division³May be entered for voice coordination⁴Net used by FSO when separate from FS cell⁵Currently RATT net⁶COLTs will operate in the net directed by brigade FSO⁷As directed

NOTE: Admin/log VHF-FM (V) nets at corps artillery, FA brigade, div arty, and DS battalion may be entered, as required, by any subordinate element to coordinate administrative and logistic operations.

LEGEND:

V = voice

D = digital

TA/intel = target acquisition/intelligence

When the maneuver brigade is OPCON to a division, the brigade FS cell and FSO may operate in the following nets:

- Division command/operations net VHF-FM (voice).
- Division fire support net HF-AM/SSB (voice and/or facsimile).
- Div arty command net VHF-FM (voice).
- Div arty operations/fire nets 1, 2, and 3 VHF-FM (digital).
- Div arty command fire net HF-AM/SSB (voice and/or facsimile).

Single-Channel Ground-Airborne Radio System

The single-channel ground-airborne radio system (SINCGARS) is the new generation combat net radio (CNR) designed to provide a major means of command and control. Its main features are its resistance to jamming through frequency hopping and its increased capacity of 2,320 channels. The basic radio is designed on a modular basis to achieve commonality among various systems configurations. It can be used in the manpack or vehicular package. It is interoperable with the AN/VRC-12-series radios. The present radio net structure will not change in terms of mission capability, net size, assignment of net stations, or distance covered. Planning considerations, however, require frequency management on a decentralized basis. This means frequency management will be done at battalion level and will require intensive management by staff and supervisors at all levels of command.

Battlefield Electronic CEOI System

The battlefield electronic communications-electronics operation instructions (CEOI) system (BECS) is a decentralized system for frequency management and the

publication of unit CEOIs (now called signal operation instructions). The BECS has been designed to provide more responsiveness to rapidly changing and highly mobile battlefield conditions. The system consists of a basic generation unit (BGU) and an electronic notebook (EN). Any radio operator who normally carries a paper SOI will have an electronic notebook instead. Distribution channels are the same as those now used for the paper SOI.

Mobile Subscriber Equipment

Mobile subscriber equipment (MSE) is a common-user area communications system

COMMUNICATIONS TIPS

DO –	DON'T–
Use the lowest power setting for effective transmission.	Use homemade codes.
Make transmissions as short as possible.	Use homemade call signs.
Use proper radiotelephone procedures.	Start vehicle with radios on.
Use the proper antenna directional antenna (possible).	Attempt to talk around sensitive information.
Use masking, if possible, to hide your signal.	Display frequencies or call signs.
Use only authorized codes.	Make antenna <i>farms</i> .
Remote radios if possible.	
Enforce net discipline.	
Authenticate.	
Try to work through jamming.	
Plan for the use of retrans.	
Keep radios aligned and tuned.	

very similar to the civilian telephone system. It has mobile subscribers as well as regular telephone subscribers. The MSE in conjunction with the improved high frequency radio (IHFR) will eliminate radio teletypewriters.

Loss of Communications

Communication is essential for fire support. If communication is lost with a station, everything possible must be done to reestablish the link. The FS cell should –

• Troubleshoot the radio.

- Erect omnidirectional or unidirectional antennas.

Digital nets are backed up by voice nets and vice versa. If digital communication is lost, resolve the problem on the voice net. If a station cannot be contacted on any fire support net, coordinate with maneuver counterparts to use their nets/stations to reestablish communication. Unit SOP must delineate exact actions to be taken to reestablish communication, and all personnel must be intimately familiar with those actions.

Retransmission

Frequency modulated VHF transmission distances are restricted by terrain and obstacles. The siting of radio equipment is often critical. The following are helpful hints for using FM retrans:

• A minimum, make a map recon of the area of operation. Coordinate with the S2 and S3 during the planning phase.

- Analyze the terrain for optimum communications to support the scheme of maneuver.
- Select primary and alternate locations for retrans. Consider accessibility, defense, and logistical support.

- Arrange the timetable for site occupation and net operation. Don't wait until retrans is needed before sending it out.
- Ensure operators are well trained. They must be able to provide manual relay if they have equipment failures.
- Ensure operators are aware of the tactical situation.
- Ensure users understand how retrans works.
- If retransmitting digital traffic, program additional key and/or delay time to allow radios to key up.

• Users of forward entry devices (FEDs) may plan to use nearby battery computer systems to relay messages to TACFIRE. This capability is useful when direct communication with TACFIRE is not possible. Relay addressing should be established per SOP or as identified in the appropriate SOI.

Communications Planning Ranges

The table below is to be used in communications planning. The ranges presented here were determined under ideal conditions; weather and terrain may have drastic degrading influences.

PLANNING RANGES FOR FIRE SUPPORT RADIOS

RADIO	RANGE (KM) ¹
AN/PRC-77 with whlp antenna	8
AN/PRC-77 with long-wire antenna (AT-984/G)	28
AN/GRC-160 with whlp antenna	8

PLANNING RANGES FOR FIRE SUPPORT RADIOS (CONTINUED)

RADIO	RANGE (KM) ¹
AN/GRC-160 with RC-292, OE-254, or OE-303 antenna	19
AN/GRC-160 with long-wire antenna (AT-984/G)	28
AN/VRC-46 with whip antenna	40
AN/VRC-46 with RC-292, OE-254, or OE-303 antenna	58
¹ The normal planning range for the AN/GRC-160 series is 8 km; and for the VRC-46 series, it is 40 km. The above extended ranges are achieved by use of various antenna arrays.	

Field-Expedient Antennas

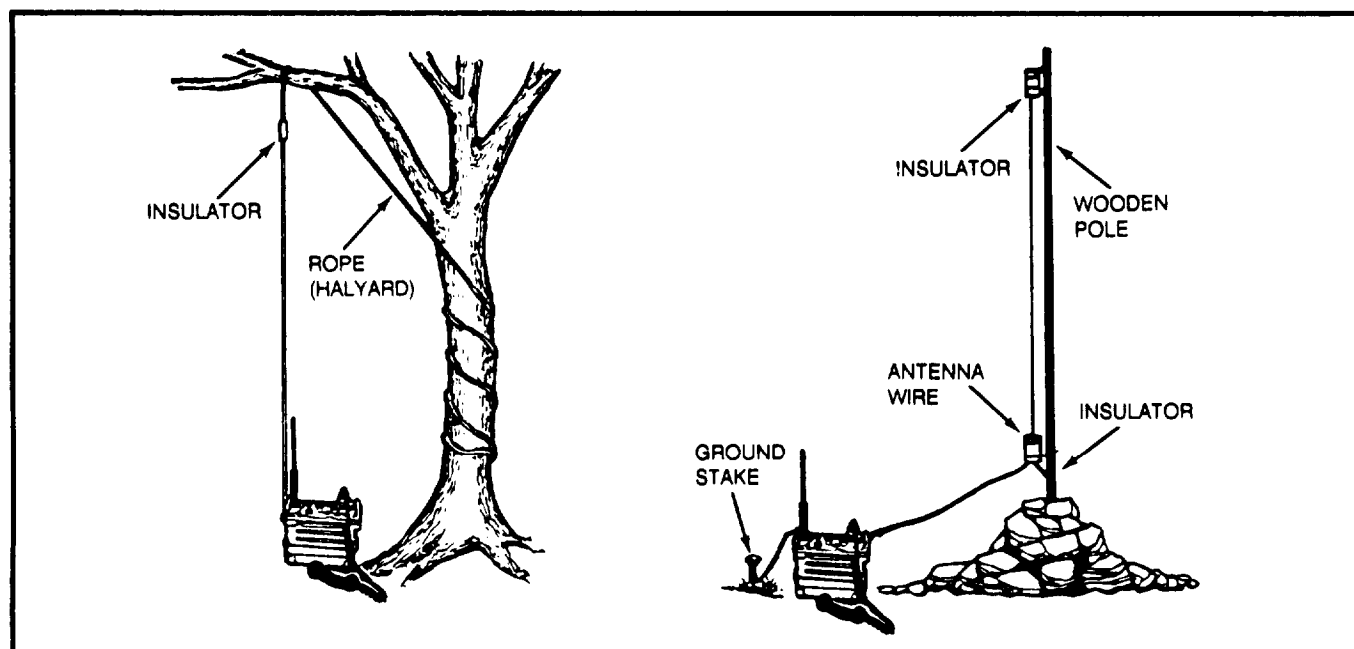
Poor or erratic radio communications may be the result of excessive distances between stations, unfavorable terrain or weather, or defective antenna equipment. All fire support

personnel must understand the application of Field-expedient antennas for maintaining or enhancing communications and for electronic counter-countermeasures (ECCM). Regardless of the type of antenna used, proper maintenance must be performed to get optimum performance from the equipment. The field-expedient antennas discussed below are relatively simple, easy to construct from available materials, and highly effective.

Replacement Whip Antenna

In a static position, a broken whip antenna may be replaced by using WD-1 communications wire and an overhead branch or some support assembly. Cut a 10-foot piece of wire, attach an insulator to one end, and use a rope attached to the insulator to elevate the antenna. Strip about 1 inch of insulation from the end to be attached to the radio. Loosen the antenna base on the radio, place the bare wire between the antenna base and the antenna support receptacle, and retighten the antenna base. Ensure the improvised antenna is vertical.

REPLACEMENT WHIP ANTENNAS



Horizontal Long-Wire Antenna

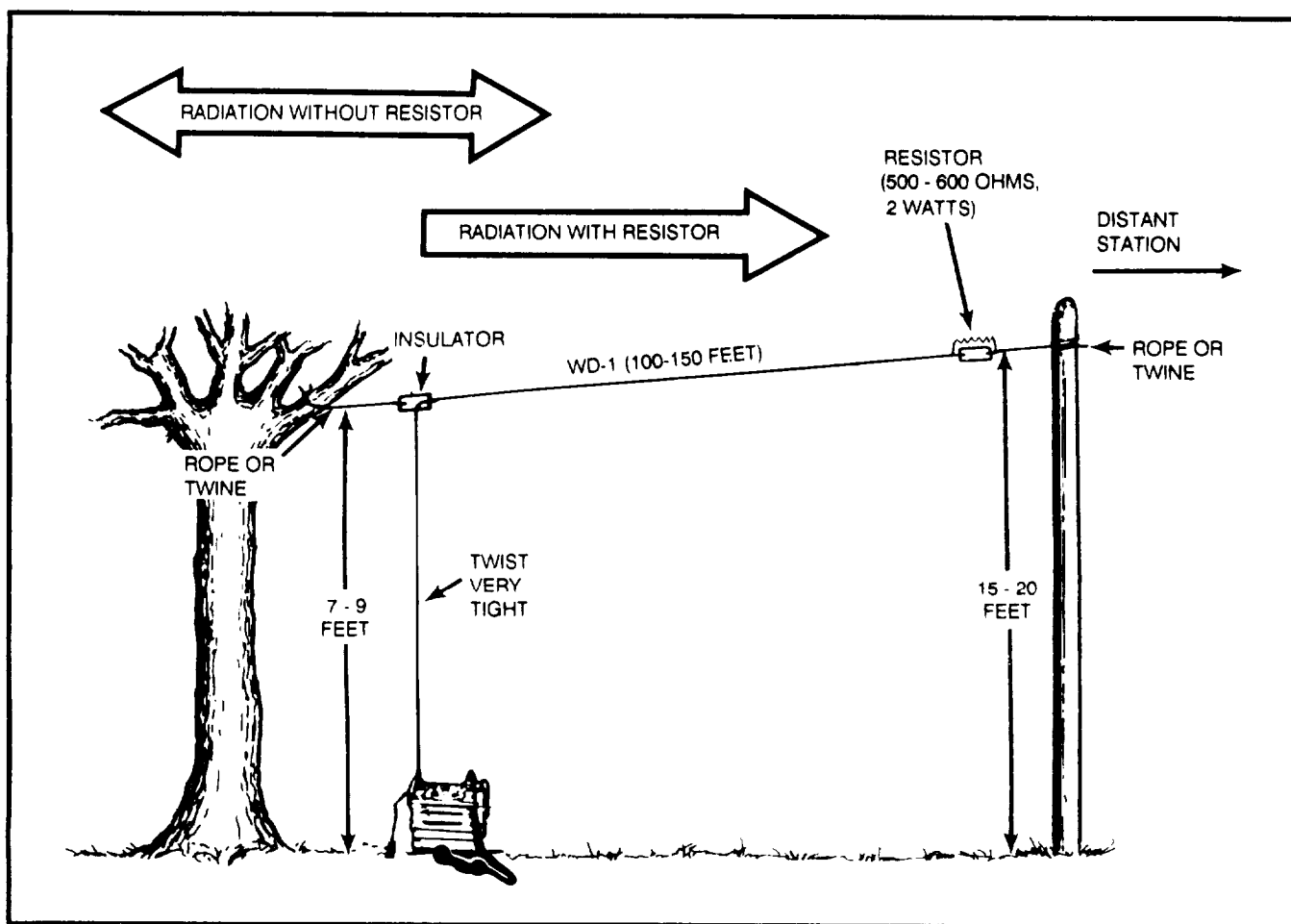
This is probably the simplest, yet most effective, antenna for communicating over long distances. Maximum radiation is off the ends of this antenna; thus, it is highly directional. It not only increases the range of transmission and reception, but it also tends to reject or reduce signals from other directions. This makes it an excellent antijamming device.

WD-1 is ideal for making this antenna. The wire should be 100 to 150 feet long. Tightly twist the first section of the WD-1, and connect the end between the antenna base and the antenna support receptacle on the radio. The wire must be adequately insulated

to prevent accidental grounding. The antenna should be erected at least 7 to 9 feet high at the radio and 15 to 20 feet above ground at the other end. Connect the other end to a pole or a tree in the direction in which communication is required. This ground clearance is necessary to prevent accidents or injuries involving personnel or vehicle traffic.

To make this a one-way (unidirectional) antenna, add a resistor at the end toward the distant station. A dead flashlight battery BA-30 makes an ideal resistor for low-power radios. Attach a nail or screw to each end of the battery, ensuring they don't touch, and connect the wire to each.

HORIZONTAL LONG-WIRE ANTENNA



Center-Fed Doublet Antenna

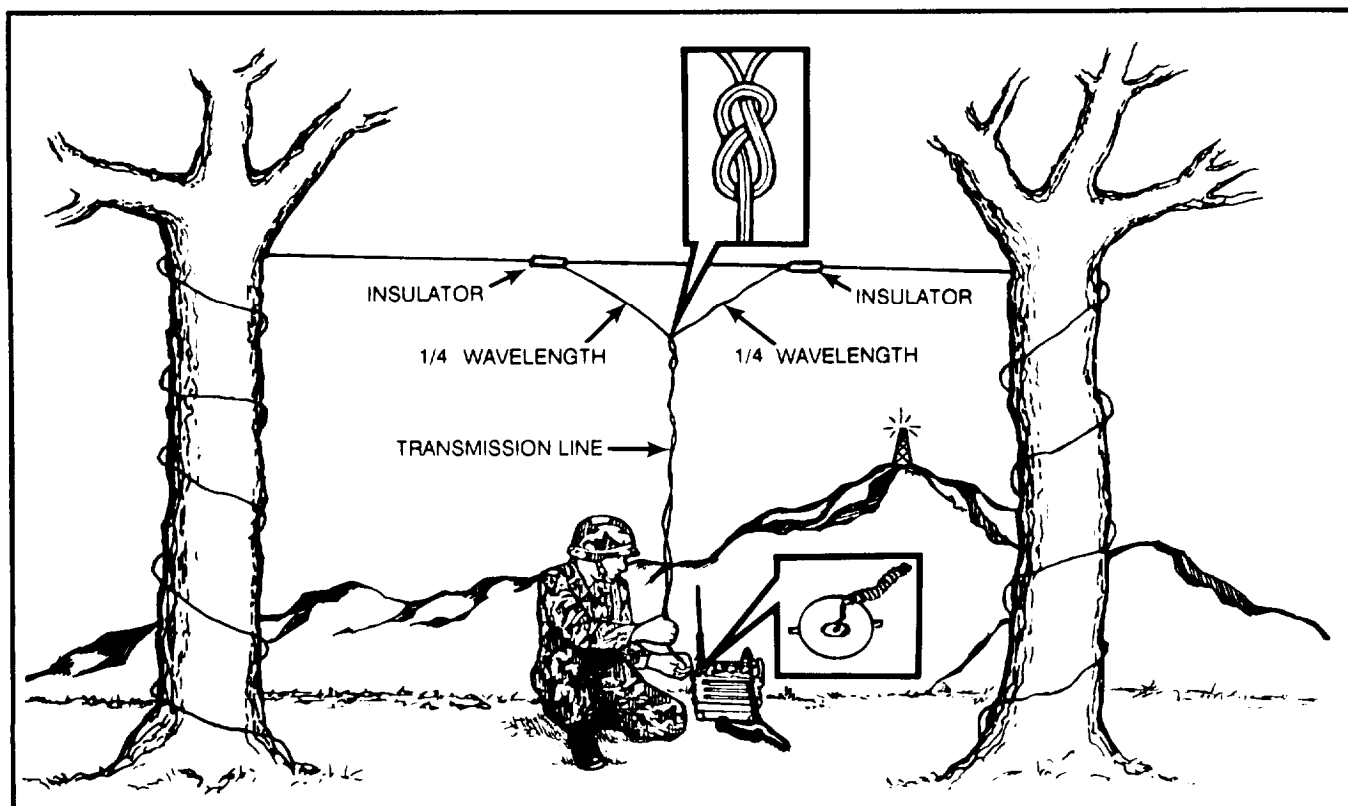
The center-fed doublet is an effective two-way (bidirectional) antenna. It is particularly efficient in jungle environments and for ECCM if both the sending and receiving stations are using the same type of antenna. Unlike the whip and many other antennas discussed in this appendix, this antenna is electronically horizontal and will not communicate with those that are electronically vertical.

The length of each element is critical and depends on the operating frequency. This length must be one-quarter wavelength. To determine the length of each element in feet, divide 468 by the frequency in megahertz (MHz) which gives you one-half wavelength. Then divide this result by 2 to get one-quarter wavelength in feet. An example using the operating frequency of 46.80 MHz follows:

$468 \div 46.80 = 10$; $10 \div 2 = 5$ feet; so each element is 5 feet long.

After determining the length of each element, construct the antenna by measuring off slightly more than the required length of wire and tie a figure-eight knot at that point. Separate the wire into the elements, and attach insulators at each end. Ensure the elements are the exact length required. Tightly twist the remaining wire going to the radio to make a transmission cable, and strip each end of the wire. Put one wire into the center of the antenna cable connector, and attach the other wire to the metal case of the radio. Attach the insulators to the rope to permit erecting the antenna between two trees or other support assemblies. Raise the antenna 20 to 30 feet, and ensure the broadside is directed toward the receiving station(s).

CENTER-FED DOUBLET ANTENNA



Vertical Half-Rhombic Antenna

The vertical half-rhombic antenna consists of 100 to 150 feet of WD-1 on a 30- to 45-foot-high support. The support should be centered with approximately half of the wire on each side. Attach insulators to the ends, and fasten rope to these insulators. This permits the ends to be tied down to stakes and the antenna element to be insulated from a ground. Make a transmission cable by tightly twisting the section of WD-1 coming from the radio end of the antenna element. Strip the ends of the cable approximately 1 inch, and connect these leads between the antenna base and the antenna support receptacle on the radio. The antenna in this configuration is a two-way (bidirectional) antenna.

To make this a one-way (unidirectional) antenna, add a resistor at the end toward the distant station. A dead flashlight battery BA-30 makes an ideal resistor for low-power radios. Attach a nail or screw to each end of the battery, ensuring they don't touch, and connect the wire to each.

Resistors and Field-Expedient Resistors

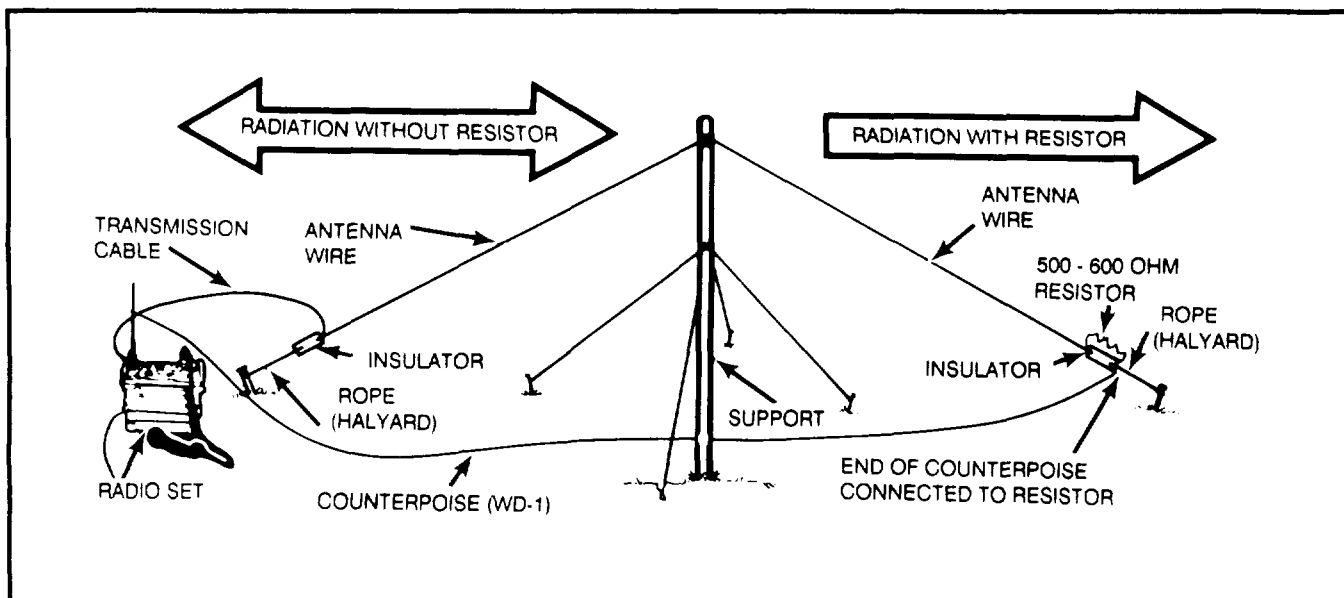
Resistors are used to draw the signal in the desired direction of transmission.

Resistors used to construct the long-wire and half-rhombic antennas are readily available through supply channels and local radio repair shops. These resistors must have a resistance of 500 to 600 ohms and be at least half the wattage of the transmitter power output. For example, a 600-ohm, 2-watt resistor works with the AN/PRC-77. Typical power outputs for combat net radios are as follows:

- AN/VRC- 12-series (-46, -47, and so forth):
 - High power = 35 watts (minimum).
 - Low power = 0.5 to 8 watts.
- Ap/PRC-77 = 4 watts.

Ž SINCGARS = 50 watts (maximum).

VERTICAL HALF-RHOMBIC ANTENNA



NOTE: SINCGARS radios do not perform frequency hopping very well with field-expedient antennas, but any antenna is better than none at all. The use of a field-expedient antenna may degrade the SINCGARS to a single-channel operation, but it will permit communication.

Field-expedient resistors should be of the same values as those listed above, approximately 500 to 600 ohms at about half the wattage output. A dead BA-30 with nails driven into each end will approximate 500 to 600 ohms at 1 to 3 watts. An earplug container with holes drilled in the case opposite each other and filled with sand and a few drops of crankcase oil will work much like the battery.

Field-Expedient Insulators

Insulators keep the signal from going in an unwanted direction. Almost anything that will not conduct electricity but has some strength can be an insulator. The very best insulators are glass, plastic, and rubber. Less effective but still usable are cloth, wood, and rope; however, these are not good when wet.

NOTE: The US Army Signal School is in the process of replacing the terms *FM* (*frequency modulated*) and *AM* or *AM/SSB* (*amplitude modulated and sing/e sideband*) in most radio net titles with terms more closely denoting range. The following frequency range designations will be used:

- HF - high frequency (replacing AM/SSB).
- VHF - very high frequency (replacing FM).

FIELD-EXPEDIENT INSULATORS

