Field Manual 34-40-7

Headquarters,
Department of the Army
Washington DC, 23 November 1992

COMMUNICATIONS JAMMING HANDBOOK

Table of Contents

DISTRIBUTION RESTRICTION: Distribution authorized to U.S. Government agencies only to protect technical or operational information from automatic dissemination under the International Exchange Program or by other means. This determination was made on 25 June 1991. Other requests for this document will be referred to Commander, United States Army Intelligence Center and Fort Huachuca, ATTN: ATZS-LSS, Fort Huachuca, AZ 85613-6000.

DESTRUCTION NOTICE: Destroy by any method that will prevent disclosure of contents or reconstruction of the document.

***This field manual supersedes TC 34-41, 9 May 1986.**

Preface

This manual explains how to employ the effective jamming techniques referenced in FM 34-1. Instructions are presented to the mission planner for calculating the minimum jammer power output requirements and the maximum distance a jammer can be placed from a target receiver based upon the jammer's power output. This information can be found by using the electronic warfare jamming calculator (appendix). Doctrine, tactics, techniques, and procedures in this field manual are intended for commanders and their staffs, division tactical operation centers, technical control and analysis elements (TCAEs), mission management personnel, and other personnel who plan or conduct jamming operations. This publication applies equally to active Army and Reserve Components.

The proponent of this publication is Headquarters, United States Army Training and Doctrine Command. Send comments and recommendations on DA Form 2028 directly to the Commander, United States Army Intelligence School, Fort Devens (USAISD), ATTN: ATSI-ETD-PD, Fort Devens, MA 01433-6301.

Unless this publication states otherwise, masculine nouns and pronouns do not refer exclusively to men.

CHAPTER 1

Introduction

Regardless of the terminology, most scholars would agree that communications involve at least four basic elements: **transmitter, message, medium,** and **receiver.** Communications occur when the receiver understands the idea sent by the transmitter well enough to provide some form of feedback. This publication approaches those communications that must rely on the electromagnetic spectrum as a medium to convey messages. It focuses on the disruption of the listener's ability to receive.

IMPORTANCE OF COMMUNICATIONS

The execution of the AirLand Battle Doctrine requires the skillful use of resources, target acquisition, and strike capability. To do this, a timely and responsive working relationship must exist between the respective combat forces. Reliable communications are needed to achieve this goal. The lack of communications can affect the outcome of any battle.

IMPACT OF JAMMING ON COMMUNICATIONS

Jamming is an electronic countermeasures (ECM) technique which supports intelligence and electronic warfare (IEW) doctrine. IEW doctrine directs that jamming be integrated into various phases of combat operations. Jamming degrades communications by reducing or denying the enemy's ability to pass key information at critical times and can cause enemy operators to become irritated, confused, or misled during offensive, defensive, or retrograde operations. When applied successfully, jamming can contribute to the failure of those actions which depend on communications using the electromagnetic spectrum. For example, an enemy fire direction net must communicate in order to function. Proper jamming can force the net to change frequencies, reestablish communications, increase power output, or switch to a less reliable means of communications.

ELECTRONIC WARFARE SUPPORT MEASURES SUPPORT TO JAMMING

Electronic warfare support measures are the primary source of information used to identify and develop jamming targets. The primary function of electronic warfare support measures is to gather information on the enemy's electronic systems. Electronic warfare support measures information can be passed directly to our analytical systems where it is correlated with data collected from multiple sources and used to determine the enemy's locations and intentions. From listening to the enemy's transmissions, we gain significant information about his electronic systems. Some of this information is used to direct our actions to reduce his combat effectiveness by interfering with his electronic systems. Further, it assists us to identify enemy targets and position our equipment to best disrupt or deny the enemy's use of his systems. The techniques employed to deny the enemy's use of his electronic systems area part of ECM called jamming. Jamming is the action taken to reduce or deny the enemy's effective use of his electronic systems.

Indiscriminate jamming wastes resources, could impede friendly communications, or could attract artillery fire. Consequently, jamming operators need to know exactly who, what frequency, and when to jam. To obtain this information, mission planners require data supplied through electronic warfare support measures. We listen to and locate enemy emitters to gain this information; not only to correlate it with other data for intelligence production, but to identify data needed to deny the enemy the use of his electronic systems. Electronic warfare support measures also provide technical data on the enemy's ability to jam friendly electronic systems. This information enables us to conduct protective measures to ensure our continued use of friendly electronic systems.

DECISION TO JAM

The commander's decision to use jamming is influenced by several factors. The key factor is timing. Intercepting, direction finding (DF), and jamming cannot be conducted simultaneously against the same targeted communications link. The identifiable electronic signature created by jamming signals readily exposes friendly jammer locations. The tactical commander should treat ECM assets the same as artillery assets, because ECM mission results on communications can be as devastating as artillery on personnel and equipment. ECM assets are deployed to support committed units based on their mission priority, the capabilities of available systems, and potential enemy actions. In the planning phase, thoughts should reflect the relative scarcity of ECM assets, their limitations, and their transient effects. The commander must balance the negative aspects of jamming operations against the positive tactical advantages of disrupting enemy communications.

Jamming, when integrated into combat operations, must support the commander's battle plan. IEW doctrine dictates that commanders will integrate jamming with fire support and maneuver forces to disrupt and confuse enemy forces during offensive, defensive, or retrograde operations.

The commander's decision to employ jamming is carried out by military intelligence (MI) units and should be coordinated with the fire support element and integrated into the commander's fire support plan. These MI units detect, identify, and locate enemy communications nets and intercept their traffic to provide the commander with intelligence. The commander uses this intelligence to decide when and where to employ jamming in his concept of the operation. The MI units also direct ECM against enemy communications, jamming those based on the commander's decision. This capability to locate the enemy, to intercept the enemy's messages, and to hamper the enemy's operations at critical periods contributes directly and indirectly to the effectiveness of the friendly commander's concept of the operation.

Enemy nets, which routinely pass information of intelligence value, should be identified and monitored. Other nets, such as those having a high tactical value to the enemy but little or no intelligence value to friendly forces, could be attacked with jammers or fire support depending on the tactical situation. Enemy secure communications may also be jammed with the intention of drawing the enemy into clear voice communications, thus allowing interception and further identification. Enemy jammers should be located, reported, and destroyed based on the demands of the tactical operation. Guidance for jamming, destroying, or exploiting enemy electronic emitters should be reviewed before each tactical operation. Additionally the TABOO, RESTRICTED, and GUARDED frequency lists must be reviewed prior to the execution of all jamming missions (see FM 34-40).

Jamming should interrupt or disrupt the enemy's communication at decisive moments in the battle, for example, when key information needs to be passed or new instructions are required. Jamming may be effective for only the short periods that the enemy needs to take evasive action or to execute countermeasures. Jammers need to be used judiciously and moved often to avoid their destruction.

Jammers support other combat actions by—

- Disrupting key command and control nets, thus slowing or disorganizing the enemy in critical situations.
- Denying the enemy the ability to react to changes on the battlefield.
- Reducing the effectiveness of enemy fire support and air control nets.

EMPLOYMENT OF JAMMING

There are three steps in employing jamming. The first step concerns information collection and target acquisition. The second step involves planning the jamming mission. The third step is the execution of the jamming mission. This sequence is also called the **decide, detect,** and **deliver** method.

The field commander is confronted with an enemy electronic array that comprises thousands of emitters and hundreds of communication nets. Collectively this emitter density is meaningless unless the emitters are sorted by—

- Function.
- Position in a net.
- Position on the battlefield.
- Ability to affect the combat plan.

Once the enemy emitter has been identified and located, this information flows to a coordination center where an interface occurs between intelligence and operations. Based on this information the commander provides the guidance on whether to jam, destroy, deceive, or intercept for intelligence. As often as possible, this decision must be a part of the initial planning and coordination. When the decision is to intercept for intelligence purposes, it must be continually reevaluated to determine whether to continue collecting, to initiate jamming, or to destroy. The commander provides the guidance to the TCAE or the staff to identify certain nets that have a high tactical value to the enemy, but minimal or no intelligence value to friendly forces. Enemy command nets of units in contact, fire direction nets, and enemy target acquisition systems usually meet this criterion. As these nets are identified and located, they are jammed or destroyed in accordance with the commander's attack guidance.

Jamming must complement the concept of operation. Jamming provides the commander with time to reactor time to change his estimate to gain the tactical advantage. To maintain this tactical advantage, jamming would best be used against priority targets and with careful timing to achieve the desired tactical results.

CHAPTER 2

Integrating Jamming Into Combat Operations

The objective of jamming is to disrupt the enemy's effective use of his combat forces by reducing the effectiveness of his communications. The function of jamming is to disrupt or deny the enemy the reception of his electromagnetic signals radiating from his radio transmitters. Jamming can be subtle and difficult to detect, or it can be overt and obvious when mission requirements arise which override survivability. Jamming integration is explained in a step-by-step process (Table *2-1)*, which is based on the following war-game scenario:

The mechanized division's commander directs the G3 to plan an operation to seize Hill 322. Intelligence reports indicate elements of the enemy's 231st Motorized Rifle Regimsnt are active in this area. The G3, in coordination with the G2, tasks the collection management and dissemination section to determine the enemy unit's location. The operation plan requires the division to attack through the regimental area. The 2d Brigade will lead the main attack and the 1st Brigade will conduct a supporting attack.

Table 2-1. Six steps of jamming integration.

	FUNCTIONS	ACTION OFFICE
STEP 1	FOCUS ON THE TACTICAL OBJECTIVE.	COMMANDER, G2, AND G3
STEP 2	PLACE ENEMY UNITS IN PRIORITY ORDER.	G2 AND G3
STEP 3	PLACE IDENTIFIED SYSTEMS AND FUNCTIONS IN A PRIORITY ORDER.	G2 AND G3
STEP 4	IDENTIFY ENEMY ELECTRONICS USED TO CONTROL WEAPONS SYSTEMS AND THREAT FUNCTIONS.	EWS
STEP 5	PROVIDE TECHNICAL DATA.	TCAE
STEP 6	COMPUTE JAMMING DATA AND TASK ASSETS.	TCAE

The first three steps are always accomplished by close coordination between the G2 and G3. These actions are never formally labeled, except as a part of a mental war-gaming of a sequence of actions and counteractions. These three steps are a form of tactical threat analysis, which identifies potential threats posed by enemy maneuver or weapon systems. Identified potential threats are then placed in priority order for jamming. The second three steps involve the technical considerations for jamming.

FOCUS ON THE TACTICAL OBJECTIVE

In step 1 (Figure 2-1), the G3 is acting for the commander. The G3 provides the same focus for integrating jamming as he would for integrating any other division weapon system. In the electronic warfare annex of the operation order, the G3 directs that priority jamming support be provided to the 2d Brigade. This, in effect, focuses the jamming support on a specific unit or operation and establishes the guidelines for integrating jamming into the combat operation. Until this is done, jamming support cannot be integrated into the combat operation.

The initial guidance provided by the G3 makes planning and coordinating easier for the mission managers. An artillery unit cannot furnish integrated support until it receives the necessary data on where and when to fire. Likewise, jamming cannot support combat operations effectively until it is focused on the threat confronting our forces.

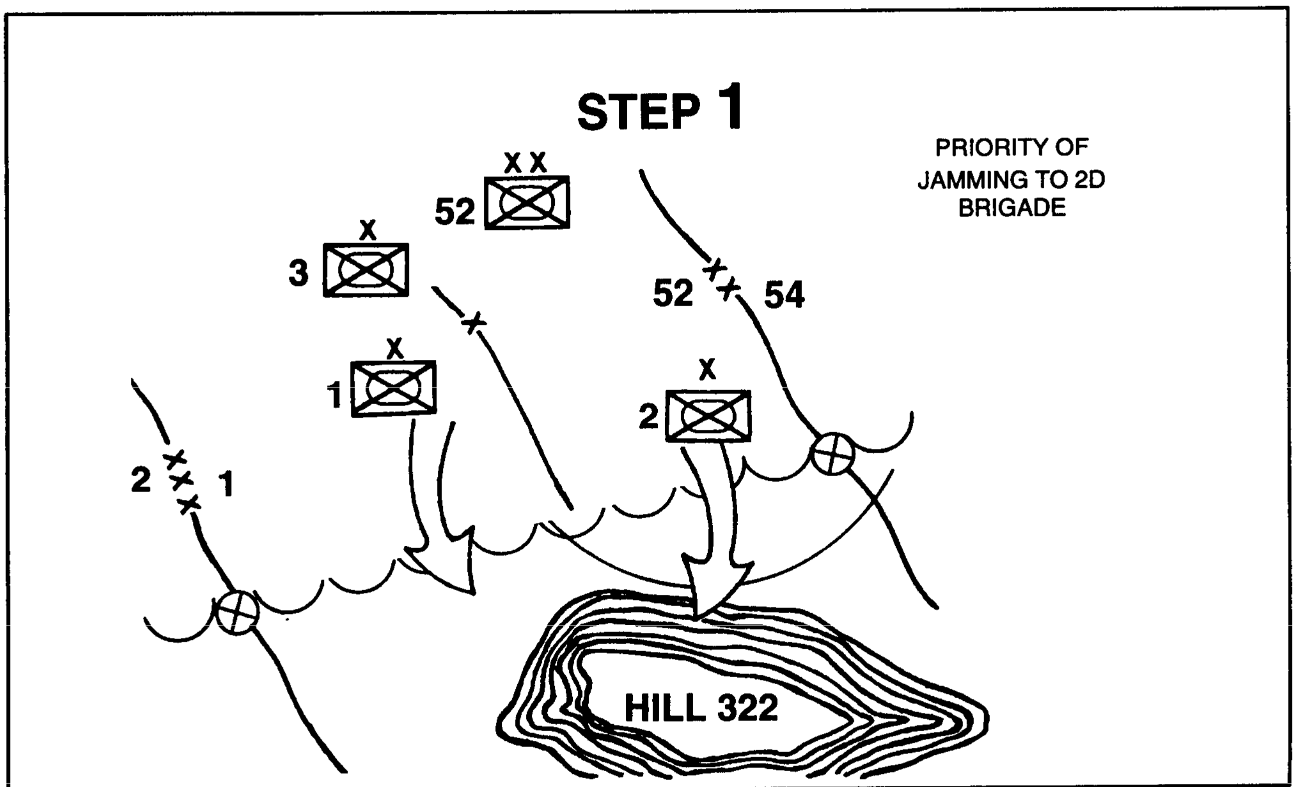


Figure 2-1. Focus on the tactical objective.

This initial focusing step narrows the area of concentration. It also identifies any conflicts among jamming, intelligence collection, and friendly use of the electromagnetic spectrum. This conflict resolution involves the G2, G3, signal officer, and MI assets to perform the overall assessment of the target and friendly force's use of the electromagnetic spectum. If jamming is integrated into the operation, the signal officer may have to realign the signal operation instructions.

PLACE ENEMY UNITS IN PRIORITY ORDER

In step 2 (Figure 2-2), the G2 and G3 consider the enemy units that could prevent the accomplishment of the division's mission. These units are placed in a priority order for jamming, based on their potential threat to the mission. (In combat, priorities are normally situation dependent.)

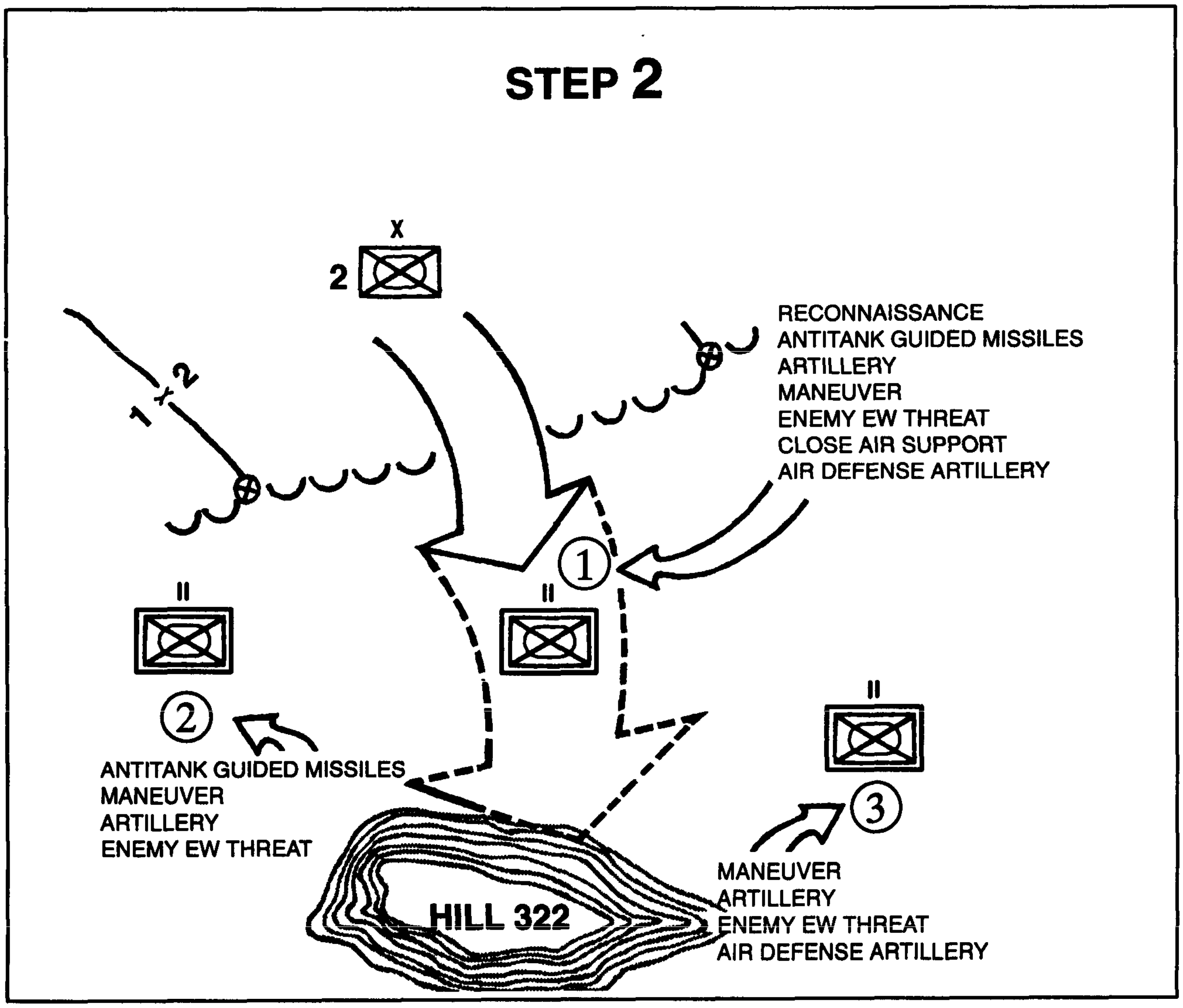


Figure 2-2. Priority order for jamming enemy units.

PLACE IDENTIFIED SYSTEMS AND FUNCTIONS IN PRIORITY ORDER

In step 3 (Figure 2-3), the G2 and G3 identify the various weapons systems and threat functions available to the units listed in step 2. These weapons systems and threat functions are then placed in priority order on the basis of the greatest danger to the attacking friendly force.

The second and third steps are constrained to fit into the specific guidelines as directed by the G3 (in step 1). The further the mission progresses on the battlefield, the more specific the direction becomes.

Enemy Reconnaissance

In step 2, we circled enemy units in priority order (1 through 4) on the basis of their potential threat to the tactical operation. Listed near each unit (also in priority order, as shown in Figure 2-2) are weapon systems and threat functions which impose the greatest threat to the attack. The greatest threat imposed by the priority one unit is the enemy's reconnaissance elements. This is expected since reconnaissance elements tip-off other forces and weapon systems. If we successfully jam the reception of their reports, we can delay their reporting of the 2d Brigade’s point of attack. The jamming will, in turn, delay the enemy’s reaction time against our attacking force.

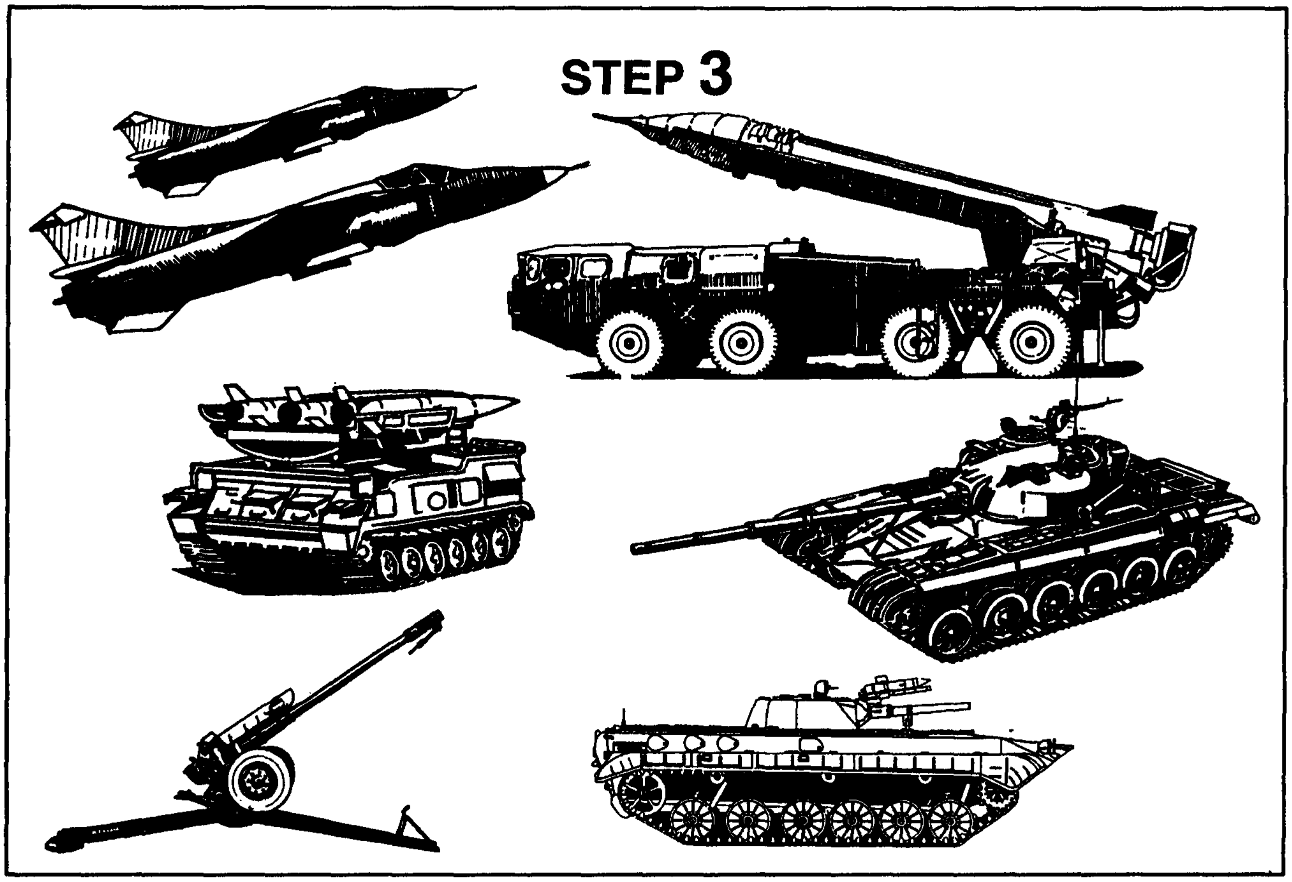


Figure 2-3. Identify and place enemy weapons systems and threat functions in priority order.

Enemy Antitank Guided Missile Control Nets

The next threat under the priority one unit is the enemy's antitank guided missile control nets. The enemy will eventually detect our attacking force and will begin to target our key elements. Key elements include personnel, weapons systems, tanks, and armored personnel carriers. Jamming the communications controlling the antitank guided missiles reduces the effective coordination and movement of their weapons systems.

Artillery Threat

The artillery threat is listed in the third priority. Therefore, we jam their fire request and fire direction net between the command and observation post (COP) and the firing battalions. The division commander may also want the artillery threat destroyed. In that case, the electronic warfare support measures assets can be used to locate these targets for our own artillery or close air support.

Maneuver

Maneuver is listed fourth since this particular enemy unit appears to be in a defensive position.

Enemy Electronic Warfare Threat

The enemy electronic warfare threat, especially jammers, is listed next. We can get to this point of attack without an overdependence on our radios. Since we have just started the attack, all of the unexpected events which complicate preplanned coordination have not begun. As we continue to attack, our radios become increasingly important. To ensure our continued use of these radios, we must use our DF assets to locate enemy jammers. Once located, these jammers must be destroyed by friendly artillery or close air support (Figure 2-4).

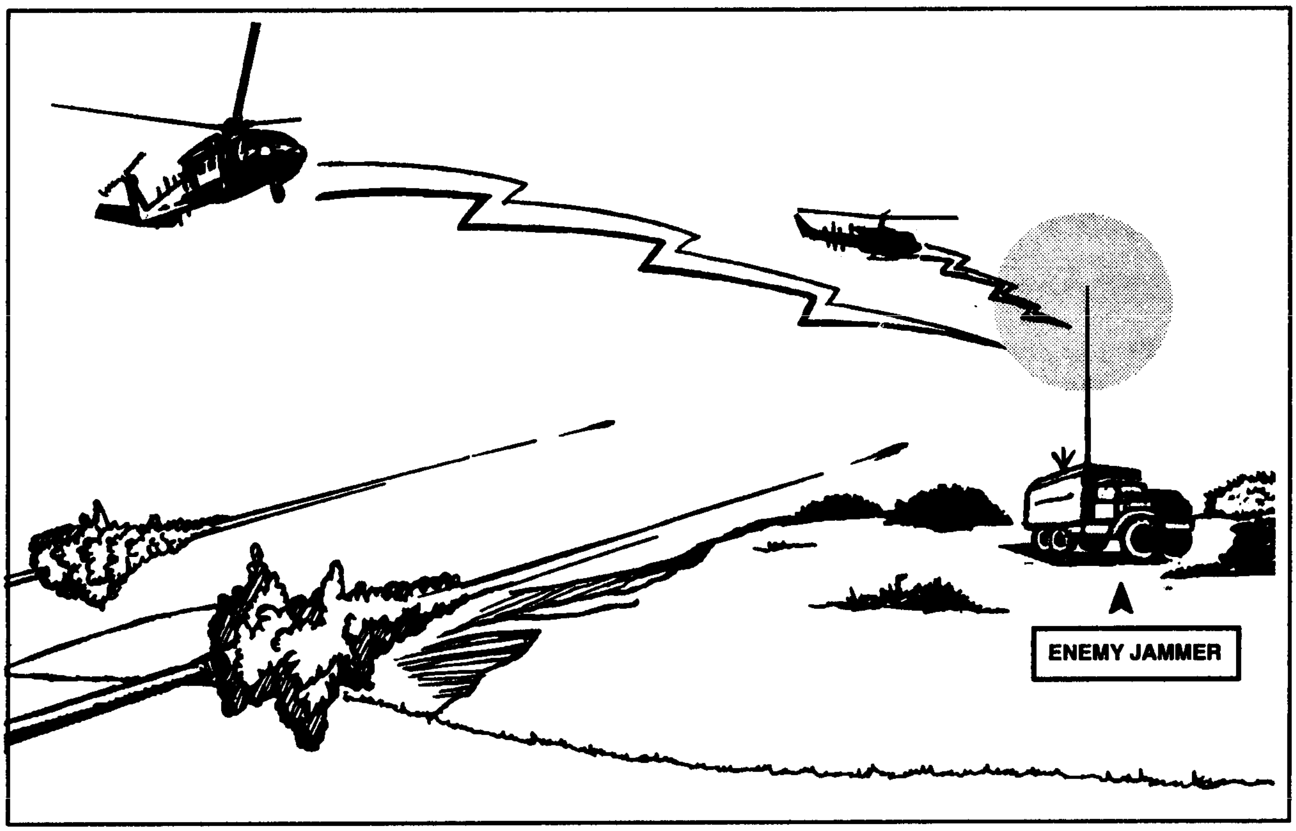


Figure 2-4. Enemy jammer destruction.

Close Air Support Threat

The close air support threat is listed next to last because the enemy normally will not react until our point of attack has been established. As the attack continues, the close air support threat becomes more important and must be given a higher priority.

Air Defense Artillery Threat

The air defense artillery threat is listed last only because our attack may not require air assets. It is listed to alert the electronic warfare support measures assets concerned with locating enemy radars in the combat zone. If our attack stalls, we can use close air support to regain the momentum. Close air support can attack enemy radars located by electronic warfare support measures, while our jammers attack their communications.

The priority two unit has only four threats identified. This is done, primarily, to show them as possible targets of opportunity since that unit should be preoccupied with the 1st Brigade's supporting attack. The threats imposed by this enemy unit are also placed in priority order since the enemy unit could target our armor or maneuver against the flank of the 2d Brigade's attack.

Priority three is outside the zone of influence, but as we advance, so will our zone of influence. This enemy unit could maneuver against us, attempt a limited counterattack, or direct artillery against our advance. The electronic warfare and air defense artillery threats gain more importance as our advance progresses.

These first three steps are always accomplished by close coordination with the G2 and G3. As previously stated, we have never really labeled these actions other than as a part of the mental war-gaming of a sequence of actions and counteractions. These three steps identify the potential threat from enemy maneuver or weapon systems. Identified potential threats are then prioritized, jammed, or attacked by fire.

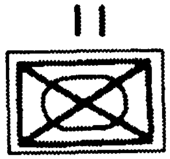
IDENTIFY ENEMY ELECTRONICS USED TO CONTROL WEAPONS SYSTEMS AND THREAT FUNCTIONS

The initial jamming mission planning begins with step 4. It is the transition point between tactical and technical jamming considerations. We must now identify those enemy electronics used to control the weapons systems and threat functions of greatest concern. We can do that by answering two questions. What communications systems are associated with each threat function? And, what technical and operational characteristics are known about these systems? We already know about the enemy's electronic systems in general. We know some systems can use the same radios. We know jamming can be more effective against some threats than against others. We also know that jamming alone will not totally defeat the enemy. At this point, we progress with the planning phase just as we would for constructing a schedule of fires, except that we are putting jamming on the target, not artillery fire.

The electronic warfare section (EWS) searches its electronic order of battle files. The search is for enemy communications systems serving each weapon system and threat function. The EWS concludes that the 231st Motorized Rifle Regiment's reconnaissance element uses a very high frequency (VHF) frequency modulated (FM) radio. This radio has a maximum power output of 20 watts. The EWS also determines that the net control station will receive the initial reports of our point of attack. The net control station is located about 8 kilometers (km) to the rear of the

231st Reconnaissance Battalion. The EWS also knows that the enemy target acquisition batteries are deployed in our zone of attack. These batteries use battlefield surveillance radars to detect moving targets. The EWS further resolves that a target acquisition battery uses VHF FM radio to report information. The EWS continues through the enemy electronic order of battle inventory, identifying any additional data useful to the TCAE or other operational elements. Steps 1, 2, and 3 must be completed before step 4 (Figure 2-5).

STEP 4



- ☐ RECONNAISSANCE
- ☐ ANTITANK GUIDE MISSILES
- ☐ ARTILLERY
- ☐ MANEUVER
- ☐ ENEMY EW THREAT
- ☐ CLOSE AIR SUPPORT
- ☐ AIR DEFENSE ARTILLERY

231st RECON BN ________________
- VHF FM RADIO
- 20 WATTS
- 25 kHz BW
- LPA ANTENNA
- 8 km DISTANCE TO NCS

231st TA BTRY ________________
- GSR
- VHF RADIO

311th BN ________________
- VHF FM RADIO

Figure 2-5. Identify enemy electronics used to control weapons systems and threat functions.

PROVIDE TECHNICAL DATA

In step 5 (Figure 2-6), technical data is provided to the TCAE. This requires detailed coordination with the EWS. The TCAE provides jamming mission planning to the MI battalion's S3 based on the initial planning by the G2 and G3 as well as input from the EWS. The TCAE lists the targets from the electronic warfare annex in priority order and then enters technical and operational characteristics for each target. The following information on each enemy target is entered:

- Unit.
- Frequency.
- Call signs.
- Power.
- Antenna type.
- Antenna height.
- Link distance.
- Enemy transmitter location.
- Enemy transmitter location elevation.
- Target receiver location.
- Target receiver location elevation.

STEP 5

UNIT	FREQ	C/S	PWR	ANT TYPE	ANT HT	LINK DIST	ET LOC	ET LOC ELEV	TR LOC	TR LOC ELEV
231ST RECON	44.25	AK17	20	WHIP	10	8 km	AT245976	321m	AT435968	348m
231ST TGT ACQ BTRY	40.50	TK12	20	WHIP	10	12 km	AT765213	250m	AT976217	295m
231ST	26.25		25	0	26	16 km	AT211283	225m	AT470531	325m

Figure 2-6. Provide technical data.

COMPUTE JAMMING DATA AND TASK ASSETS

In step 6 (Figure 2-7), the TCAE uses the technical data listed in step 5 to compute the minimum jammer power output required for jamming to be effective. This means that the jammer must be capable of producing at least this amount of power output for the jamming mission to be effective. The same data can also be used to compute the maximum distance the jammer location can be located from the target receiver location based on the jammer's maximum power output. This same information, plus target priorities and jamming on-off times, are a part of the multiple asset tasking message sent to the jamming assets.

The jamming computations are further refined by successive planning and directing by the TCAE personnel (Figure 2-8, page 2-10). The TCAE's efforts conform to the requirements initially provided by the G3.

In steps 5 and 6, we have entered some of the data available from the enemy electronic order of battle. For example, in step 5, we indicated that the radio station associated with the first priority target (the 231st Reconnaissance Battalion) transmits on 44.25 megahertz. The alternate frequency is unknown. This radio station uses the call sign **AK17.** Its transmitter radiates 20 watts of power with a 25 kilohertz bandwidth from a vertically polarized whip antenna. The whip antenna is omnidirectional. The TCAE has calculated that 100 watts of power are needed to jam the target receiver from coordinates

STEP 6

TGT #	PRI #	FREQ	C/S	TARGET AZ MAG	JAMMER			TIME ON	TIME OFF	REMARKS
					PWR	LOC	ANT			
1	1A	44.25	AK17	42°	100	EZ341795	WHIP	H-30	H-15	32.25
2	1B	40.50	TK12	53°	150	EZ341795	WHIP	H-40	H-35	32.25

Figure 2-7. Tasking data.

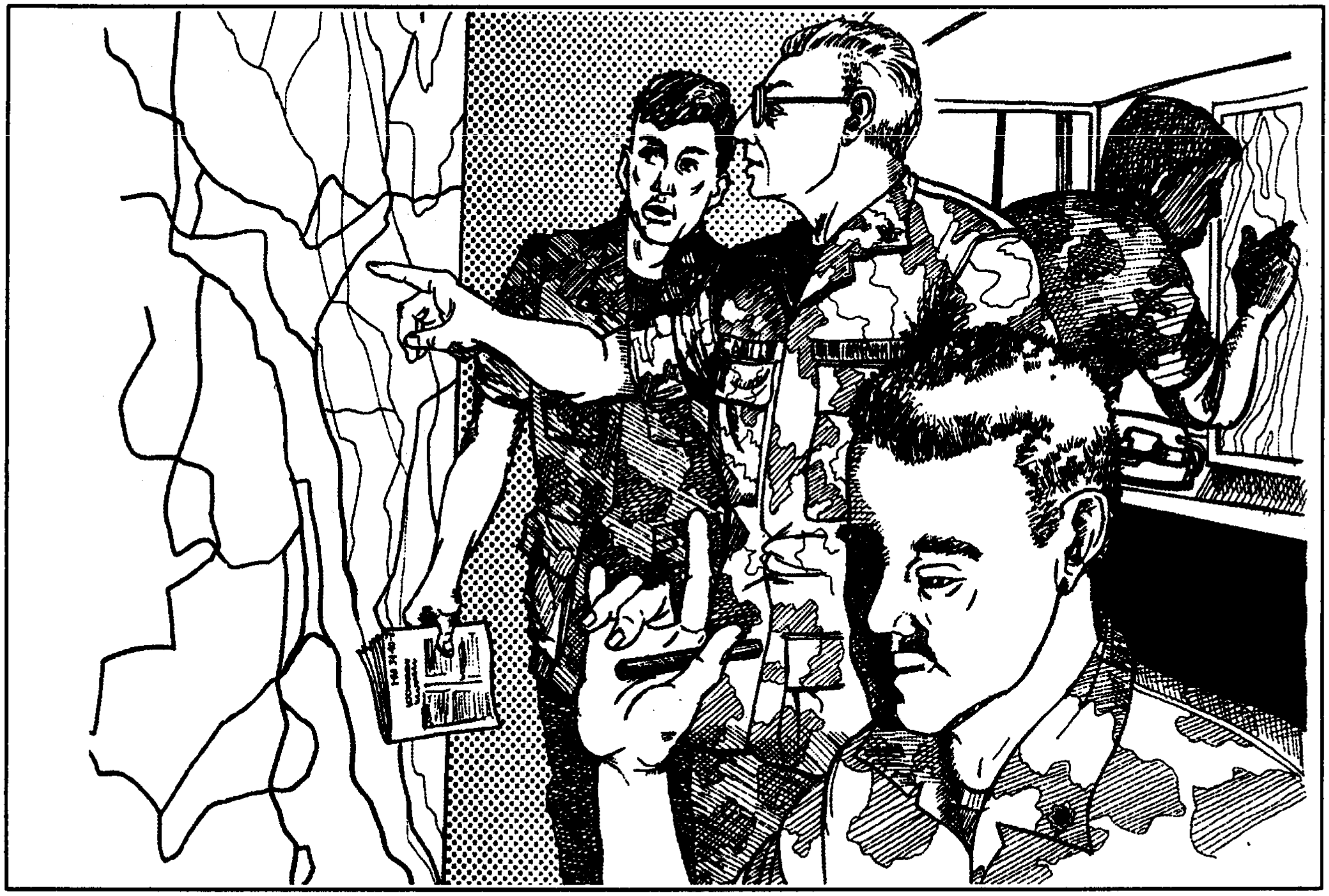


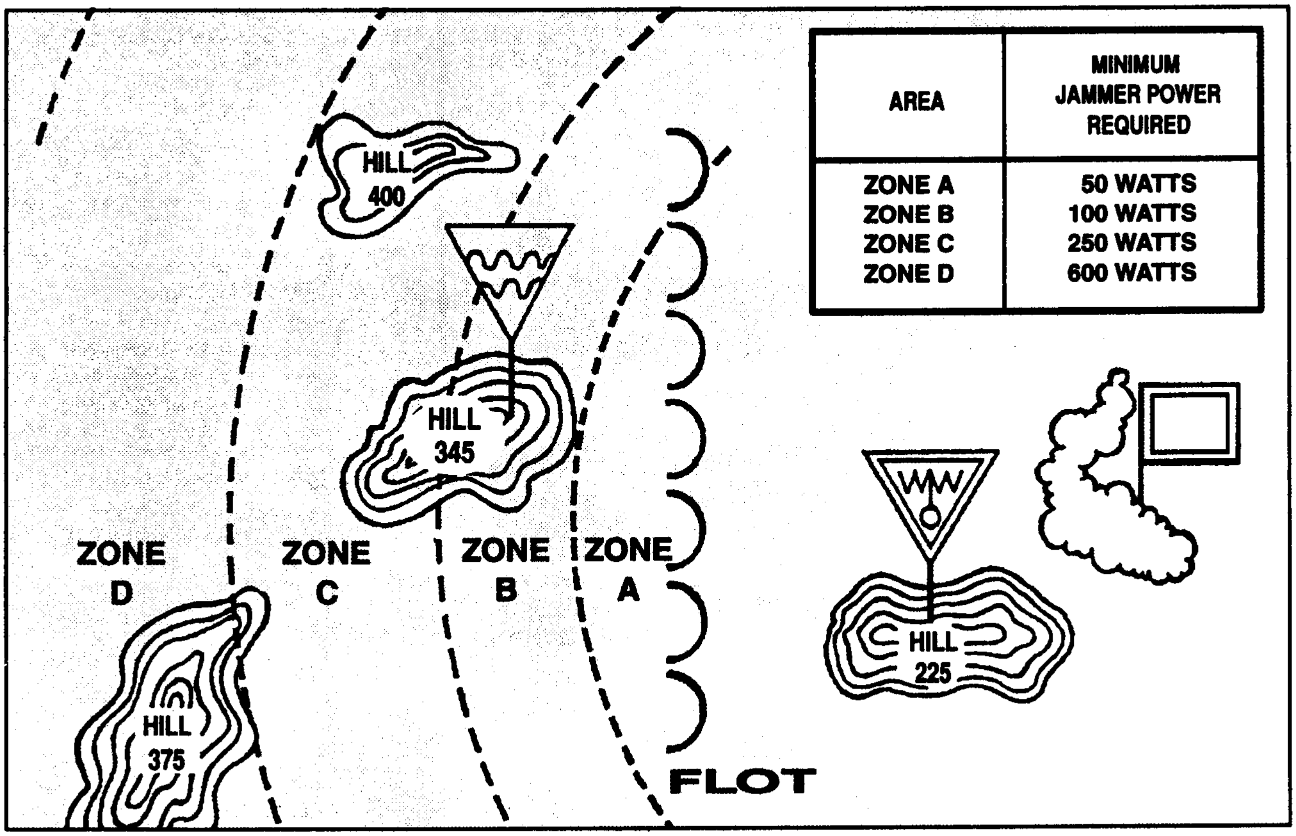
Figure 2-8. TCAE planning.

EZ341795 (Hill 345). This calculation was made using the Electronic Warfare Jamming Calculator, GTA 30-6-5 (see appendix). The various zones are calculated based on different jammer outputs using the GTA 30-6-5.

In step 6, we calculated that the jammer would have to be on Hill 345 in Zone B to be effective. Figure 2-9 shows that the battlefield has been cross-referenced and assigned zones for locating the jamming teams.

Assigning zones also provides greater flexibility to the jamming teams and permits them to adapt to local conditions and restrictions. In the remarks block of Figure 2-7, we identified the ON-OFF control frequency. This frequency must be monitored by the jamming teams to facilitate positive control so jammers can be turned on and off for careful synchronization with other battlefield systems (for example, artillery preparatory fire, a diversion, or a deception operation) or if unexpected problems arise (for example, jamming a frequency used by a medical evacuation helicopter).

We have discussed the sequence of actions required by several different echelons when integrating jamming into combat operations. It is important to understand the relationships that take place among the tacticians (as the managers), technicians, and operating elements. The G3 or S3 implements the commander’s guidance by integrating jamming with the rest of the battle plan.



AREA	MINIMUM JAMMER POWER REQUIRED
ZONE A	50 WATTS
ZONE B	100 WATTS
ZONE C	250 WATTS
ZONE D	600 WATTS

Figure 2-9. Jammer positions.

CHAPTER 3

Planning the Jamming Operation

An artillery commander's fire control element performs many geometric calculations prior to executing a fire mission. These calculations are necessary to bring steel effectively on the target. The jamming mission planner must also perform geometric calculations to bring fire effectively on the target receiver through electromagnetic energy (electromagnetic steel).

IMPORTANCE OF JAMMING

The jamming mission planner determines the minimum jammer power output required to jam the target receiver effectively. When an excess amount of jamming power is radiated into the air, it is easier for the enemy's DF equipment to intercept and locate the friendly jammer. For the jamming team to accomplish its mission, the mission plainer must determine the distance between the jamming team's location and the target receiver's location. A proposed jamming mission must be carefully evaluated to determine the proper deployment of the jamming team. Distances between the enemy transmitter location and the target receiver location, and between the friendly jammer location and the target receiver location, are two of the critical considerations for jamming team placement. Each jamming team deployment is different. Therefore, constant evaluation of proposed jamming targets is necessary. Terrain is important because **line of sight** (LOS) is necessary between the jammer's location and the target receiver's location. The enemy can be expected to use terrain to gain an advantage. The type of jammer to be employed is another consideration because some jamming systems have a different power output than others.

PLANNED JAMMING

Planned jamming requires the greatest amount of detail; for example, identifying the unit, the location, and the time window for the mission. It must be totally synchronized with fire support and maneuver to achieve maximum results. Planned jamming missions can engage a target simultaneously with fire, or singularly engage lower priority targets simultaneously with fire on higher priority targets. The electronic warfare tasking list (EWTL) can and should list specific targets and times to guide jamming so all targets, regardless of the jamming method used, can be specified in the EWTL. Planned jamming missions could be integrated with fire missions using a field artillery target list work sheet and a scheduling work sheet (Figures 3-1 and 3-2). A planned mission can be used in a direct offensive, a supporting offensive, or a deceptive role. In the direct offensive role, the mission would be targeted against the unit being attacked. A supporting offensive role would consist of jamming those enemy units capable of reinforcing their point of attack. A deceptive jamming mission can consist of jamming against one enemy unit prior to attacking a different enemy unit. The type of role or mission chosen depends on the tactical situation, the degree of knowledge of the enemy situation, the availability of assets, and the objective of the tactical mission. Planned missions can be further divided into scheduled and on-call missions.

Scheduled Mission

The scheduled mission, on a completed scheduling work sheet, depicts the enemy's unit, target location, and time that jamming is to be conducted. The time of the jamming mission is synchronized with the time of the fire mission to provide the greatest degree of support to the maneuver unit.

TARGET LIST WORK SHEET

For use of this form, see FM 6-20; the proponent agency is TRADOC.

Sheet ____ of ____

Line No	Target No	Description	Location	Altitude	Attitude	Length	Width	Source/ Accuracy	Remarks					
1														
2														
3														
4														

EXAMPLE

Figure 3-1. Artillery target list work sheet.

PRIORITY ESM	PRIORITY ECM	TIME WINDOW	TARGET UNIT	TARGET LOCATION	TARGET ACTIVITY	CONTROL MECHANISM	FEEDBACK/ COORDINATION

EXAMPLE

Figure 3-2. Scheduling work sheet.

On-Call Jamming

On-call jamming is dependent upon the unit and location; however, time cannot be ascertained because it is situationally dependent. Therefore, on-call jamming missions lend themselves to targeting reinforcing or second echelon units. On-call jamming missions should be incorporated as necessary into the master fire support (targeting) plan and the fire support execution matrix. Communications interfaces must be adequate to be able to execute the on-call mission at the appropriate time.

ELECTRONIC MASKING

Electronic masking, often called screen jamming, is also a planned mission. The purpose of electronic masking is to protect or mask friendly communications by denying the enemy the ability to intercept and locate them. Electronic masking is used when mission requirements necessitate the immediate transmission of critical information, and there is no other way to convey the information. Just as offensive jamming **captures** the receiver of the enemy, electronic masking **captures** enemy intercept and DF systems by jamming on the friendly frequency using directional antennas close to the forward line of own troops (FLOT). Electronic masking can best be used to mask the radio signals of friendly reinforcements being moved on line, thus preventing enemy signals intelligence from determining the disposition of the reinforcing unit. Figure 3-3 depicts an electronic masking operation. The enemy's ability to locate a jammer accurately through direction finding is reduced by using two or more jammers for an electronic masking operation.

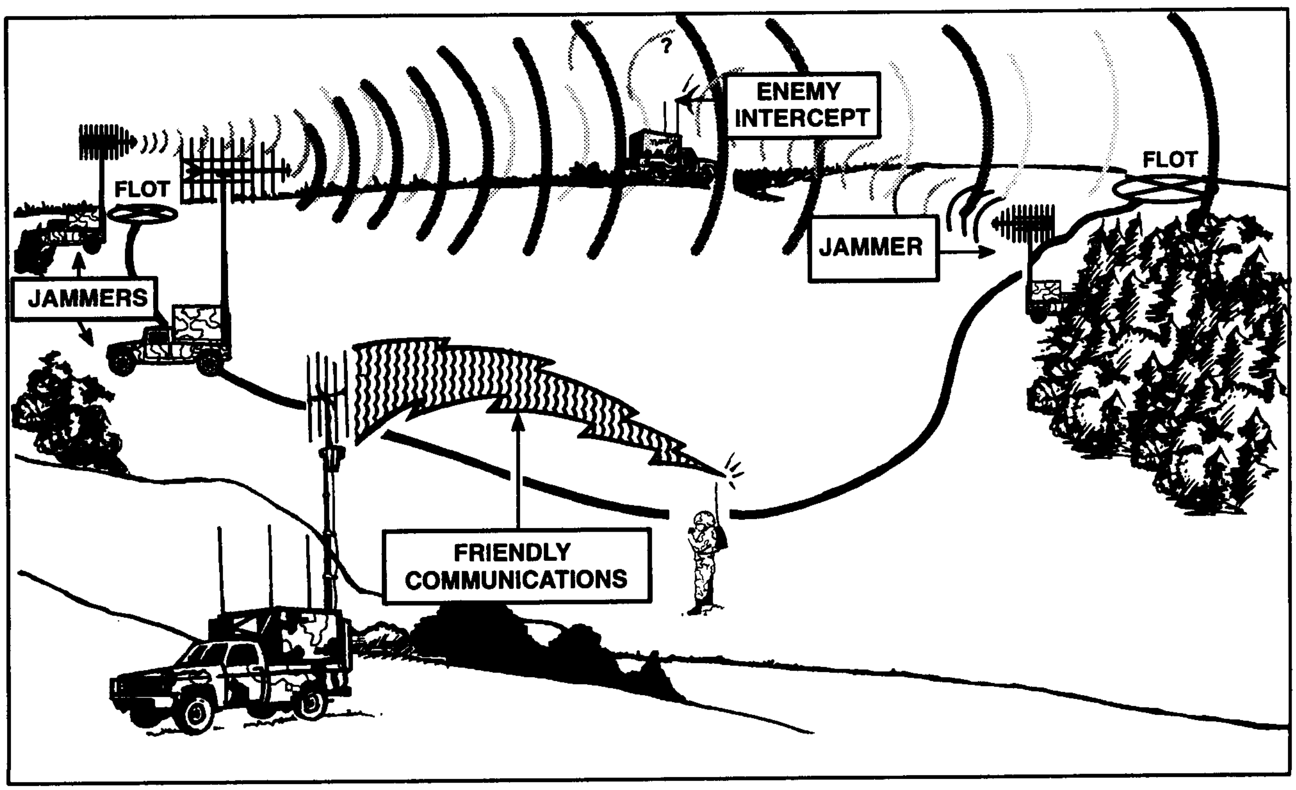


Figure 3-3. Electronic masking operation.

SOP JAMMING

Standing operating procedures (SOP) jamming means allowing the jamming operator to jam targets upon recognition. The SOP jamming technique is used when it is impossible to compute the jamming-to-signal ratio for effective jamming. The SOP jamming technique requires that the jammer's maximum power output **must** be used to ensure mission effectiveness; therefore, the jammer's power output cannot be reduced during SOP jamming. In certain situations, even the least amount of power reduction could render the jamming ineffective. Our jamming operations must be able to ensure success when the decision to jam is made. SOP jamming has the following disadvantages, which should be considered prior to its implementation:

- It does not allow for step-by-step coordination with frequency managers, intelligence collectors, or friendly forces in the jamming mission area of operations.
- The operator will not know if the jamming equipment location is close enough for the jamming signal to overcome the enemy transmitter signal at the target (enemy) receiver's location, without prior planning.
- Uncontrolled, high-powered jammers can have a disastrous effect on unwarned and unprepared friendly communications.
- Maximum jammer power output means maximum electronic visibility and vulnerability to the enemy electronic warfare forces, which could result in the destruction of the friendly jamming asset.

The two methods for employing the SOP jamming technique are called *jam upon recognition* and *targets of opportunity*.

In the *jam upon recognition* method, the operator is tasked to search for enemy targets. As soon as the target is identified, it is jammed. The operator is not tasked to jam specific targets at specific times. Under emergency conditions there is no time to plan and coordinate the jamming effort.

The *targets of opportunity* method is used against specific enemy units placed in priority. This method occurs after the targeting process is completed. The G3 or S3 organizes specific enemy targets in a priority order based on the input from the EWS and the fire support coordinator. The TCAE's ECM planning section determines when to jam each target based on the distinguishing traits of the target's communications. Each communications jamming team receives the SOP target jamming list. The list contains target call signs, type of traffic, and frequencies. The communications jamming teams are authorized to jam each target according to the instructions on the SOP target jamming list.

The SOP jamming schedule is neither time nor location oriented. Jamming can be performed as *jam upon recognition* based on tasking requirements and target activity or *targets of opportunity*, which requires no tasking and is based solely on target activity. Remember, the jammer's maximum power output is used, and commanders must be made aware of the disadvantages of SOP jamming.

SURGICAL VERSUS SIGNAL INITIATED JAMMING

Planned, on-call, and SOP jamming are the forms of jamming referred to as **surgical jamming.** The surgical jamming technique interrupts the target signal using a continuous wave jamming signal which makes it difficult for the enemy operator to know if he is being jammed. Signal initiated jamming (SIJ) is the jamming of frequencies programmed into the jammer and they are automatically jammed as they become active. As a result, a communications check could be jammed and tip off the jamming effort. SIJ increases the chance of fratricide, since the programmed frequency would be jammed regardless of whether it is friendly or enemy. In addition, SIJ bypasses the decision process to jam or listen. SIJ is effective only when the operator can verify that the transmission should be jammed. Surgical jamming is the most effective and is desired over SIJ. Also, the jammer's maximum power output is very important to the success of surgical jamming, when the jamming-to-signal ratio cannot be computed.

HIGH POWERED COMMUNICATIONS

High powered communications consist of using the jammer as the communications equipment to increase the power output for friendly communications. At critical points of the battle, when communications are mandatory, high powered communications will overcome either natural (static) or intentional (enemy ECM) interference.

FUNCTIONS OF MISSION PLANNING

Planning the jamming mission in response to specific tactical operations consists of many functions. These functions include—-

- Target isolation.
- Resource selection.
- Mission analysis.
- Effective jamming.
- Terrain analysis.

Target Isolation

Upon receipt of a jamming mission requirement, the jamming mission planner obtains target data by searching the enemy electronic order of battle, electronic warfare support measures, and other files. As information on the potential target is checked, frequency parameters are reviewed to determine if they conflict with restricted frequencies. Conflicts are identified and reported to the command establishing the restriction, who is responsible for resolving the conflicts. Unresolved restrictions are noted and added to the target files as restricted frequencies until they are resolved.

Resource Selection

The next step is to compare the jamming mission with available resources. Information on the type, number, location, and status of friendly jammers is required to effectively assign the mission. The multiple asset status report provides the status of the major assets to the asset manager. Jamming mission requirements that cannot be satisfied by organic direct support capabilities require support from a higher echelon.

Mission Analysis

The mission planner conducts a detailed analysis of the actual target network based on his geometric calculations, which indicates that the mission has a high probability of success. Analysis isolates the expected pattern of activity and structure for the various jamming operation phases being planned and establishes the engagement methods and timing for maximum target degradation. The multiple asset effectiveness report provides mission effectiveness data from the jammer to the asset mission manager.

The type and number of jamming resources required are examined to ensure that those selected are capable of accomplishing the planned mission. If required, any additional jamming resources needed are identified and requested from the supporting MI unit, Coordination, logistics, and communication problems are identified and procedures for their resolution are established. The multiple asset tasking message is then prepared and passed to the appropriate jamming team.

Effective Jamming

If the jamming-to-signal ratio for FM signals is large enough (or larger), jamming will be effective. If the jamming-to-signal ratio is too small, then jamming will not be effective (see jamming formulas in the appendix). Effective jamming disrupts, delays, or prevents the effective use of communications by the enemy. The jammer should, ideally, radiate only the amount of power output necessary (minimum jammer power output required) to interfere with the reception of the enemy transmitter signal in the target receiver. Jamming is most effective when it interferes with the enemy's communications without disclosing its presence. The jammer's power output must electronically **capture** the target receiver (Figure 3-4). **Capture** occurs when the strength of the friendly jammer's signal is stronger than the enemy transmitter's signal in the target receiver. In this situation, the frequency modulated receiver will be **captured** by the friendly jamming signal causing the target receiver to **reject** the weaker enemy transmitter signal.

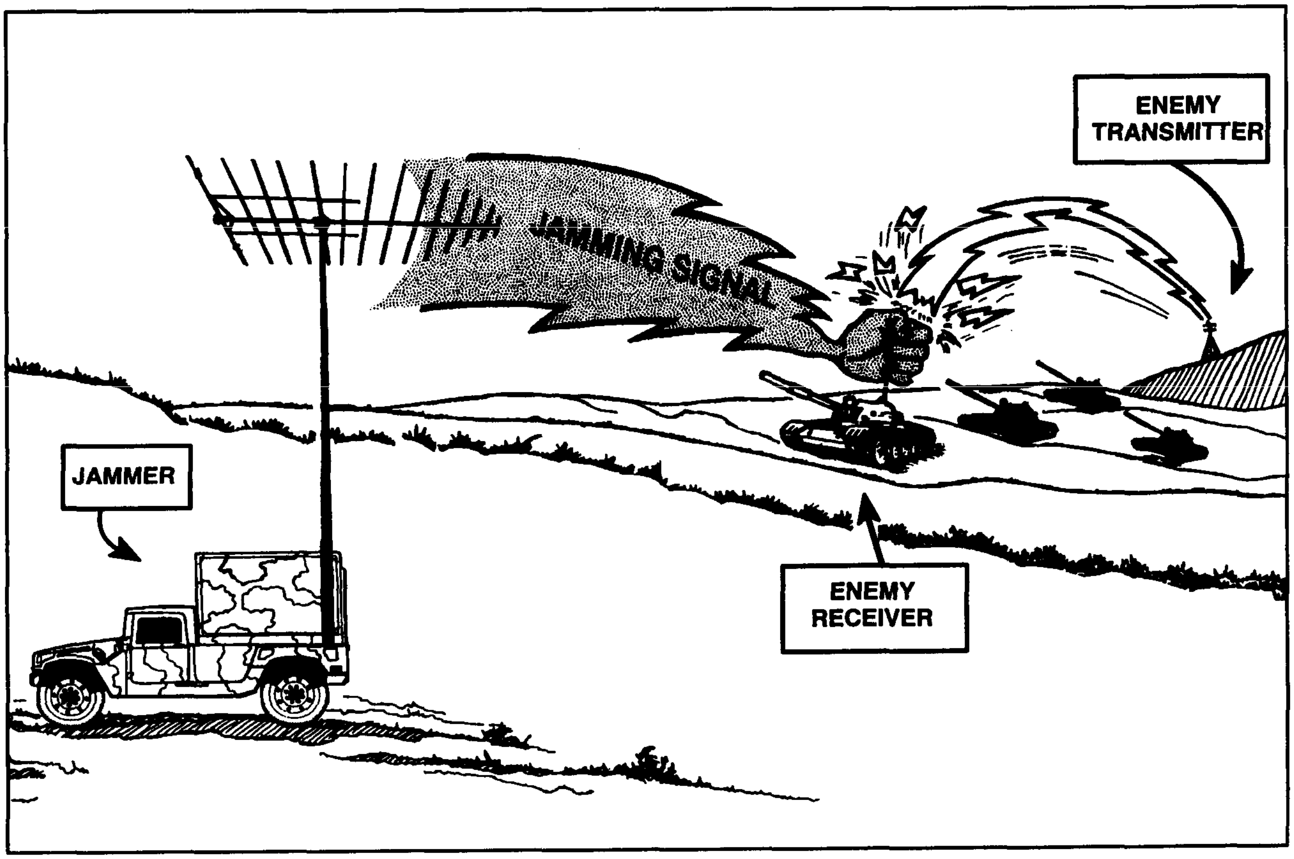


Figure 3-4. Capturing the targeted receiver system.

Terrain Analysis

An analysis of the terrain features between the jammers' location and friendly units is necessary to prevent inadvertent jamming of friendly communications. Jamming sites should be located where they can take advantage of any terrain features that could reduce or block the jamming frequency from interfering with friendly communications.

UNDERSTANDING JAMMING

To understand jamming, consider the following situation:

The operation plan identifies the enemy's COP and the associated communications as priority targets for jamming. The COP has located our battalion task force (BTF) and is passing this information to the advance guard battalion (AGB) (Figure 3-5). There is no inteeference with their communications. The AGB operator is able to hear and copy all of the COP's transmissions.

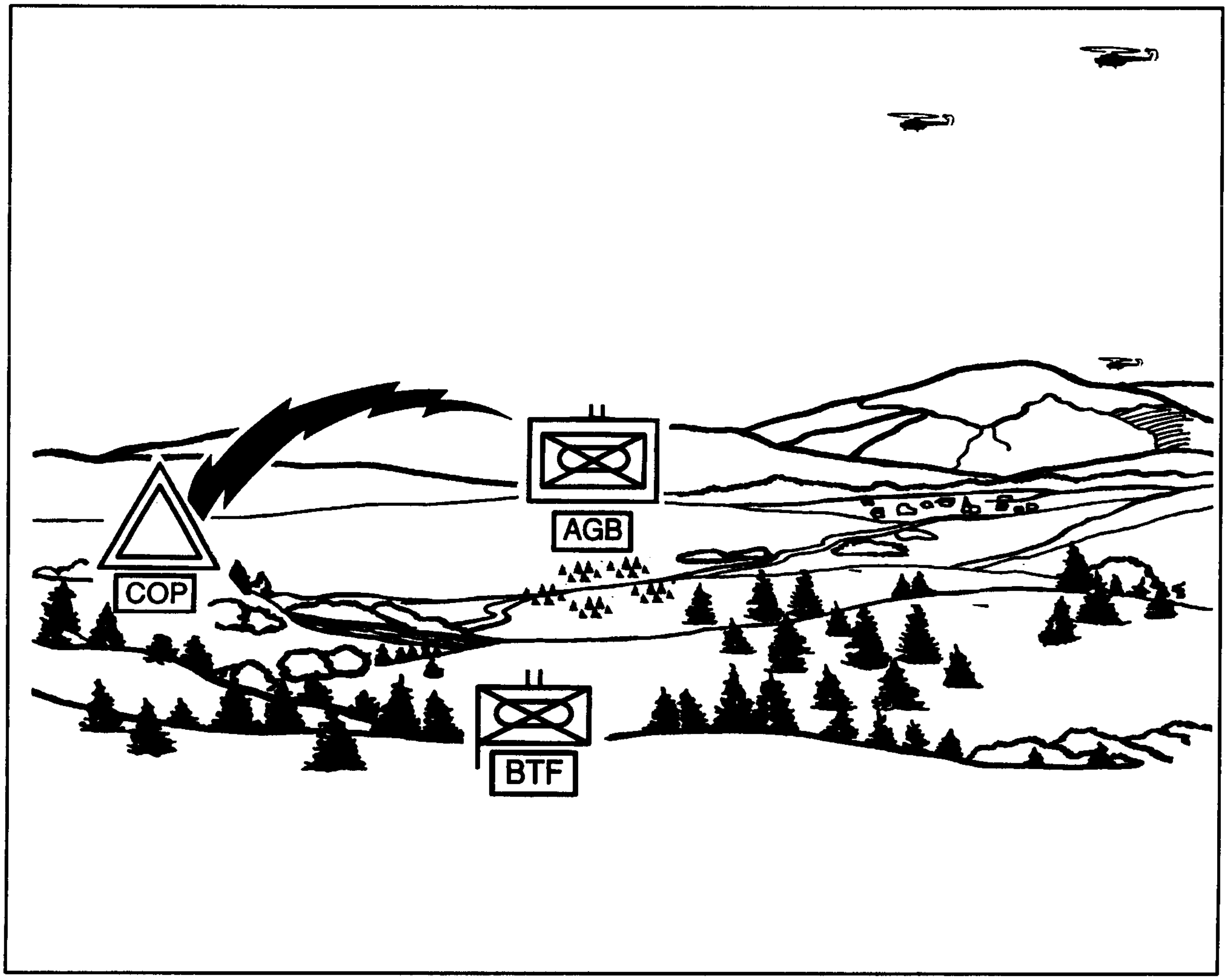


Figure 3-5. The advance guard battalion.

Identifying the Target

Intercept positions have identified the COP and AGB frequency and intercepted the link's transmissions. DF operations provided a general location for both stations. The emitter locations are given to the TCAE, where the jamming mission is planned. The mission planner determines the minimum jammer power output required to jam the COP and AGB communications as well as a location to deploy the friendly jammer (Figure 3-6).

Tasking the Mission

This information is forwarded, using secure communications, to the appropriate jamming team. Upon receiving the tasking, the jamming equipment is deployed to the designated location. The jamming equipment operator then—

- Tunes the jammer to proper frequency.
- Makes the necessary adjustments based on the multiple asset tasking message.
- Jams the target receiver as directed.

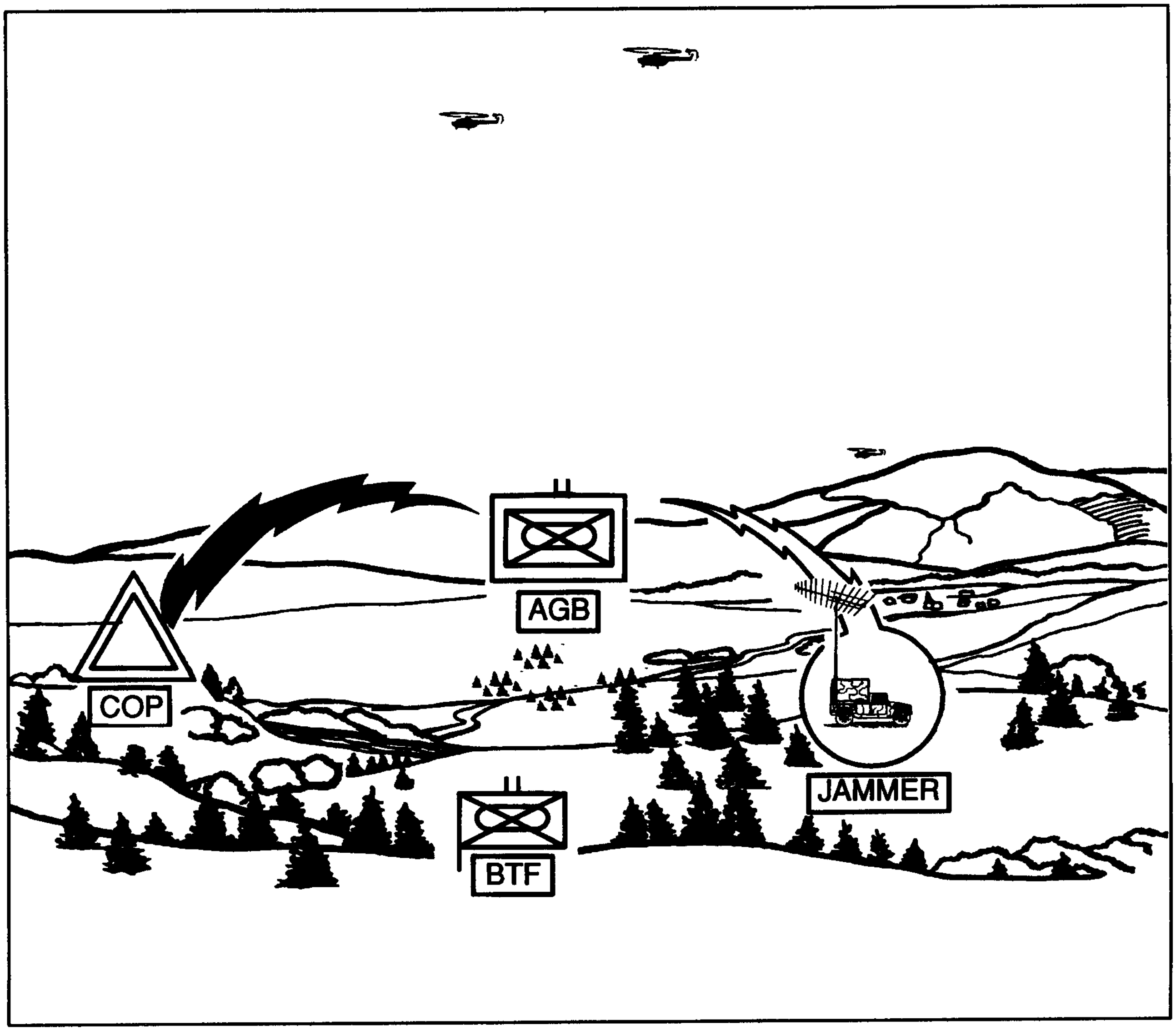


Figure 3-6. Jammer deployment.

Accomplishing the Mission

This mission successfully disrupted the enemy communication and delayed passage of the information. Therefore, the mission planner computed the correct minimum jammer power output required for this mission and the enemy's target receiver was captured. Jamming interfered with receipt of the message and required the AGB operator to ask for repeats of the message.

Determining the Power Output

It is very difficult, if not impossible, to determine the exact jammer power output required to electronically capture a target receiver. The criteria for determining the minimum jammer power output required to capture a receiver is not universally accepted. Before determining the minimum amount of jammer power output required for a given tactical situation, the mission planner must understand that groundbased jamming is very complex. In free space, some of these variables are not important. However, on the ground they can become critical. Some of the variables which can cause attenuation of radio waves are terrain, ground conductivity, vegetation, and weather (Figure 3-7).

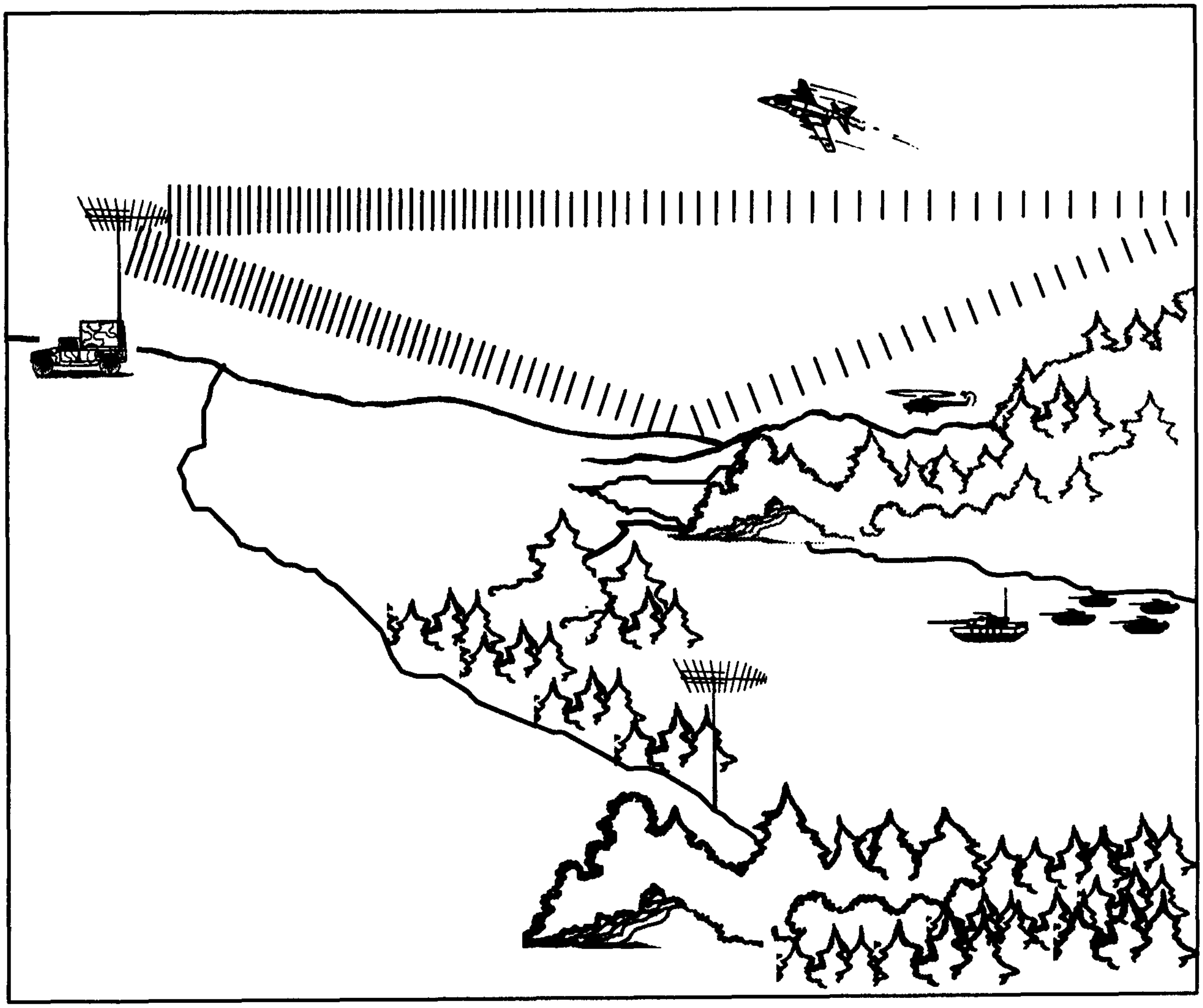


Figure 3-7. Radio wave attenuation.

CHAPTER 4

Training

Two categories of training are required to prepare the soldier to operate a jammer in combat: resident and in-unit training. Voice interceptors (military occupational specialty 98G) must be skilled in communications intercept to recognize the target signal. While training in most MI disciplines results in the awarding of a military occupational specialty, soldiers qualified in the skill of jamming receive an additional skill identifier of K3.

RESIDENT TRAINING

Resident training is currently taught during the *Communications Electronic Warfare Operations Course (CEWOC).* This training consists of installing and operating ECM, electronic warfare support measures, and communications equipment. Training is conducted in ECM and electronic warfare support measures missions against those targets unique to the student's tactical duty assignment. A simulated field training exercise is conducted at the end of each course. During the field training exercise the student is evaluated for knowledge of—

- Electronic warfare skills.
- Perimeter defense.
- Nuclear, biological, and chemical operations.
- Survival skills.

IN-UNIT TRAINING

In-unit training refines skills learned during resident training. It combines technical skills with survival skills. This combination ensures that the unit can conduct jamming operations and survive. Survival is critical to the continued success of a unit. Therefore, in-unit training must emphasize the survival principles. It must stress the importance of reducing the amount of power and time a jammer's transmitter is keyed and that you transmit only with the amount of power needed to accomplish the mission. Using only the amount of power necessary to effectively jam and keying the jammer's transmitter in short bursts reduces the probability of detection by enemy intercept and DF equipment. In-unit training should provide a means of measuring and controlling these two jamming principles. This is possible when in-unit training is designed to allow soldiers to practice their jamming skills.

Unit trainers are challenged to make jamming training as realistic as possible. Realism is achieved when the jamming mission planner and the jamming equipment operator are trained in a simulated combat situation. This setting allows the effectiveness of the mission planner to be measured. The successful execution of the jamming mission indicates that the mission planner is effective. Successful mission planning and execution during in-unit training provide the technical and tactical skills needed in combat.

APPENDIX

Jamming Calculations

The three methods used in jamming calculations involve jamming formulas, the GTA 30-6-5, and the JAMPOT fan. The jamming formulas are used to determine the jamming power output and jammer distance to target. Calculations are made manually. The GTA 30-6-5 results require the aid of the electronic warfare jamming calculator. Likewise, the results achieved with the JAMPOT fan require the aid of a JAMPOT fan template.

ABBREVIATIONS AND FORMUL4S

Understanding the abbreviations and jamming formulas presented makes jamming mission computation easier. When planning a jamming mission, it is necessary to make a thorough and reasonable appraisal of the significant technical factors that impact on effective jamming missions. Once these factors are determined, they are used to select the proper jamming equipment to conduct the jamming mission.

Abbreviations

Study the following abbreviations before reading further. They will be used often, and a little time spent on them now may preclude the necessity of constantly turning the pages to understand what they mean. Additionally, as you use these formulas, ensure you are using the numbers in the proper units (for example, power in watts, distance in kilometers, and elevation in feet).

P_j = Minimum amount of jammer power output required in watts (read on power output meter of the jammer).

P_t = Power output of the enemy transmitter in watts.

H_j = Elevation of the jammer location above the sea level.

NOTE: *The elevation of the jammer location and the enemy transmitter location does not include the height of the antenna above the ground or the length of the antenna.* ***It is the location elevation above the sea level.***

H_t = Elevation of the enemy transmitter location above the sea level.

D_j = Jammer location-to-target receiver location distance in kilometers.

D_t = Enemy transmitter location-to-target receiver location distance in kilometers.

K = Number 2 for jamming frequency modulated receivers (jammer tuning accuracy).

n = Terrain and ground conductivity factor.

- **5 =** Very rough terrain (rocky mountains or desert) with poor ground conductivity.
- **4 =** Moderately rough terrain (rolling to high hills, forested farmland) with fair to good ground conductivity.
- **3 =** Rolling hills (farmland type terrain) with good ground conductivity.
- **2 =** Level terrain (over water, sea, lakes, and ponds) with good ground conductivity.

Jamming Formulas

Jamming formulas provide the tools needed to compute the jamming power output and jammer distances. The formulas presented here are based on a tactical situation where the enemy transmitter-receiver link and jammer-enemy receiver link are operating over moderately rough terrain with no high hills between the two locations. The enemy transmitter and friendly jammer locations are at approximately the same elevation above the sea level (difference is less than 10 meters). When the terrain features differ by more than 10 meters between the enemy transmitter and friendly jammer locations, the mission planner must factor this difference into his calculations.

FORMULA 1

Formula 1 (Figure A-1) is used to compute the minimum jammer power output that is required (the least amount) to effectively jam the target receiver.

Formula 1 is written as–

$$P_j = P_t \times K \times \left(\frac{H_t}{H_j}\right)^2 \times \left(\frac{D_j}{D_t}\right)^n$$

Figure A-1. Formula 1.

EQUIPMENT PARAMETERS

The equipment parameters of friendly and enemy equipment are needed to solve this formula. The parameters of friendly equipment can be obtained from the technical manuals written for the equipment. Technical intelligence publications on enemy communications systems provide similar data and can be obtained from the G2. When information is not available on enemy communications systems, it may become necessary to estimate the parameters to reach a solution. In the following tactical situation, the essential parameters needed to compute formula 1 are given as:

f = Frequency (37.5 megahertz).

D_t = Enemy transmitter location-to-target receiver location distance in km (9 km).

D_j = Jammer location-to-target receiver location distance in km (17 km).

P_t = Power output of the enemy transmitter in watts (5 watts).

P_j = Minimum amount of jammer power output required in watts (solve).

H_t = Elevation of the enemy transmitter location above the sea level in meters (385 meters).

H_j = Elevation of the jammer location above the sea level in meters (388 meters).

K = FM jammer tuning accuracy (2).

n = Terrain and ground conductivity factor (4).

Substitute the parameters in formula 1 using the steps shown in Table A-1 on page A-4 to solve for P_j.

Table A-1. Formula 1 calculations.

STEP 1

Replace P_t with 5.

$$P_j = 5 \times K \times \left(\frac{H_t}{H_i}\right)^2 \times \left(\frac{D_j}{D_t}\right)^n$$

STEP 2

Replace K with 2.

$$P_j = 5 \times 2 \times \left(\frac{H_t}{H_j}\right)^2 \times \left(\frac{D_j}{D_t}\right)^n$$

STEP 3

Replace H_t with 385.

$$P_j = 5 \times 2 \times \left(\frac{385}{H_j}\right)^2 \times \left(\frac{D_j}{D_t}\right)^n$$

STEP 4

Replace H_j with 386.

$$P_j = 5 \times 2 \times \left(\frac{385}{386}\right)^2 \times \left(\frac{D_j}{D_t}\right)^n$$

STEP 5

Replace D_j with 17.

$$P_j = 5 \times 2 \times \left(\frac{385}{386}\right)^2 \times \left(\frac{17}{D_t}\right)^n$$

STEP 6

Replace D_t with 9.

$$P_j = 5 \times 2 \times \left(\frac{385}{386}\right)^2 \times \left(\frac{17}{9}\right)^n$$

STEP 7

Replace n with 4.

$$P_j = 5 \times 2 \times \left(\frac{385}{386}\right)^2 \times \left(\frac{17}{9}\right)^4$$

At this point, you have replaced the formula 1 parameters with the given numerical values to solve for P_j. The following steps involve completing the mathematical computations.

(Steps 8 through 13 are continued on the next page.)

Table A-1. Formula 1 calculations (continued).

STEP 8

Multiply 5 by 2; divide 385 by 386; divide 17 by 9.

$$P_j = 10 \times (1)^2 \times (1.88)^4$$

If the difference between H_t (385) and H_j (386) is less than 10 meters, the elevation factor is 1. When dividing D_j (17) by D_t (9), use the second decimal place and do not round off.

STEP 9

Reduce $(1)^2$ to 1. $P_j = 10 \times 1 \times (1.88)^4$

STEP 10

Multiply 1.88 by 1.88. $P_j = 10 \times (3.53)^2$

STEP 11

Multiply 3.53 by 3.53. $P_j = 10 \times 12.46$

STEP 12

Multiply 12.46 by 10. $P_j = 124.60$ or 125 *watts*

STEP 13

If the jammer's LPA antenna is used, divide the power output from step 12 by 2.

$$P_j = \frac{125}{2} = 62.5 \text{ watts}$$

The selected jammer must be able to produce and use 125 watts of power output to overcome the enemy's transmitter signal at the target receiver location. Less than 124.6 watts of power will not be effective. If more than 125 watts are used, jamming will still be effective. The 125 watts represents the minimum power output reading for effective jamming using a whip antenna in this tactical situation. The 62.5 watts is the minimum power for the same problem when using the jammer's log periodic array (LPA) antenna.

FORMULA 2

Formula 2 (Figure A-2) is used to compute the maximum distance that a jammer's location can be from the target receiver location and still be effective. Use 1,500 watts as the maximum jammer power output in this tactical situation. Substitute the rest of the numerical values from formula 1 for the parameters in formula 2. Use the steps in Table A-2 to find the solution for the maximum jammer location-to-target receiver location distance.

Formula 2 is written as–

$$D_j = D_t \sqrt[n]{\frac{P_j}{P_t \times K \times \left(\frac{H_t}{H_j}\right)^2}}$$

Figure A-2. Formula 2.

Table A-2. Formula 2 calculations.

STEP 1 Replace D_t with 9.	$D_j = 9 \sqrt[n]{\frac{P_j}{P_t \times K \times \left(\frac{H_t}{H_j}\right)^2}}$
STEP 2 Replace n with 4.	$D_j = 9 \sqrt[4]{\frac{P_j}{P_t \times K \times \left(\frac{H_t}{H_j}\right)^2}}$

(Steps 3 through 8 are continued on the next page.)

Table A-2. Formula 2 calculations (continued).

STEP 3

Replace P_t with 5.

$$D_j = 9\sqrt[4]{\frac{P_j}{5 \times K \times \left(\frac{H_t}{H_j}\right)^2}}$$

STEP 4

Replace K with 2.

$$D_j = 9\sqrt[4]{\frac{P_j}{5 \times 2 \times \left(\frac{H_t}{H_j}\right)^2}}$$

STEP 5

Replace H_t with 385.

$$D_j = 9\sqrt[4]{\frac{P_j}{5 \times 2 \times \left(\frac{385}{H_j}\right)^2}}$$

STEP 6

Replace H_j with 386.

$$D_j = 9\sqrt[4]{\frac{P_j}{5 \times 2 \times \left(\frac{385}{386}\right)^2}}$$

STEP 7

Replace P_j with 1,500.

$$D_j = 9\sqrt[4]{\frac{1500}{5 \times 2 \times \left(\frac{385}{386}\right)^2}}$$

At this point, you have replaced the formula 2 parameters with the numerical values given to solve for D_j. Perform the mathematical calculations in the following steps (8 through 13), to find the solution for the maximum distance between the jammer and target receiver when using the **jammer's whip antenna**. If the jammer's LPA antenna is used, go directly to step 14. Do not perform steps 8 through 13.

STEP 8

Multiplying 2 by 5 equals 10. Dividing 385 by 386 equals .99; however, when the difference between elevation levels is less than 10 meters, use the multiplication factor of 1. Therefore, 1^2 is reduced to 1.

$$D_j = 9\sqrt[4]{\frac{1500}{10 \times 1}}$$

(Steps 9 through 13 are continued on the next page.)

Table A-2. Formula 2 calculations (continued).

STEP 9

Multiplying 10 times 1 equals 10.

$$D_j = 9 \sqrt[4]{\frac{1500}{10}}$$

STEP 10

Dividing 1,500 by 10 equals 150.

$$D_j = 9 \sqrt[4]{150}$$

Steps 11 and 12 perform the same function as the fourth root (step 10). Taking the square root twice is the same as taking the fourth root of a number.

STEP 11

The square root of 150 is 12.247 or 12.25.

$$D_j = 9 \sqrt[2]{150} = 12.25$$

STEP 12

The square root of 12.25 is 3.5.

$$D_j = 9 \sqrt[2]{12.25} = 3.5$$

STEP 13

Multiply 9 times 3.5.

$$D_j = 9 \times 3.5 = 31.5$$

The distance is 31.5 kilometers when using the jammer's **whip antenna**. Steps 1 through 13 of formula 2 illustrate the maximum distance a jammer can be operated and still be effective against a target receiver in this tactical situation.

(Steps 14 through 17 are continued on the next page.)

Table A-2. Formula 2 calculations (continued).

NOTE: Steps 1 through 13 are calculated based on the power output using a whip antenna. The LPA antenna increases the potential of the maximum power output and requires different calculations. Continue with steps 14 through 20 when the LPA antenna is used instead of the whip antenna.

STEP 14

Double the selected jammer's maximum power output when using the LPA antenna. If the maximum power output is 1,500 watts, then P_j times 2 equals 3,000 watts. Replace P_j with 3,000.

$$D_j = 9\sqrt[4]{\frac{3000}{5 \times 2 \times \left(\frac{385}{386}\right)^2}}$$

STEP 15

Multiplying 2 by 5 equals 10. Dividing 385 by 386 equals .99; however, when the difference between elevation levels is less than 10 meters, use the multiplication factor of 1. Therefore, 1^2 is reduced to 1.

$$D_j = 9\sqrt[4]{\frac{3000}{10 \times 1}}$$

STEP 16

Multiplying 10 times 1 equals 10.

$$D_j = 9\sqrt[4]{\frac{3000}{10}}$$

STEP 17

Dividing 3,000 by 10 equals 300.

$$D_j = 9\sqrt[4]{300}$$

Steps 18 and 19 perform the same function as finding the fourth root (step 17). Taking the square root twice provides the same result as taking the fourth root of a number.

(Steps 18 through 20 are continued on the next page.)

Table A-2. Formula 2 calculations (continued).

STEP 18

The square root of 300 = 17.32

$$D_j = 9 \sqrt[2]{300} = 17.32$$

STEP 19

The square root of 17.32 is 4.16.

$$D_j = 9 \sqrt[2]{17.32} = 4.16$$

STEP 20

Multiply 9 by 4.16.

$$D_j = 9 \times 4.16 = 37.44\ km$$

The formula 2 computation illustrates the maximum distance that the jammer can be located from the target receiver's location and still be effective. In this tactical situation, that distance is 37.44 kilometers when using the jammer's LPA antenna.

TERRAIN AND GROUND CONDUCTIVITY FACTORS

As previously mentioned, the attenuation of radio waves is subject to terrain and ground conductivity factors (n). Table A-3 on page A-11 is used to compute the minimum jammer power output and maximum jammer location-to-target receiver location distance. Multiply the watts from Table A-3 by the power output of the enemy's transmitter to obtain the minimum power output. The factor of n equals 5 is used for very rough terrain (deserts or mountains) with poor ground conductivity. The table is a matrix. The left column (reading down from 0.5 to 10.0) is the jammer location-to-target receiver location distance in kilometers. The top line of numbers (0.5 to 5.0) is the enemy transmitter-to-target receiver location distance in kilometers. The internal numbers (1 through 26.4K) are expressed in watts or kilowatts (K equals multiplication by 1,000).

To use the table, take the kilometers reading from the left column and the kilometers reading from the top line and find where they intersect. For example, if the jammer is 1.5 kilometers from the target and the enemy transmitter is 0.5 from the target, the factor is 486 watts. This means if the enemy transmitter uses only 1 watt, the jammer must use at least 486 watts to be successful under these conditions.

The factor of 486 is achieved by dividing the jammer location-to-target receiver distance (1.5) by the enemy transmitter location-to-target receiver distance (0.5). The result (3) is first raised to the fifth power (243) and then doubled *(486)*. When fractions are encountered as result of division (for example 8.5 km divided by 4.5 kilometers equals 1.8888), only the first two digits to the right of the decimal are used, and the fraction is not rounded off. Therefore, for the purpose of finding then factor, 1.8888 is viewed as 1.88.

Table A-3. Desert or mountain terrain (n = 5) in kilometers.

D_j	D_t 0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
0.5	2	1	1	1	1	1	1	1	1	1
1.0	64	2	1	1	1	1	1	1	1	1
1.5	486	15	2	1	1	1	1	1	1	1
2.0	2048	64	9	2	1	1	1	1	1	1
2.5	6250	196	26	6	2	1	1	1	1	1
3.0	15.6K	486	64	15	5	2	1	1	1	1
3.5	33.6K	1051	139	33	11	5	2	1	1	1
4.0	65.5K	2048	270	64	21	9	4	2	1	1
4.5	118K	3691	486	116	38	15	7	4	2	1
5.0	200K	6250	823	196	64	26	12	6	4	2
5.5		10K	1326	315	103	42	20	10	6	4
6.0		15.6K	2048	486	160	64	30	15	9	5
6.5		23.2K	3056	726	238	96	45	23	13	8
7.0		33.6K	4427	1051	345	139	64	33	19	11
7.5		47.5K	6250	1483	486	196	91	47	26	15
8.0		65.6K	8630	2048	671	270	125	64	36	21
8.5		88.8K	11.7K	2774	909	366	169	87	48	29
9.0		118K	15.6K	3691	1210	486	225	116	64	38
9.5			20.4K	4836	1585	637	295	152	84	50
10.0			26.4K	6250	2048	823	381	196	108	64

Table A-4 is similar to Table A-3, but the internal numbers are changed. They are based a factor of n = 4. After dividing the jammer-t.o-target receiver distance by the enemy transmitter location-to-target receiver distance, the result is raised to the fourth power and then doubled.

Table A-4. Rolling hills terrain (n = 4) (moderately rough, with good ground conductivity) in kilometers.

	D_t									
D_j	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
0.5	2	1	1	1	1	1	1	1	1	1
1.0	32	2	1	1	1	1	1	1	1	1
1.5	162	10	2	1	1	1	1	1	1	1
2.0	512	32	6	2	1	1	1	1	1	1
2.5	1250	78	15	5	2	1	1	1	1	1
3.0	2592	162	32	10	4	2	1	1	1	1
3.5	4802	300	59	19	8	4	2	1	1	1
4.0	8192	512	101	32	13	6	3	2	1	1
4.5	13.1K	820	162	51	21	10	6	3	2	1
5.0	20K	1250	247	78	32	15	8	5	3	2
5.5	29.3K	1830	362	114	47	23	12	7	5	3
6.0	41.5K	2592	512	162	66	32	17	10	6	4
6.5	57.1K	3570	705	223	91	44	23	14	9	6
7.0	76.8K	4802	949	300	123	59	32	19	12	8
7.5	101K	6328	1250	396	162	78	42	25	15	10
8.0	131K	8192	1618	512	210	101	55	32	20	13
8.5	167K	10.4K	2062	653	267	129	70	41	26	17
9.0	210K	13.1K	2592	820	336	162	87	51	32	21
9.5	261K	16.3K	3218	1018	417	201	109	64	40	26
10.0	320K	20K	3951	1250	512	247	132	78	49	32

Table A-5 is based on a factor of n = 3. After dividing the jammer-to-target receiver distance by the enemy transmitter location-to-target receiver distance, the result is raised to the third power and doubled.

Table A-5. Moderately level terrain (n = 3) (rolling hills or farmland, with good ground conductivity) in kilometers.

D_j	D_t 0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
0.5	2	1	1	1	1	1	1	1	1	1
1.0	16	2	1	1	1	1	1	1	1	1
1.5	54	7	2	1	1	1	1	1	1	1
2.0	128	16	5	2	1	1	1	1	1	1
2.5	250	31	9	4	2	1	1	1	1	1
3.0	432	54	16	7	4	2	1	1	1	1
3.5	686	86	25	11	6	3	2	1	1	1
4.0	1024	128	38	16	8	5	3	2	1	1
4.5	1458	182	54	23	12	7	4	3	2	1
5.0	2000	250	74	31	16	9	6	4	3	2
5.5	2662	333	99	42	21	12	8	5	4	3
6.0	3456	432	128	54	28	16	10	7	5	4
6.5	4394	549	163	69	35	20	13	9	6	4
7.0	5488	686	203	86	44	25	16	11	8	6
7.5	6750	844	250	106	54	31	20	13	9	7
8.0	8192	1024	303	128	66	38	24	16	11	8
8.5	9826	1228	364	154	79	46	29	19	14	10
9.0	11.7K	1458	432	182	93	54	34	23	16	12
9.5	13.7K	1715	508	214	110	64	40	27	19	14
10.0	16K	2000	593	250	128	74	47	31	22	16

Table A-6 is based on a factor of n = 2. After dividing the jammer-to-target receiver distance by the enemy transmitter location-to-target receiver distance, the result is raised to the second power and doubled.

Table A-6. Level terrain (n = 2) (over sea water, with good ground conductivity) in kilometers.

D_j	D_t 0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
0.5	2	1	1	1	1	1	1	1	1	1
1.0	8	2	1	1	1	1	1	1	1	1
1.5	18	5	2	1	1	1	1	1	1	1
2.0	32	8	4	2	1	1	1	1	1	1
2.5	50	13	6	4	2	1	1	1	1	1
3.0	72	18	8	5	3	2	1	1	1	1
3.5	98	25	11	6	4	3	2	1	1	1
4.0	128	32	14	8	5	4	3	2	1	1
4.5	162	41	18	10	7	5	3	3	2	1
5.0	200	50	22	13	8	6	4	3	3	2
5.5	242	61	27	15	10	7	5	4	3	2
6.0	288	72	32	18	12	8	6	5	4	3
6.5	338	85	38	21	14	9	7	5	4	3
7.0	392	98	44	25	16	11	8	6	5	4
7.5	450	113	50	28	18	13	9	7	6	5
8.0	512	128	57	32	21	14	10	8	6	5
8.5	578	145	64	36	23	16	12	9	7	6
9.0	648	162	72	41	26	18	13	10	8	7
9.5	722	181	80	45	29	20	15	11	9	7
10.0	800	200	89	50	32	22	16	13	10	8

Tables A-3 through A-6 are reliable under the following conditions:

- Elevation of the jammer location above the sea level is approximately the same as the elevation of the enemy transmitter location (less than 10 meters difference).
- Power values obtained from the tables match the reading on the jammer's power output meter. (Antenna loss and voltage standing wave ratio have been taken into account.)
- Power values are used with the jammer's whip antenna.
- Jammer location must have a reasonable LOS propagation path to the target receiver location with no high hills between the two locations.
- Jammer is used against frequency modulated voice communications in the VHF range.

The exceptions to the above conditions are—

- If the elevation of the jammer location and the enemy transmitter location difference is 10 meters or more.
- If the LPA antenna is used instead of a whip antenna, the power indicated must be divided by 2.

ELEVATION RATIO AND MULTIPLICATION FACTORS

Table A-7, page A-16, is used to convert the minimum jammer power output value obtained from Table A-3. It is used when the elevation difference of the jammer location and the enemy transmitter location is 10 or more meters.

Determine the Elevation Ratio

To convert the minimum jammer power output from Table A-3, the elevation ratio must be determined. To do this, divide the jammer location elevation by the enemy transmitter location elevation. The jammer location-to-enemy transmitter location elevation ratios are listed in the left column in Table A-7. Rounding down, find the next lower elevation ratio number which is closest to your computed ratio. Always round the ratio down to the next lower ratio number in the table to ensure that there will be sufficient power output for effective jamming. The figure to the right of the numbers is the elevation multiplication factor. Multiply the minimum jammer power output value from Table A-3 by the elevation multiplication factor from Table A-7. The result is the final minimum jammer power output necessary for effective jamming, in this location elevation ratio situation.

Determine the Multiplication Factor

As an example, we will use the minimum jammer power output from Table A-3 of 64 watts. The elevation of the jammer location is 435 meters and the elevation of the enemy transmitter location is 557 meters. Determine the location elevation ratio by dividing the jammer location elevation (435 meters) by the enemy transmitter location elevation (557 meters). The result is the fraction .78. Round the fraction **down** to the nearest number on Table A-7 (.75). Read to the right of .75 and the multiplication factor is 1.8. Next, multiply the jammer power output selected from Table A-3 (64 watts) by the multiplication factor of (1.8). The answer is 115.2 or 116. The 116 watts is adjusted into a power output figure used in computing the final jammer power output which can be used for effective jamming.

Table A-7. Elevation ratio and multiplication factor.

RATIO	MULTIPLIER	RATIO	MULTIPLIER	RATIO	MULTIPLIER
0.05	400.0	1.05	.91	2.05	.24
0.10	44.5	1.10	.83	2.10	.23
0.15	25.0	1.15	.76	2.15	.22
0.20	16.0	1.20	.70	2.20	.21
0.25	11.2	1.25	.64	2.25	.20
0.30	8.2	1.30	.60	2.30	.19
0.35	6.3	1.35	.55	2.35	.18
0.40	5.0	1.40	.52	2.40	.17
0.45	4.0	1.45	.48	2.45	.17
0.50	3.4	1.50	.45	2.50	.16
0.55	2.8	1.55	.42	2.55	.15
0.60	2.4	1.60	.40	2.60	.15
0.65	2.3	1.65	.37	2.65	.14
0.70	2.1	1.70	.35	2.70	.14
0.75	1.8	1.75	.33	2.75	.13
0.80	1.6	1.80	.31	2.80	.13
0.85	1.4	1.85	.30	2.85	.12
0.90	1.3	1.90	.28	2.90	.12
0.95	1.2	1.95	.27	2.95	.11
1.00	1.0	2.00	.25	3.00	.11

NOTE: For all elevation ratios above 3.00, use an elevation multiplier of .11.

MINIMUM JAMMER POWER OUTPUT REQUIREMENT

Table A-8 is a step-by-step exercise to determine the minimum jammer power output for effective jamming using Table A-3 (desert terrain) with the following parameters:

- Enemy transmitter-to-target receiver distance
- Jammer-to-target receiver distance (18 km).
- Enemy transmitter power output (1.5 watts).
- Jammer location elevation above the sea level (85 meters).
- Enemy transmitter location elevation above the sea level (68 meters).

Table A-8. Finding the minimum jammer power output.

STEP 1

When the parameters for D_j or D_t are too large for the table being used, divide both distances by the lowest common denominator to bring the numbers into the range of the table. In this case, D_j equals 18 km and D_t equals 8 km. Divide both by 2 to bring the numbers into the desired range. Dividing 18 by 2 equals 9 for the D_j. Dividing 8 by 2 equals a D_t of 4. A D_j of 9 and D_t of 4 are within the range of Table 3-3.

STEP 2

Read Table 3-3 from left to right along the 9.0 D_j line to the 4.0 D_t column. The reading is 116 watts of power output where they intersect.

D_j \ D_t	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
8.5		88.8K	11.7K	2774	909	366	169	87	48	29
9.0		118K	15.6K	3691	1210	486	225	**116**	64	38
9.5			20.4K	4836	1585	637	295	152	84	50

STEP 3

Multiply 116 watts (from Table 3-3) times 1.5 (enemy transmitter power output). *Your answer should be* **174** *watts.*

STEP 4

Divide the jammer location elevation (85) by the enemy transmitter location elevation (68). *The answer is* **1.25**.

(Steps 5 through 7are continued on the next page).

Table A-8. Finding the minimum jammer power output (continued).

STEP 5

Use Table 3-7 to determine the multiplication factor. Find 1.25 in the ratio column. The fraction to right of 1.25 is the elevation multiplier (.64).

RATIO	MULTIPLIER	RATIO	MULTIPLIER	RATIO	MULTIPLIER
0.25	11.2	**1.25**	**.64**	2.25	.20
0.30	8.2	1.30	.60	2.30	.19
0.35	6.3	1.35	.55	2.35	.18

STEP 6

Multiply 174 watts by .64 to find the minimum jammer power output required for effective jamming. *The minimum jammer power for this situation is* **111.36**.

Select a jammer which meets or exceeds this minimum of 111 watts. Table A-9 contains a list of current jammers to aid in the selection process.

STEP 7

If the jammer's LPA antenna is used, divide the power output from step 6 by 2. Dividing 111 by 2 equals 55.5 or 56 watts.

Table A-9. Jamming equipment list.

NAME	FREQUENCY RANGE	MAXIMUM POWER OUTPUT	MODULATION
AN/TLQ-15	1.5-20 MHz	2,000 watts	CW, AM, FM, DSSB
AN/TLQ-17A(V)3	1.5-80 MHz	550 watts	CW, AM, FM, SSB
AN/ULQ-19	20-80 MHz	100 watts	FM

MAXIMUM JAMMER DISTANCE

The following parameters are provided to compute the maximum distance a jammer location can be from the target receiver location (Table A-10):

- Enemy transmitter-to-target receiver distance (3 km).
- Enemy transmitter power output (2 watts).
- Jammer power output (550 watts).
- Jammer location elevation above the sea level (385 meters).
- Enemy transmitter location elevation above the sea level (386 meters).

Table A-10. Finding the maximum effective distance between a jammer and its target.

STEP 1

Determine the difference between the jammer location elevation (385) and the enemy transmitter location elevation (386). Since the elevation difference is less than 10 meters the elevation multiplication factor is 1.

STEP 2

Divide the power output of the selected jammer in watts by the multiplication factor.

$$\frac{550}{1} = 550 \textit{ watts}$$

STEP 3

Divide the power output (550) by the enemy transmitter power output (2).

$$\frac{550}{2} = 275 \textit{ watts}$$

(Steps 4 through 6 are continued on the next page.)

Table A-10. Finding the maximum effective distance between a jammer and its target (continued).

STEP 4

From Table 3-3, determine the power output in watts. Read down the D_t=3.0 column to the next lower power output value under 275 watts (270 watts).

D_j	D_t 0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
7.5		47.5K	6250	1483	486	196	91	47	26	15
8.0		65.6K	8630	2048	671	**270**	125	64	36	21
8.5		88.8K	11.7K	2774	909	366	169	87	48	29

NOTE: If the D_t value is not on the table, divide this distance by a number that would bring it into the range of the table. For example, if the enemy transmitter-to-target receiver distance were 6 km, it would have to be divided by 2 to use the table. In this case, the D_j must also be multiplied by 2 to maintain the proper ratio.

STEP 5

Read left to the jammer to target receiver distance column. *The maximum effective distance is* **8.0** *km.*

STEP 6

If the jammer's LPA antenna is used, multiply the distance shown in step 5 by 2. In this case, the maximum distance that the jammer can be located from the target receiver and remain effective would be 16 km.

2 x 8.0 = 16 km

THE GTA 30-6-5 CALCULATOR

The **Electronic Warfare (EW) Jamming Calculator** (Figure A-3), provides a quick and easy method to calculate the minimum jammer power output required for effective jamming. This calculator can be used with any size map.

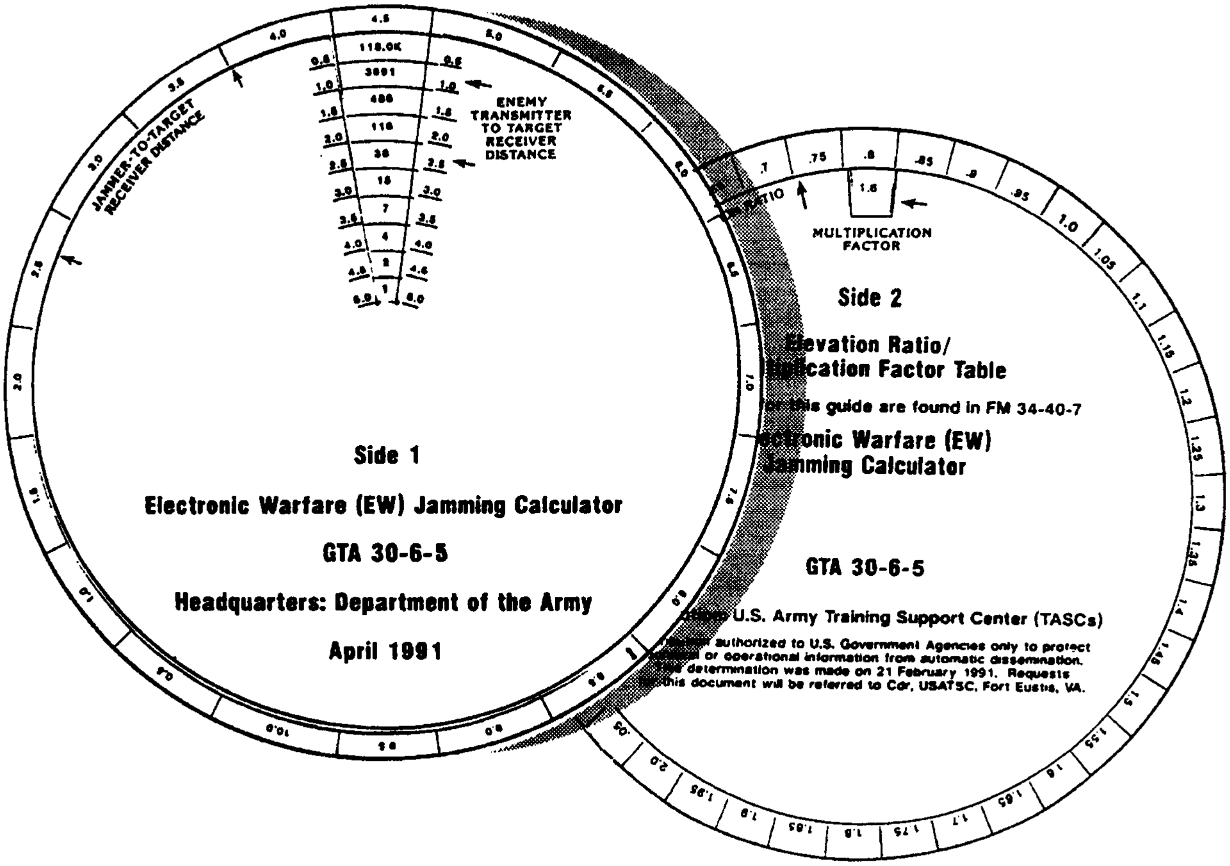


Figure A-3. Both sides of the GTA 30-6-5 calculator.

GTA 30-6-5 Calculator Effectiveness

The GTA 30-6-5 calculator is effective under the following conditions and parameters when—

- Frequency modulated voice communications in the VHF range are used.
- The enemy communication transmitter power output is known.
- The enemy communication transmitter-to-target receiver distance in kilometers is known.
- The jammer location-to-target receiver location distance in kilometers is known.
- The jammer location, enemy transmitter location, and target receiver location are known.
- All location elevations are measured from the sea level.
- Power output values calculated using the GTA 30-6-5 calculations are for the jammer's whip antenna. (If the LPA antenna is used, divide the final calculated power output by 2.)
- The minimum jammer power output calculated (in watts) must be read on the jammer's power output meter.
- Jammer location must have a reasonable LOS propagation path to the target receiver's location with no high hills between the two locations.

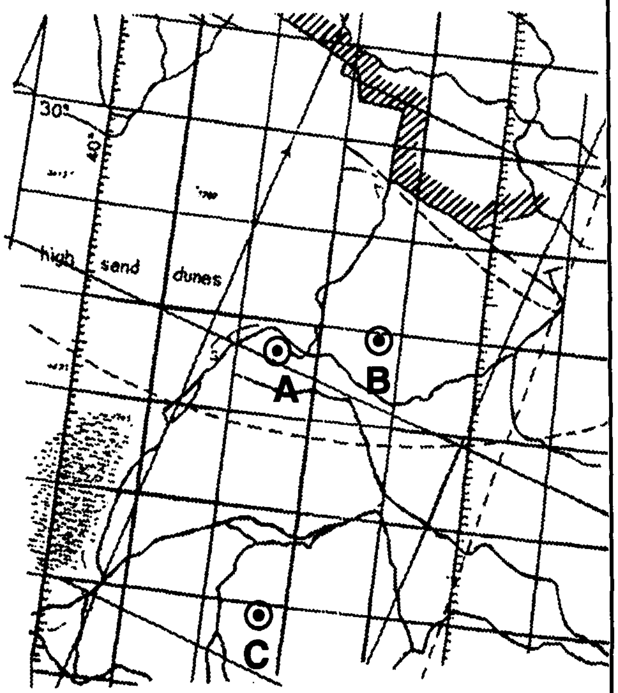
Minimum Jammer Power Output Required for Effective Jamming

Use the GTA 30-6-5 calculator shown in Figure A-3 to determine the minimum jammer power output required for effective jamming. Calculations include the minimum power for the whip antenna and the LPA antenna (Table A-11).

Table A-11. Minimum jamming power calculations.

STEP 1

Plot the locations of the enemy transmitter (A), the target receiver (B), and the selected jammer (C) on a map. The jammer selected is the AN/TLQ-17A(V)3 with maximum power output of 550 watts. The enemy transmitter power output is 3 watts.



(Steps 2 through 3B are continued on the next page.)

Table A-11. Minimum jamming power calculations (continued).

STEP 2

Determine the jammer location-to-target receiver location distance (D_j). Always **round up** the D_j number to the next higher .5 km. Determine the enemy transmitter location-to-target receiver distance (D_t).

Always **round down** the D_t number to the next lower .5 km. Determine the jammer location elevation (H_j) in meters. Determine the enemy transmitter location elevation (H_t) in meters.

D_j = 8.6 *km* = 9.0 *km*

D_t = 5.3 *km* = 5.0 *km*

H_j = 390 *meters*

H_t = 392 *meters*

STEP 3

When the H_j and H_t difference, above the sea level, is **less** than 10 meters, use the elevation multiplication factor of 1.

NOTE: Steps 3A through 3C would be used when the difference between the H_j and H_t is greater than 10 meters. These computations will compensate for the location elevation difference.

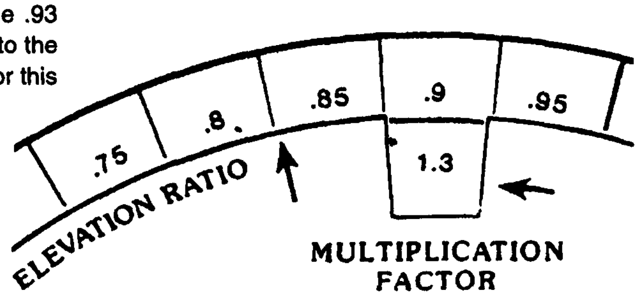
STEP 3A

If the H_t elevation were 420 instead of 392, divide the jammer's elevation (H_j of 390) by the enemy transmitter's elevation (H_t of 420). This fraction **(.93)** is the elevation ratio number.

$$\frac{H_j = 390}{H_t = 420} = .93$$

STEP 3B

Go to Side 2 on the GTA 30-6-5 calculator. Using the .93 elevation ratio number for this example, round it down to the next lower number found in the outer ring of Side 2. For this example it is **.9**.

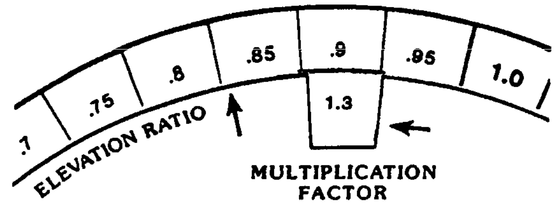


(Steps 3C through 4C are continued on the next page.)

Table A-11. Minimum jamming power calculations (continued).

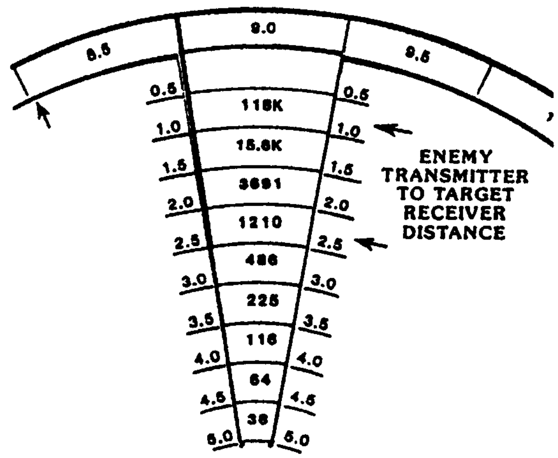
STEP 3C

Align the opening or slot of the smaller disk under the ELEVATION RATIO .9 on the outer ring. The MULTIPLICATION FACTOR of 1.3 will appear in the slot of the smaller disk.



STEP 4

Go to Side 1 of the GTA 30-6-5 calculator. Using the distances from step 2--where D_j is 9.0 km and D_t is 5.0 km, locate the JAMMER-TO-TARGET RECEIVER DISTANCE (D_j) of 9.0 km on the outer ring. Align the slot of the smaller disk with the 9.0 on the outer ring. Go down the edge of the slot on the smaller disk and find the ENEMY TRANSMITTER TO TARGET RECEIVER DISTANCE (D_t) 5.0 km.

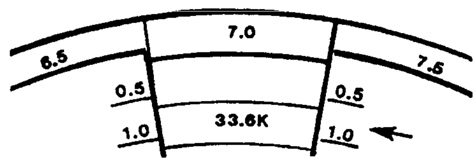


STEP 4A

When either the D_j or D_t is **greater** than the numbers listed on Side 1, divide both distances by the lowest possible denominator (2, 3, or 4 as required) to bring them within the range of the calculator. For example, if the D_j is 14 km and the D_t is 5.0 km, the lowest common denominator would be 2. Dividing the D_j and D_t by 2 equals 7.0 and 2.5.

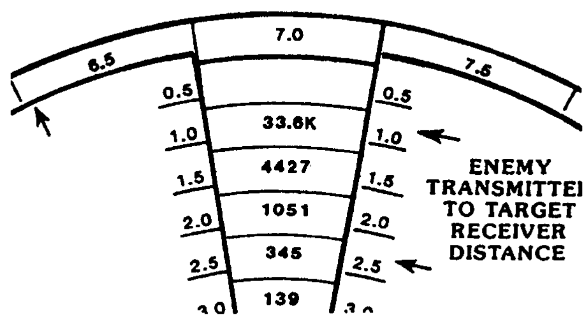
STEP 4B

Use Side 1 of the GTA 30-6-5 calculator. Locate the JAMMER-TO-TARGET RECEIVER DISTANCE (D_j) of 7.0 km on the outer ring. Align the slot of the smaller disk with the 7.0 on the outer ring.



STEP 4C

Go down the edge of the slot on the smaller disk and find the ENEMY TRANSMITTER TO TARGET RECEIVER DISTANCE (D_t) of **2.5 km.** The number **345** appears in the opening, next to the 2.5 km. The 345 is simply a power output number in watts. It is not the minimum jamming power output required value. It must be multiplied by the enemy power output.



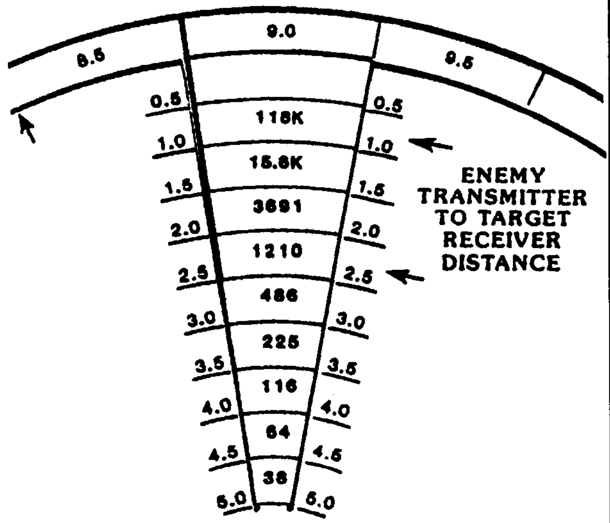
(Steps 5 and 6 are continued on the next page.)

Table A-11. Minimum jamming power calculations (continued).

NOTE: Step 4C is repeated in step 5 using the D_j (9.0) and the D_t (5.0) from step 4.

STEP 5

After finding 9.0 on the outer ring, go down the edge of the slot on the smaller disk and find the ENEMY TRANSMITTER TO TARGET RECEIVER DISTANCE (D_t) of 5.0 km. The number 38 appears in the opening, next to the 5.0 ENEMY TRANSMITTER TO TARGET RECEIVER DISTANCE (D_t). Remember, 38 is simply a power output number in watts. It is not the minimum jamming power output required value.



STEP 6

Multiply the calculated power of 38 watts by the enemy transmitter power output of 3 watts (from step 1). (If the result produces a fraction, always round the number up.) The minimum jammer power output required for effective jamming, for this example, is 114 watts using the jammer's **whip** antenna.

38 x 3 = 114 watts

NOTE: Steps 3, 4, 5, and 6 were calculated using the multiplication factor of 1. Multiply the elevation multiplication factor of 1.3 (from step 3C) by the computed minimum jammer power output of 114 watts (step 6). When using the jammer's LPA antenna instead of the whip antenna, perform step 7.

114 x 1.3 = 148.2

(Step 7 is continued on the next page.)

Table A-11. Minimum jamming power calculations (continued).

STEP 7 When using the jammer's LPA, take the computed minimum jammer power output required of 114 watts from step 6 and divide it by 2. This 57 watts is the minimum jammer power output required for effective jamming for this example. Remember, this is the value that is read on the jammer's power output meter.	$\frac{114}{2} = 57$ *watts*

The jammer must be capable of producing at least 114 watts with the whip antenna or 57 watts for the LPA antenna for jamming to be effective. If a higher power value is used, the jammer will still be effective. Using any power output less than these values will not effectively jam the target receiver for this example.

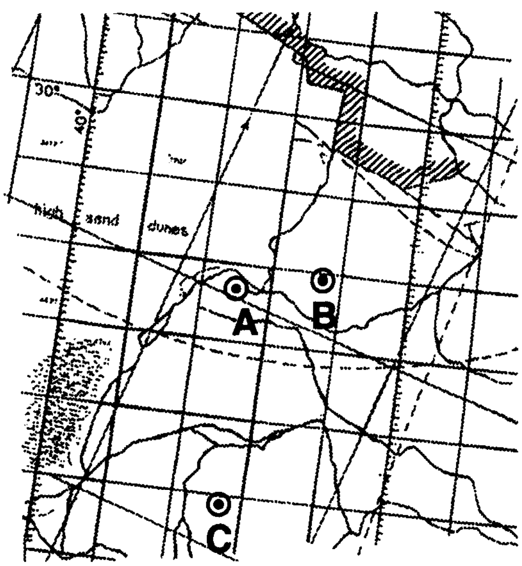
Compute the Maximum Distance the Jammer Can Be From the Target Receiver

Perform the following steps in Table A-12 to calculate the maximum distance the selected jammer site can be from the target receiver and still jam effectively. Use the GTA 30-6-5 calculator to find the maximum power output of the jammer.

Table A-12. Maximum distance from jammer to target.

STEP 1

Plot the locations of the enemy transmitter (A), the target receiver (B), and the selected jammer (C) on a map. The selected jammer is the AN/TLQ-17A(V)3 with a maximum output of 550 watts. The enemy transmitter power output is 2 watts.



(Steps 2 through 4A are continued on the next page.)

Table A-12. Maximum distance from jammer to target (continued).

STEP 2

Measure the distance between the A and B. The measurement for this example is 3.1 km. (Always round down this distance to the next lower .5 km.) For this example, the distance for calculating purposes is 3.0 km.

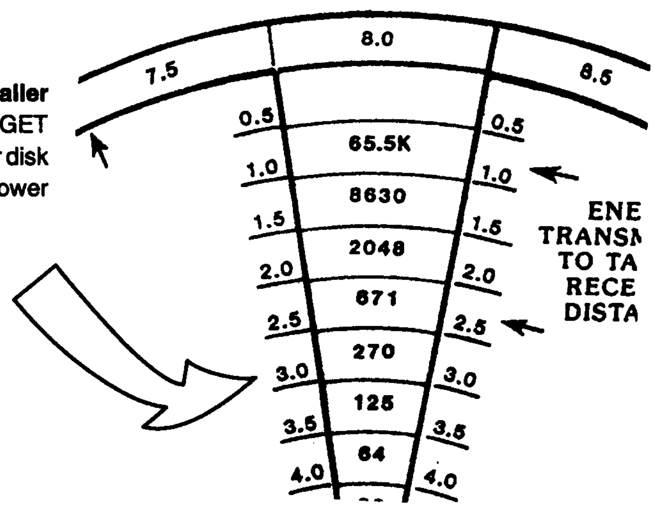
STEP 3

Divide the jammer's maximum power output (P_j) 550 by the enemy transmitter power output (P_t) 2.

$$\frac{P_j\ 550}{P_t\ 2} = 275$$

STEP 4

Go to Side 1 of the GTA 30-6-5. Along the slot of the **smaller** disk, find the ENEMY TRANSMITTER TO TARGET RECEIVER DISTANCE (D_t) of 3.0 km. Rotate this smaller disk until the calculated power of 275 watts or the next lower power number (270) appears in the opening next to the 3.0 km.



Side 1

NOTE: If the enemy transmitter distance were 6 km instead of 3.1, we would have to divide the 6 km by 2 to bring it into the range of Side 1. Steps 4A through 4D are computed using the enemy transmitter distance of 6 km.

STEP 4A

When the enemy transmitter distance exceeds those shown on Side 1, divide the distance by the lowest number that would bring it into the range of the calculator.

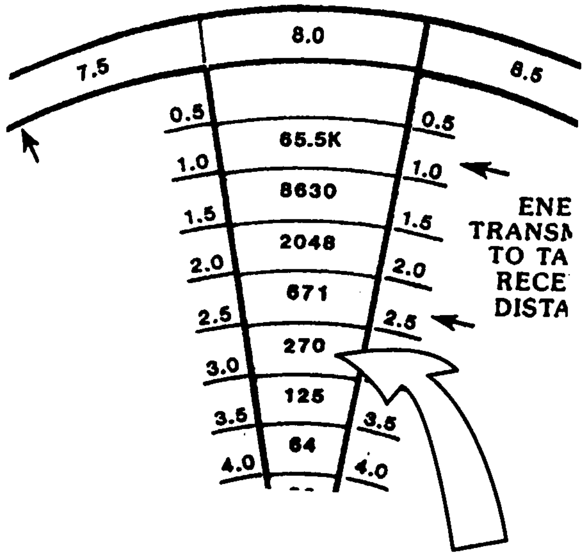
$$\frac{6}{2} = 3$$

(Steps 4B through 5 are continued on the next page.)

Table A-12. Maximum distance from jammer to target (continued).

STEP 4B

Go to the 3 km number along the ENEMY TRANSMITTER TO TARGET RECEIVER DISTANCE slot and rotate the smaller disk until the 275 watts or the next lower power number (270) is found.



STEP 4C

Read the JAMMER-TO-TARGET RECEIVER DISTANCE on the outer ring of Side 1. The jammer distance for the 270 watts is 8.0 km.

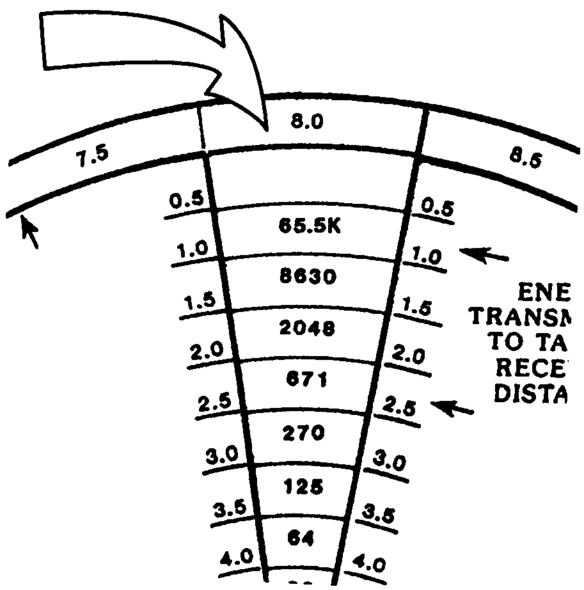
STEP 4D

The jammer distance must be multiplied by the same factor used to bring it into the range of the calculator. In this case, it must be multiplied by 2 to maintain the correct distance ratio.

$8 \times 2 = 16\ km$

STEP 5

Read the JAMMER-TO-TARGET RECEIVER DISTANCE on the outer ring of Side 1. The jammer distance for the 270 watts is 8.0 km.



(Steps 6 through 6C are continued in the next page.)

Table A-12. Maximum distance from jammer to target (continued).

STEP 6

Determine the elevation of several preselected jammer location sites. If the selected jammer location elevation and the enemy transmitter location elevation difference is **less** than 10 meters, use the elevation multiplication factor of 1. This means the maximum distance the jammer can be from the target receiver, using a whip antenna, is 8 km. If the selected jammer location elevation and the enemy transmitter location elevation difference is **greater** than 10 meters, use steps 6A through 6D to determine the elevation multiplication factor.

$$\frac{8}{1} = 8$$

NOTE: If more than one site is selected, use the lowest elevation of those selected.

STEP 6A

To determine the elevation MULTIPLICATION FACTOR using Side 2, the elevation ratio must be computed. In this example, the selected jammer site elevation is 390 meters and the enemy transmitter site elevation is 500 meters. (All elevations are measured from the sea level.)

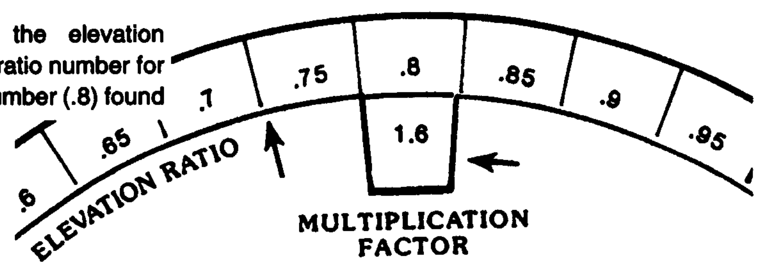
STEP 6B

Divide the jammer location elevation of 390 meters by the enemy transmitter elevation of 500 meters. The elevation ratio fraction is .78.

$$\frac{390}{500} = .78$$

STEP 6C

Convert the elevation ratio fraction to the elevation multiplication factor. Using the .78 elevation ratio number for this example, round it up to the next higher number (.8) found on the outer ring of Side 2.



Side 2

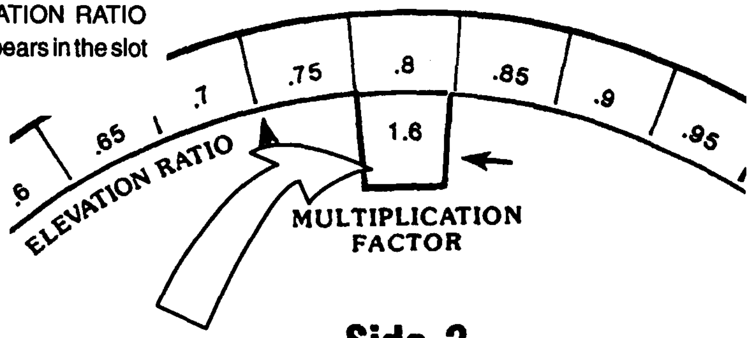
Elevation Ratio/ Multiplication Factor Table

(Steps 6D through 7 are continued on the next page.)

Table A-12. Maximum distance from jammer to target (continued).

STEP 6D

Align the slot of the smaller disk on the ELEVATION RATIO of .8. The MULTIPLICATION FACTOR of 1.6 appears in the slot of the smaller disk.



Side 2

Elevation Ratio/ Multiplication Factor Table

STEP 6E

Divide the MULTIPLICATION FACTOR (1.6) into the D_j (8 km from step 5). The maximum distance for using a whip antenna would be 5 km.

$$\frac{8}{1.6} = 5$$

NOTE: The calculations in steps 6A through 6E are based on an enemy transmitter power output of 2 watts, a preselected jammer site elevation of 390 meters, an enemy transmitter elevation of 500 meters, and the maximum power output of 550 watts of the AN/TLQ-17A(V)3 jammer using a whip antenna. If the LPA antenna is used instead of a whip antenna, perform step 7.

STEP 7

When the jammer's LPA antenna is used for the jamming mission, multiply the calculated jammer distance by 2. If necessary round down to the next lower .5 km. The maximum distance the AN/TLQ-17A(V)3 location can be from the target receiver location is 10 km. This is a radius of 10 km from the target receiver's location.

$$5 \times 2 = 10$$

GTA 30-6-5 Calculator Work Sheet

The GTA 30-6-5 calculator work sheet (Figure A-4) is to be used with the GTA 30-6-5 calculator when computing the minimum jammer power output required for a given jamming situation. Table A-13, page 32, explains how to fill in the work sheet.

	J-TO-RX DISTANCE	ET-TO-RX DISTANCE	JAMMER LOCATION ELEVATION	ET LOCATION ELEVATION	ELEVATION RATIO		ELEVATION FACTOR		JAMMING POWER GTA 30-6-5		JAMMING POWER JAMMER OUTPUT		ET POWER		MINIMUM JAMMER POWER OUTPUT REQUIRED
1.	____	____	____	____	____	=	____	X	____	=	____	X	____	=	____ watts
2.	____	____	____	____	____	=	____	X	____	=	____	X	____	=	____ watts
3.	____	____	____	____	____	=	____	X	____	=	____	X	____	=	____ watts
4.	____	____	____	____	____	=	____	X	____	=	____	X	____	=	____ watts
5.	____	____	____	____	____	=	____	X	____	=	____	X	____	=	____ watts
6.	____	____	____	____	____	=	____	X	____	=	____	X	____	=	____ watts
7.	____	____	____	____	____	=	____	X	____	=	____	X	____	=	____ watts
8.	____	____	____	____	____	=	____	X	____	=	____	X	____	=	____ watts
9.	____	____	____	____	____	=	____	X	____	=	____	X	____	=	____ watts
10.	____	____	____	____	____	=	____	X	____	=	____	X	____	=	____ watts
11.	____	____	____	____	____	=	____	X	____	=	____	X	____	=	____ watts
12.	____	____	____	____	____	=	____	X	____	=	____	X	____	=	____ watts
13.	____	____	____	____	____	=	____	X	____	=	____	X	____	=	____ watts
14.	____	____	____	____	____	=	____	X	____	=	____	X	____	=	____ watts
15.	____	____	____	____	____	=	____	X	____	=	____	X	____	=	____ watts
16.	____	____	____	____	____	=	____	X	____	=	____	X	____	=	____ watts
17.	____	____	____	____	____	=	____	X	____	=	____	X	____	=	____ watts
18.	____	____	____	____	____	=	____	X	____	=	____	X	____	=	____ watts
19.	____	____	____	____	____	=	____	X	____	=	____	X	____	=	____ watts
20.	____	____	____	____	____	=	____	X	____	=	____	X	____	=	____ watts

Figure A-4. GTA 30-6-5 calculator work sheet.

Table A-13. GTA 30-6-5 calculator work sheet computations.

STEP 1

From step 2 of Table A-11, list the measured distances in the appropriate distance columns.

J-TO-RX DISTANCE	ET-TO-RX DISTANCE
9.0 km	5.0 km

STEP 2

From step 3A of Table A-11, list the elevations in the appropriate elevation columns.

JAMMER LOCATION ELEVATION	ET LOCATION ELEVATION
390 m	420 m

STEP 2A

If elevation difference is less than 10 meters, enter 1 in the elevation RATIO and FACTOR columns.

ELEVATION

RATIO		FACTOR
1	=	1

STEP 2B

If the elevation difference is 10 meters or more, divide the jammer's elevation by the ET elevation. For example, in steps 3A and 3B of Table A-11, the ratio is .93 and the factor is 1.3.

ELEVATION

RATIO		FACTOR
.93	=	1.3

STEP 3

From step 5 of Table A-11, list the GTA 30-6-5 calculator jammer power in the GTA 30-6-5 column.

JAMMING POWER

GTA 30–6–5		JAMMER OUTPUT
38	=	

STEP 4

Multiply the elevation factor of 1.3 times the GTA 30-6-5 calculator value of 38.

ELEVATION RATIO		ELEVATION FACTOR		JAMMING POWER GTA 30–6–5		JAMMING POWER JAMMER OUTPUT
	=	1.3	x	38	=	49.4

(Steps 5 and 6 are continued on the next page.)

Table A-13. GTA 30-6-5 calculator work sheet computations (continued).

STEP 5

Multiply the 49.4 jammer output times the enemy transmitter power output (3 watts from step 1 of Table A-11). This is the minimum jammer power output required for effective jamming using the jammer's whip antenna.

JAMMING POWER: GTA 30-6-5		JAMMING POWER: JAMMER OUTPUT		ET POWER		MINIMUM JAMMER POWER OUTPUT REQUIRED
38	=	49.4	X	3	=	148.2 watts

NOTE: If the jammer's LPA antenna is to be used, continue with step 6 after completing this step.

STEP 6

Perform this step whenever using the jammer's LPA antenna. Divide the whip antenna power output by 2. In this case, the minimum jammer power output required for effective jamming is 74.1 watts.

$$\frac{148.2}{2} = 74.1 \text{ watts}$$

Figure A-5 shows a completed GTA 30-6-5 calculator work sheet. The elevation difference reflects data from step 2B.

	J-TO-RX DISTANCE	ET-TO-RX DISTANCE	JAMMER LOCATION ELEVATION	ET LOCATION ELEVATION	ELEVATION: RATIO		ELEVATION: FACTOR		JAMMING POWER: GTA 30-6-5		JAMMING POWER: JAMMER OUTPUT		ET POWER		MINIMUM JAMMER POWER OUTPUT REQUIRED
1.	9.0 km	5.0 km	390 m	420 m	.93	=	1.3	X	38	=	49.4	X	3	=	148.2 watts
2.						=		X		=		X		=	watts
3.						=		X		=		X		=	watts
4.						=		X		=		X		=	watts

Figure A-5. An example of a completed GTA 30-6-5 calculator work sheet.

THE JAMPOT FAN

The JAMPOT fan (Figure A-6) provides another method for measuring distances needed to calculate the required jamming power output. It is designed to be used with Table A-14, page A-35. The JAMPOT fan is an overlay template developed for a map scale of 1:50,000. It can also be used for a map scale of 1:100,000 by multiplying the jammer-to-target receiver distance by two.

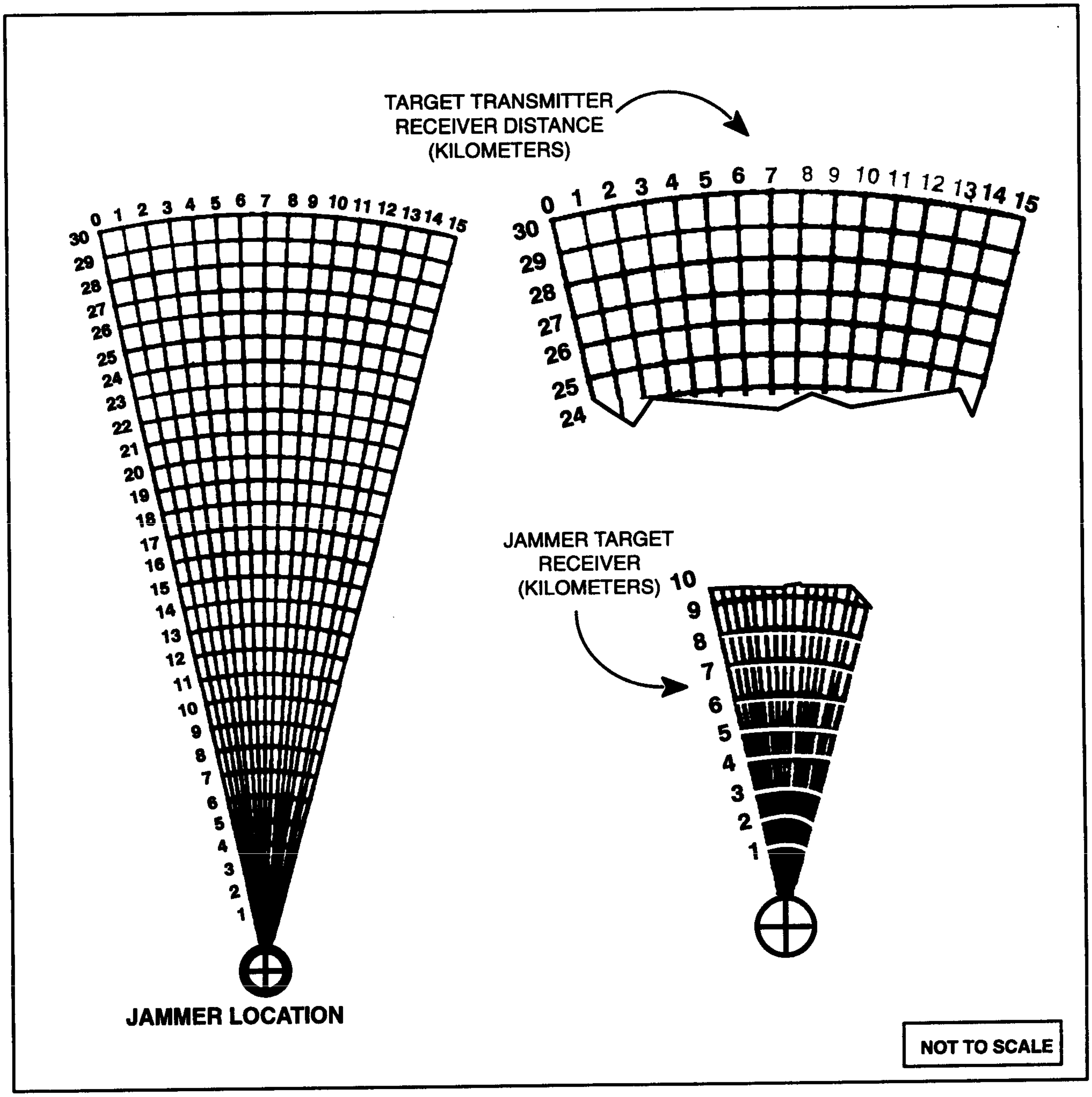


Figure A-6. The JAMPOT fan.

Table A-14. Jammer power output values.

								D_t							
D_J	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	3	1													
2	32	3	1												
3	163	10	3	1											
4	515	32	7	3	1										
5	1.3K	79	16	5	3	1									
6	2.6K	163	32	10	4	3	1								
7	4.9K	302	60	19	8	4	3	2	1						
8	8.3K	515	120	32	13	7	4	3	2	1					
9	13.2K	825	163	52	21	10	6	4	3	2	1				
10	20.1K	1.3K	248	79	32	16	9	5	3	3	2	1			
11	29.5K	1.9K	364	115	47	23	13	7	5	3	3	2	1		
12	41,7K	2.6K	515	163	67	32	18	10	7	4	3	3	2	1	
13	57.5K	3.6K	709	225	92	45	24	14	9	6	4	3	3	2	1
14	77.2K	4.9K	954	302	124	60	32	19	12	8	6	4	3	3	2
15	103K	6.4K	1.3K	398	163	79	43	25	16	10	7	5	4	3	3
16		8.3K	1.7K	515	211	102	55	32	20	13	9	7	5	4	3
17		10.5K	2.1K	656	269	130	70	41	26	17	12	8	6	5	4
18		13.2K	2.6K	825	338	163	88	52	32	21	15	10	8	6	5
19		16.4K	3.3K	1.1K	419	202	109	64	40	26	18	13	9	7	5
20		20.1K	4.0K	1.3K	515	248	134	79	49	32	22	16	12	9	7
21		24.5K	4.9K	1.5K	626	302	163	96	60	39	27	19	14	10	8
22		29.5K	5.8K	1.8K	754	364	196	115	72	47	32	23	17	13	10
23		35.2K	7.0K	2.2K	900	434	235	138	86	57	39	27	20	15	11
24		41.7K	8.2K	2.6K	1.1K	515	288	163	102	67	46	32	24	18	13
25		49.1K	9.7K	3.1K	1.3K	606	327	192	120	79	54	38	28	21	16
26		57.5K	11.4K	3.6K	1.5K	709	383	225	140	92	63	45	32	24	18
27		66.8K	13.2K	4.2K	1.7K	825	445	261	163	107	73	52	38	28	21
28		77.3K	15.3K	4.9K	2.0K	954	515	302	189	124	85	60	44	32	25
29		88.9K	17.6K	5.5K	2.3K	1.1K	592	347	217	142	97	69	50	37	28
30		103.8K	20.1K	6.4K	2.6K	1.3K	678	398	248	163	111	79	57	43	32

NOTE: Table A-14 is a matrix. The left column (from 1 through 30) represents the jammer-to-target receiver in kilometers. The top row is the target transmitter-to-receiver distance. The values are given in watts and kilowatts (K means multiplication by 1,000).

JAMPOT Fan Effectiveness

The JAMPOT fan is effective only under the following conditions and parameters:

- It must be used for frequency modulated voice, amplitude modulated voice, or continuous wave communications in the VHF range.
- The enemy target transmitter power output must be known.
- The enemy transmitter-to-target receiver distance in kilometers must be known.
- The jammer location must be known.
- The jammer must be located at the same elevation above the sea level or higher than the enemy target transmitter.
- A whip antenna must be used with the power output values in Table A-14. (If the LPA antenna is used, divide the values by two.)
- The jammer power output values obtained from Table A-14 must be read on the jammer's power output meter.
- The jammer location must have a reasonable LOS propagation path to the target receiver location with no high hills between the two locations.

Using the JAMPOT Fan

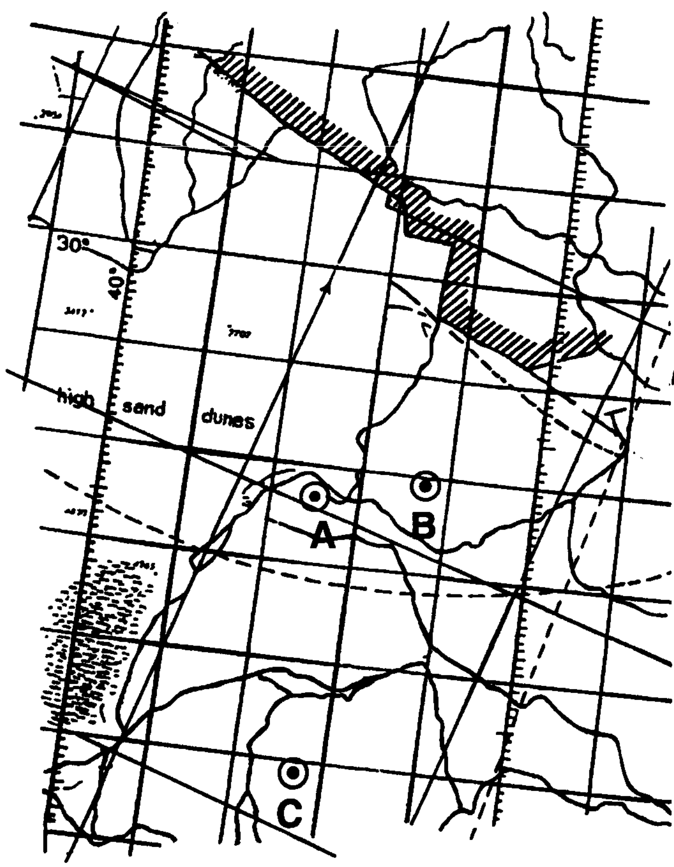
Table A-15 is a step-by-step explanation of how to use the JAMPOT fan.

Table A-15. How to use the JAMPOT fan.

STEP 1

Plot the locations of the target receiver (A), the enemy target transmitter (B), and the jammer (C) locations on a 1:50,000 scale map.

NOTE: Enemy transmitter power output is 3 watts.

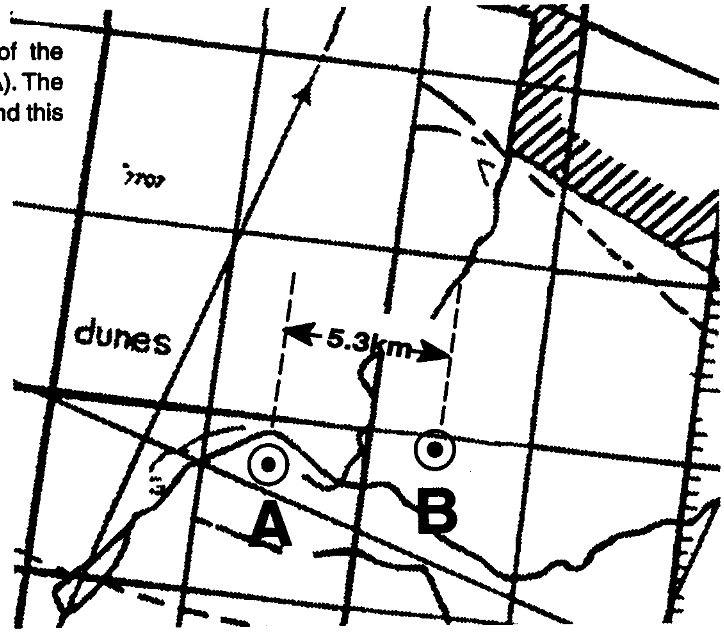


(Steps 2 and 3 are continued on the next page.)

Table A-15. How to use the JAMPOT fan (continued).

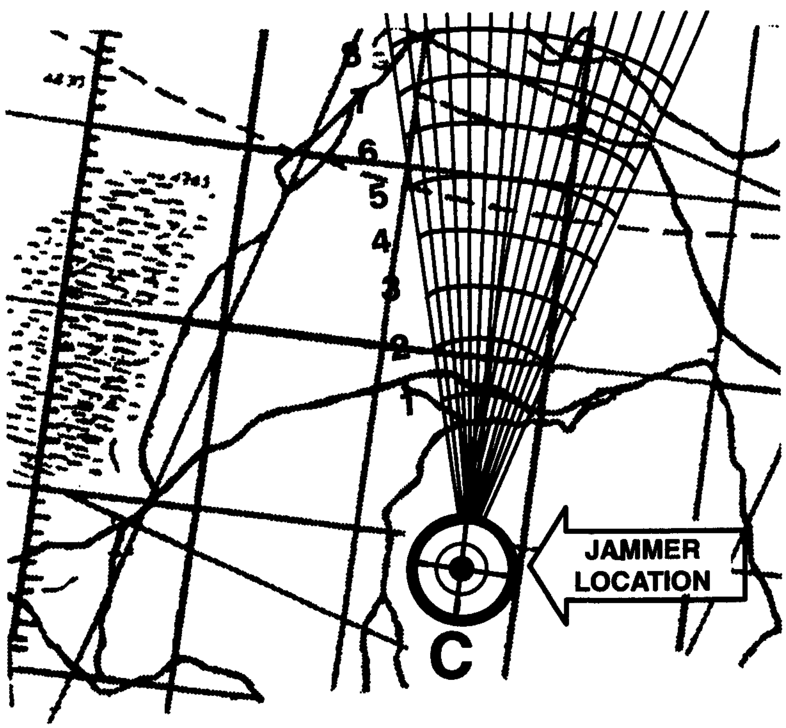
STEP 2

Measure the distance between the location of the enemy's transmitter (B) and the target receiver (A). The measurement for this example is 5.3 km. (Round this number down to the next lower km--5.)



STEP 3

Place the jammer location point of the JAMPOT fan on the jammer location (C) on the map.

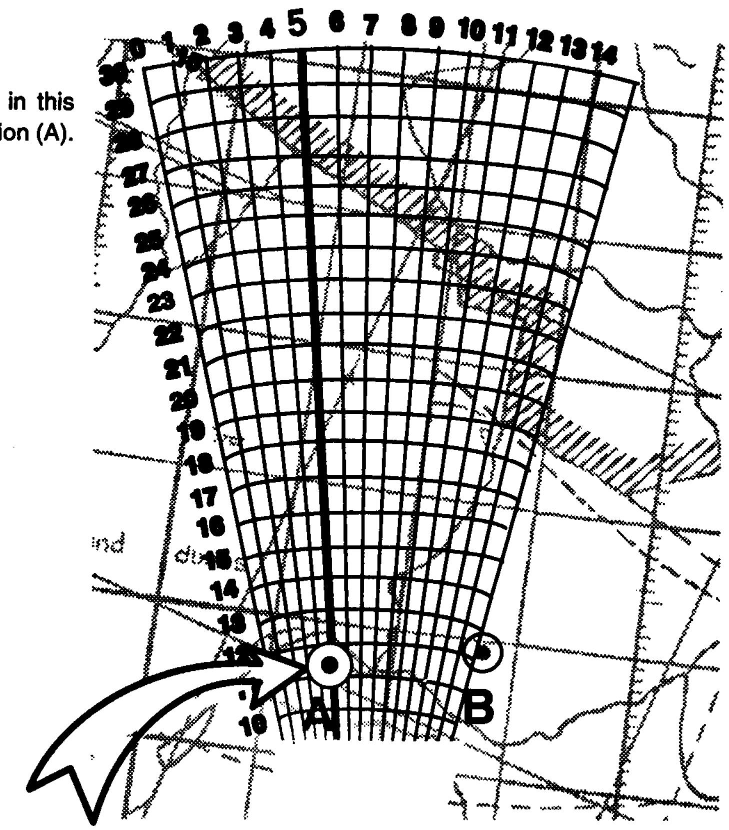


(Steps 4 and 5 are continued on the next page.)

Table A-15. How to use the JAMPOT fan (continued).

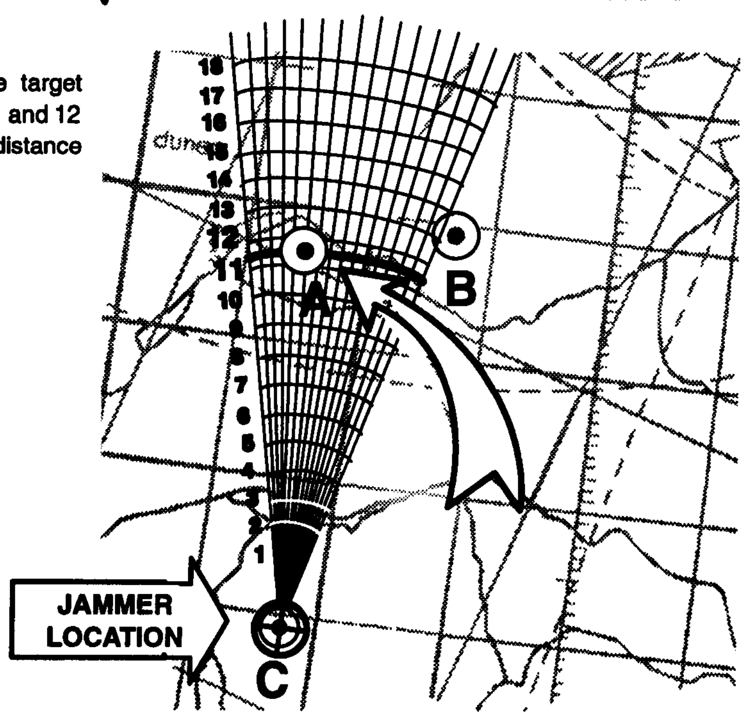
STEP 4

Place the JAMPOT target link distance line, in this case the 5 km line, on the target receiver location (A).



STEP 5

Read to the left on the JAMPOT fan. The target receiver's location (A) appears between the 11 and 12 km lines on the jammer-to-target receiver distance scale. (Round this number up to 12 km.)



(Steps 6 and 7 are continued on the next page.)

Table A-15. How to use the JAMPOT fan (continued).

STEP 6

Use Table A-14. Find the 12 kilometer jammer-to-target receiver distance by reading down the left column.

10	20.1K	1.3K	248	79	32
11	29.5K	1.9K	364	115	47
12	41.7K	2.6K	515	163	67
13	57.5K	3.6K	709	225	92
14	77.2K	4.9K	954	302	124
15	103K	6.4K	1.3K	398	163
16		8.3K	1.7K	515	211
17		10.5K	2.1K	656	269

STEP 7

Read across the top of Table A-14 to find the 5 km target link distance line.

D_j	1	2	3	4	5
1	3	1			
2	32	3	1		
3	163	10	3	1	
4	515	32	7	3	1
5	1.3K	79	16	5	3
6	2.6K	163	32	10	4
7	4.9K	302	60	19	8

(Steps 8 and 9 are continued on the next page.)

Table A-15. How to use the JAMPOT fan (continued).

STEP 8

Read down the 5 km target link distance column to the intersection of the 12 km row. The reading is 67 watts.

D_j	1	2	3	4	5
1	3	1			
2	32	3	1		
3	163	10	3	1	
4	515	32	7	3	1
5	1.3K	79	16	5	3
6	2.6K	163	32	10	4
7	4.9K	302	60	19	8
8	8.3K	515	120	32	13
9	13.2K	825	163	52	21
10	20.1K	1.3K	248	79	32
11	29.5K	1.9K	364	115	47
12	41.7K	2.6K	515	163	67
13	57.5K	3.6K	709	225	92
14	77.2K	4.9K	954	302	124

STEP 9

Multiply the 67 watts by the enemy transmitter's power output of 3 watts (given in step 1). The minimum required output for this example is 201 watts.

67 x 3 = 201 watts

References

DOCUMENTS NEEDED

These documents must be available to the intended users of this publication.

AR 105-86. *Performing Electronic Countermeasures in the United States and Canada.* 06 December 1978.

(S) FM 34-10A. *Division Intelligence and Electronic Warfare Operations (U).* 15 December 1986.

FM 100-5. *Operations.* 05 May 1986.

READINGS RECOMMENDED

These sources contain relevant supplemental information.

AR 350-3. *Tactical Intelligence Readiness Training (REDTRAIN).* 20 November 1984.

AR 525-1. *Department of the Army Command and Control System.* 02 December 1985.

AR 525-20. *Command, Control and Communications Countermeasures* (C^3CM) *Policy*. 01 July 1981.

(S) AR 525-22. *Electronic Warfare (EW) Policy (U).* 01 October 1982.

FM 6-20-10. *Tactics, Techniques, and Procedures (TTP) for the Targeting Process.* 29 March 1990.

FM 6-20-30. *TTP for Fire Support for Corps and Division Operations.* 18 October 1989.

FM 6-20-40. *TTP for Fire Support for Brigade Operations (Heavy).* 5 January 1990.

FM 6-20-60. *TTP for Fire Support for Brigade Operations (Light).* 5 January 1990.

FM 6-121. *TTP for Field Artillery Target Acquisition.* 25 September 1990.

FM 11-50. *Combat Communications Within the Division (Heavy and Light).* 4 April 1991.

FM 11-92(HTF). *Combat Communications Within the Corps (How to Fight).* 01 November 1978.

FM 24-1. *Signal Support in the AirLand Battle.* 15 October 1990.

(C) FM 32-16. *ECM Handbook (U).* 30 June 1975.

FM 34-1. *Intelligence and Electronic Warfare Operations.* 02 July 1987.

FM 34-10. *Division Intelligence and Electronic Warfare Operations.* 25 November 1986.

FM 34-25. *Corps Intelligence and Electronic Warfare Operations.* 30 September 1987.

FM 34-35. *Armored Cavalry Regiment (ACR) and Separate Brigade Intelligence and Electronic Warfare Operations.* 12 December 1990.

FM 34-80. *Brigade and Battalion Intelligence and Electronic Warfare Operations.* 15 April 1966.

FM 34-82. *Military Intelligence Unit Exercise Development Guide.* 26 November 1985.

FM 71-3. *Armored and Mechanized Infantry Brigade.* 11 May 1988.

FM 71-100. *Division Operations.* 16 June 1990.

FM 90-2. *Battlefield Deception.* 30 October 1988.

FM 101-5. *Staff Organization and Operations.* 25 May 1984.

FM 101-5-1. *Operational Terms and Symbols.* 21 October 1985.

Index

By Order of the Secretary of the Army:

GORDON R. SULLIVAN
General, United States Army
Chief of Staff

MILTON H. HAMILTON
Administrative Assistant to the
Secretary of the Army
02821

Official:

MILTON H. HAMILTON
Administrative Assistant to the
Secretary of the Army

DISTRIBUTION:

Active Army, USAR, and ARNG: To be distributed in accordance with DA Form 12-11 E, requirements for FM 34-40-7, Communications Jamming Handbook (Qty rqr block no. 0597).

✰ U.S. GOVERNMENT PRINTING OFFICE : 1994 0 - 300-421 (00147)