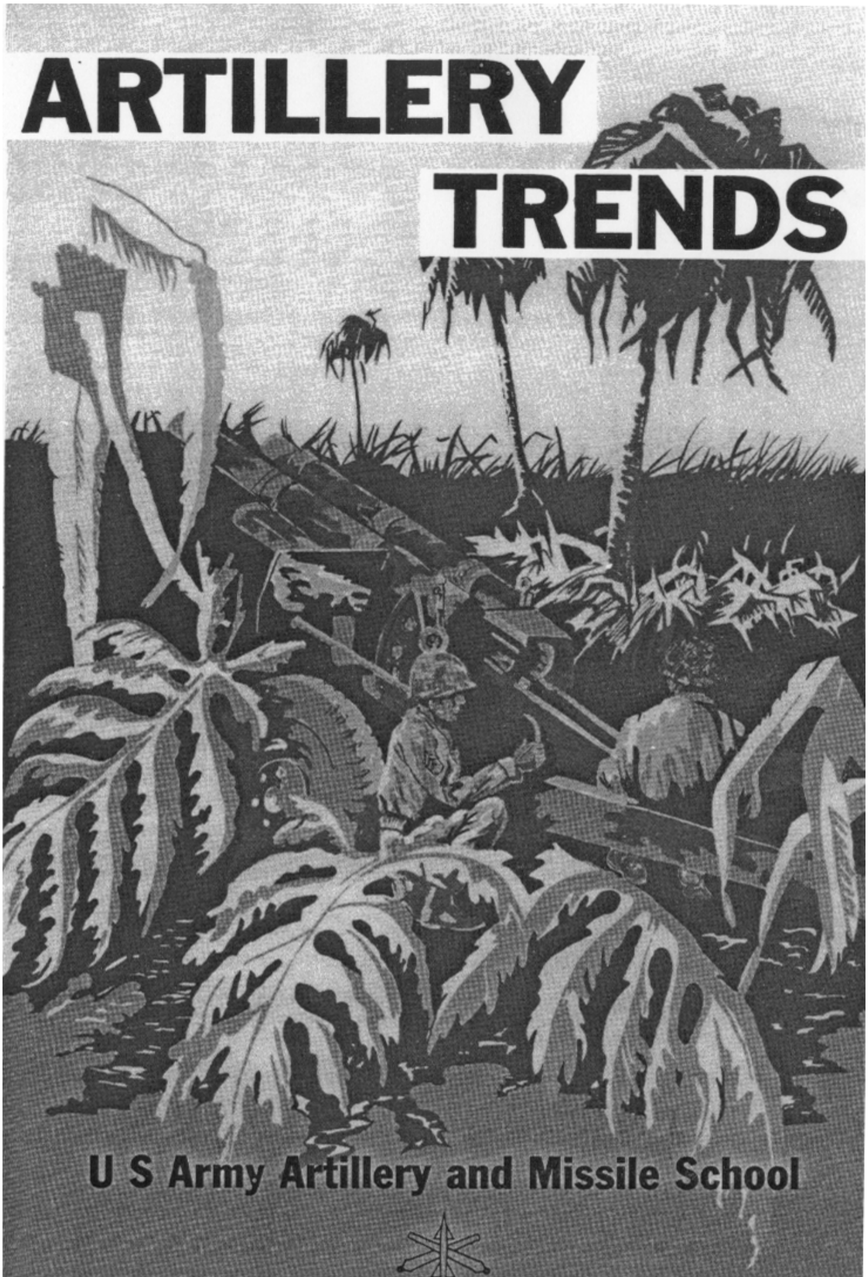
ARTILLERY TRENDS



U S Army Artillery and Missile School

August 1961

ARTILLERY TRENDS

August 1961 **Instructional Aid Number 19**

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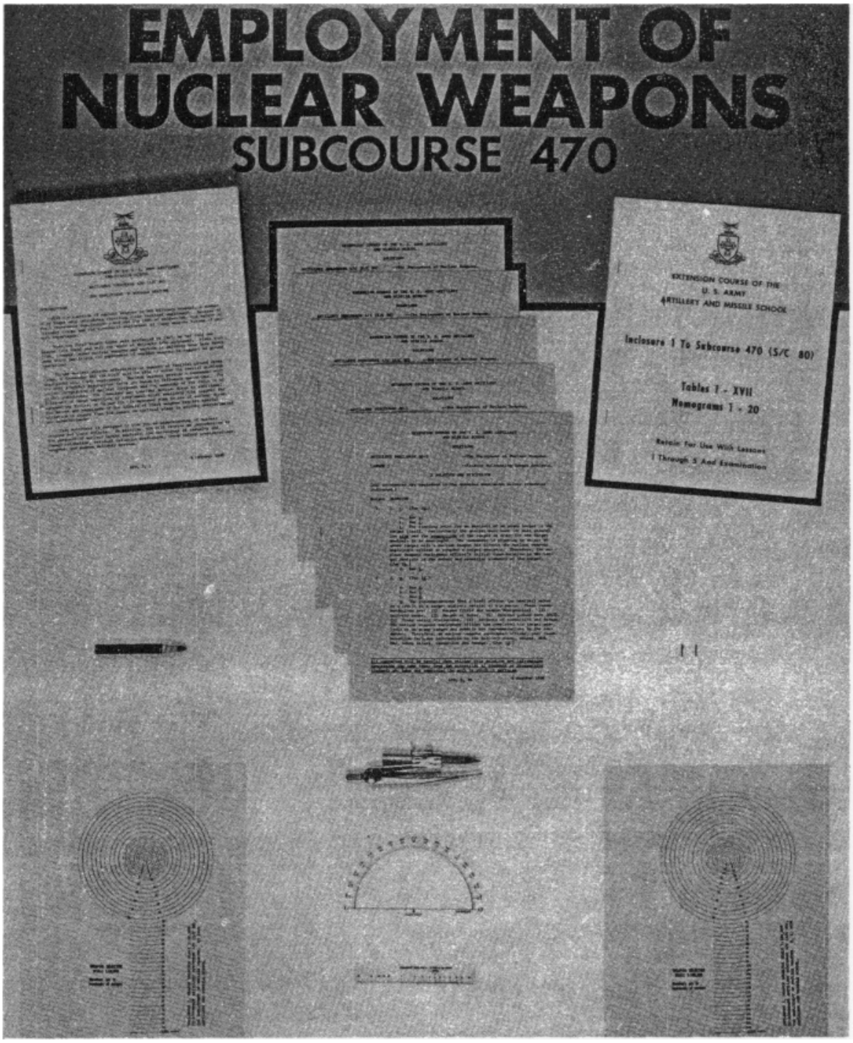
This artillery position was emplaced despite the innumerable obstacles the jungle proffers. Beginning on page 15 of this issue is a two-part article on what the obstacles of guerrilla and jungle warfare are, and how artillery can overcome them.


EMPLOYMENT OF
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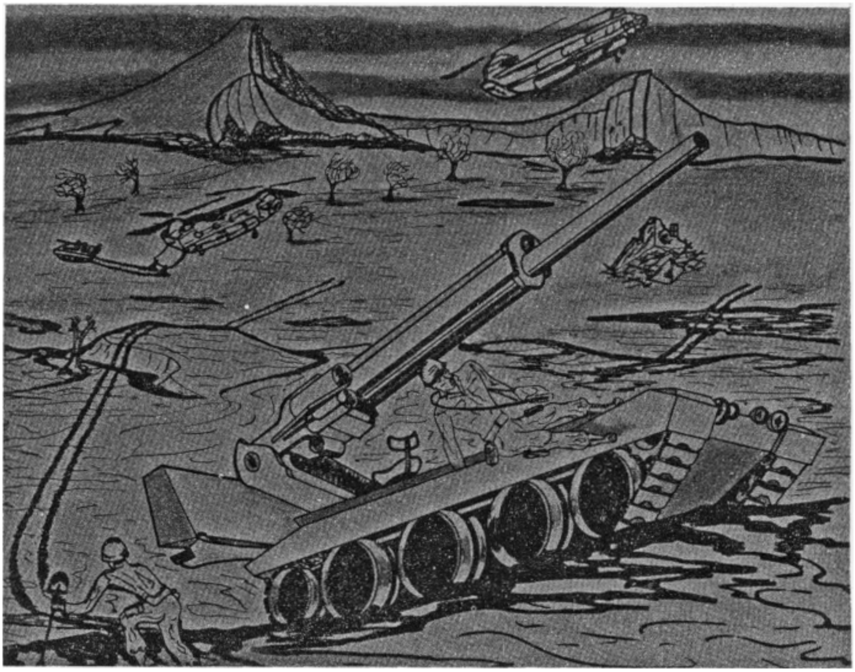


LIGHTWEIGHT 105-MM HOWITZER

Major Louis A. Chateau
Office of Combat Development and Doctrine

By 1964, the artillery may have a self-propelled weapon which is helicopter-transportable. With the increasing emphasis on mobility and tactical fluidity, and with the possibility of having to fight in new and often underdeveloped areas, air as a means of transportation takes on added importance. Artillery must also take to the air to fulfill its mission of support, and right now there are two new, lightweight 105-mm howitzers in early stages of development. Both weapons are designed to be helicopter-transportable. The ultimate goal of this development is to replace all towed 105's with the new SP's, if the latter can be manufactured within the stringent weight limit necessary to make it helicopter-transportable. If, however, this weight limit is impracticable, development of the new towed weapon will be well underway. The characteristics of the two weapons will be discussed separately here since the programs are completely independent of each other and are being conducted by two different research and development agencies.

THE LIGHT, SELF-PROPELLED 105-MM HOWITZER, XM104

The self-propelled howitzer being developed by the US Army Ordnance Tank Automotive Command, Detroit, Michigan, is a truly revolutionary development in artillery weapons. It is essentially a mobile gun platform mounting a 105-mm cannon. It has a low silhouette, measuring only 5.3 feet high and, in addition, is a trim 5.25 feet wide and 12.75 feet long.

A weight of 6000 pounds has been set as a design goal for this weapon, exactly one-ninth the weight of the M52 armored self-propelled 105-mm howitzer. The elimination of armor and the extremely small size of the XM104 carriage are the chief reasons for this startling weight reduction. The XM104 will be air-transportable for delivery by parachute or assault landing aircraft in phase I of airborne operations, and of course, if kept within the design-goal weight, will be transportable by army helicopter.

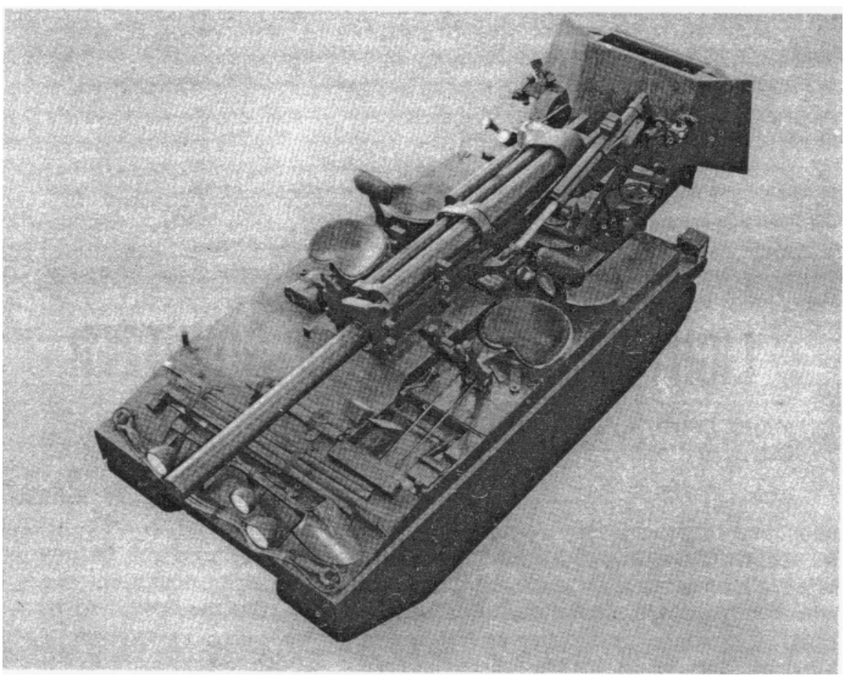


Figure 1. The XM104 self-propelled howitzer.

The vehicle will be powered by the current 1/4-ton truck engine (an "off the shelf" item) and will employ a power train of five forward gears. The XM104 will climb grades of 60 percent and run over ditches 36 inches wide. It will be capable of speeds of 35 miles per hour with a cruising range of 300 miles on its 50 gallons of internally-carried fuel.

The platform will have space to carry four men and ten rounds of ammunition (in addition to the cannon itself). A lightweight, unarmored overhead cover will be provided to protect the crew from adverse weather. The material for this cover will probably be canvas or rubberized fabric mounted on bows.

The XM104 employs torsion-bar suspension. The tracks are 72 inches long and 14 inches wide, and support four dual wheels, two of which are 22 inches in diameter, the other two being 24 inches. A lightweight track is being designed to meet a 4,000-mile-life requirement.

The new cannon, designated the XM103, will be used on the XM104 SP carriage as well as on the XM102 towed weapon. It will be mounted by the ring and pintle method and will traverse 22.5° right and left of center; it will elevate from –5° to +75°. The rear of the hull will be free from obstructions and the piece will be serviced from the ground. A ten-round-per-minute fire capability is anticipated.

The recoil mechanism is hydropneumatic, independent type and is comprised of the recoil cylinder, counterrecoil cylinder, recuperator, and built-in buffer. The recoil and counterrecoil pistons are separately attached to the cradle and are stationary; the cylinders are mounted on, and move with, the recoiling parts. Throttling or braking is accomplished by means of a control rod and orifice within the recoil cylinder. The recuperator returns and retains the howitzer in battery position upon completion of recoil. The recoil length is 44 inches (nonvariable) and is constant at all angles of elevation.

The elevation and equilibration mechanism consists of a combination elevating and equilibrator cylinder, two elevating pumps (accumulator and replenisher), locking and relief valves, equilibrator and pump (hand pump), and necessary plumbing. Rotation of the pump handle clockwise depresses the tube; counterclockwise rotation elevates the tube. Traverse will be accomplished manually with the mechanical units providing 180° of traverse at a rate of 20 mils per turn of the handwheel. The unit will contain an irreversible worm and wormgear drive and therefore will not depend on a "No-Bak" to prevent deflection of the handwheel.

The development of this weapon is progressing on schedule. If all the design goals are met, the artillery will have an *airborne self-propelled weapon* with the capabilities of the current self-propelled 105-mm howitzer, and the air transportable attributes of the towed 105-mm howitzer.

THE LIGHT, 105-MM HOWITZER XM102, TOWED

Because the weight limit on the XM104 SP 105-mm is so restrictive, a lightweight towed weapon is also being designed. Its designation is the XM102.

The primary purpose of developing this weapon is to insure that the artillery will have a helicopter-transportable howitzer suitable for support of infantry helicopter-borne operations. The XM102 howitzer, which is being developed at Rock Island Arsenal, Illinois, will weigh 3,000 pounds

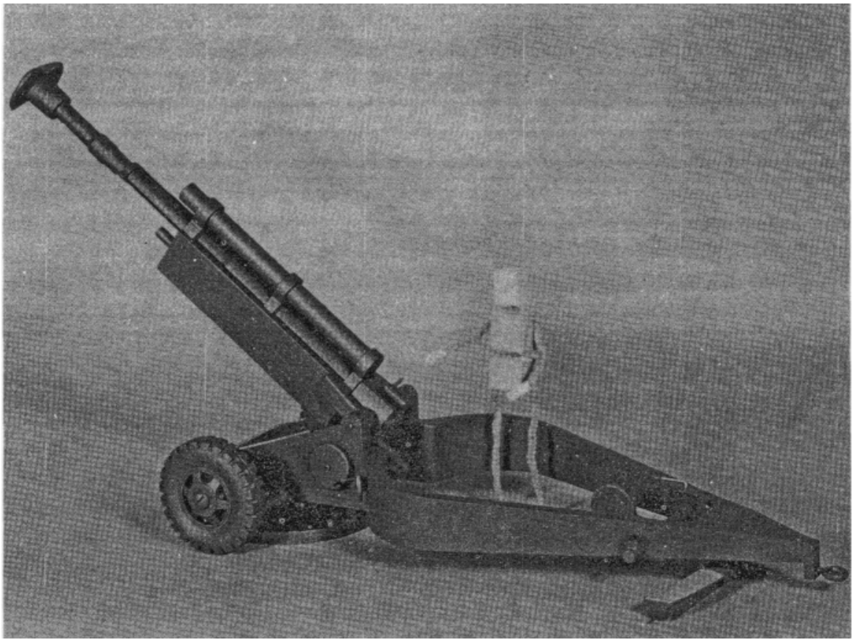


Figure 2. The XM102 towed 105-mm howitzer.

and will have a low (30-inch) silhouette. It has a number of improved features over the M2A4 105-mm howitzer in use today. It incorporates a variable, hydropneumatic recoil system which outwardly appears much the same as the M2A4. In reality, the recoil cylinder is longer, to accommodate the increased recoil at lower elevations (below 25°). The variable recoil eliminates the recoil pit for high-angle fire and permits emplacement of the weapon in 2 minutes or less.

The XM102 will fire the standard 105-mm round, as well as the T388 projectile. It has a sliding, drop-block breech which operates semi-automatically on the counterrecoil stroke. Another new feature is its single-baffle muzzle brake, which decreases the recoil forces of firing by 55 to 60 percent.

A box trail in the shape of a wishbone is the most pronounced departure from the M2A4. The box trail offers greatest rigidity and eliminates 500 to 700 pounds by decreasing overall cubic dimensions. The box girder structure is fabricated from aluminum to minimize weight. There is adequate space for a normal gun crew complement to service the piece.

In firing, the front of the carriage is supported by a circular base on which the howitzer is traversed. The jeep-size wheels are raised and lowered mechanically. Trail spades, which resemble "cookie cutters," and stakes driven through holes in the base provide stabilization. When the base is in the towing position, ground clearance is the necessary 13 inches.

The rear of the trail is supported on an arc-shaped float, which contains the traversing arc and pinion. The end of the trail traverses; therefore, the breech is always in the center of traverse, facilitating loading at any deflection. The arc permits on-carriage traverse of 356 mils right or left, and the XM102 is capable of 6,400 mils off-carriage traverse. Elevation, accomplished with handwheels located on either side, is possible from -5° to +75°.

Spring mounting and shock absorbers are unnecessary because of the XM102's low center of gravity and lightweight carriage. It can easily be towed at 35 mph over hard-surfaced roads and can ford 2 1/2 feet of water. The weapon meets maximum and minimum range requirements; it has been fired successfully at Rock Island Arsenal.

The XM102 towed howitzer will be simple and rugged in design and will be capable of direct and indirect fire both night and day in any kind of weather. Because it will be definitely helicopter-transportable and airdropable, its development is a valuable counterpart to the development of the XM104 self-propelled howitzer.

NUCLEAR WEAPONS, PREPARATORY SUBCOURSE

A number of resident students in the career course at the US Army Artillery and Missile School experience difficulty with the nuclear weapons portion of the instruction.

The Nonresident Instruction Department of the school presents an unclassified subcourse in this subject area which will provide an excellent background for prospective resident students (see page 2).

The subcourse covers the employment of nuclear weapons integrated with other means of fire support; command guidance in planning; burst capabilities of assumed weapons; target analysis and damage estimation; troop safety considerations; and passive defense measures against enemy nuclear attack. The subcourse is based on DA Pamphlet 39-1, using hypothetical weapons, weapons data, and weapons systems.

The scope and number of lessons of the subcourse are shown on page 56 of the 1961-62 extension course catalog. Enrollment procedures and forwarding instructions are also in the catalog, pages 7 through 10.

Forward your DA Form 145 to:

Commandant
US Army Artillery and Missile School
Nonresident Instruction Department
ATTN: Extension Course Division AKPSINI
Fort Sill, Oklahoma

British Field Artillery

"Renown awaits the commander who first in this war restores artillery to its prime importance on the battlefield."

Winston Churchill, 1941

Lieutenant Colonel T. F. Bristol
US Army Standardization Group, UK

Among the traditions and glories of the past which have marked the history of the United Kingdom's fighting forces, there is a dignified and dynamic niche filled by the Gunner—the Royal Artillery. From the elegant halls of the Royal Artillery Mess at Woolwich to the embattled fields of Western Europe, the Artillery of Britain has made a place for itself worthy of the words of Winston Churchill quoted above. No less dynamic than its past is the Royal Artillery's present concept of structural and tactical planning. The concept places emphasis on dual capability for the Royal Artillery; that is, flexibility to operate with either conventional or nuclear weapons. This article will discuss the organization, the tactical capabilities, and the weapons which give backbone to the British Field Artillery.

THE ARMY ORGANIZATION

The Army of the United Kingdom is divided into two main elements—fighting and administrative. Within the fighting element are the "arms," the equivalent of the United States Army branches. Units within the administrative element are called services, as in the US Army. The British Army still organizes around the regimental system, particularly in the infantry. Instead of an infantry corps, the UK infantry is composed of a number of regiments, each of which has a number of battalions (Regular Army and Territorial Army; i.e., National Guard). The infantry regiment is not a tactical unit; it is a recruiting, training, and geographical organization. In the artillery, the word "regiment" is retained for traditional reasons only. All Gunners (artillery officers) are members of the Royal Regiment of Artillery.

THE BRIGADE GROUP CONCEPT

The role of artillery has always been and will always be "to support the force it accompanies with timely fire at the proper place in the volume needed." The basic British unit for operations in the field is the battle group—an infantry battalion augmented by elements of other arms. Three battle groups or fewer form a brigade, three brigades or fewer form a division, and three divisions or fewer form a corps. The brigade group is the basic organization for British tactical planning. There are three types of brigade group—infantry, armored, and parachute. In choosing between these groups and in altering the individual groups to fit his needs, the brigade group commander has extreme flexibility. The basic composition of each of these groups is shown in figure 3.

Type	Infantry Brigade Group	Armored Brigade Group	Parachute Brigade Group
Infantry units	3 battalions	1 battalion	3 battalions 1 independent company
Armor units	1 regiment	3 regiments 1 APC squadron (company)	none
Artillery units	1 field regiment	1 medium regiment (SP)	1 light regiment

Note: Parachute infantry battalions are numerically smaller.
Independent parachute company has a dual function—reconnaissance and marking of drop zones.

Figure 3. Types of brigade group.

ARTILLERY AT BRIGADE GROUP LEVEL

To support the brigade groups shown in figure 3, a type field regiment (Royal Artillery) has been created (fig 4). Each regiment is essentially similar, with only the armament varying. The regiment resembles the US battalion in size, while the UK troop is much like the US platoon. Below is a brief description of artillery regiments which support the various brigade groups. Note the varying armament.

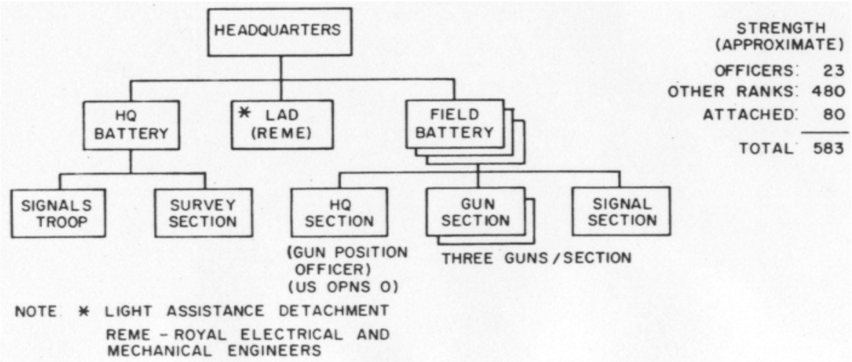


Figure 4. A type field regiment.

(1) The light field regiment supports the parachute brigade group. Its weapon is the 4.2-inch mortar, to be replaced soon by the Italian 105-mm pack howitzer (fig 5).

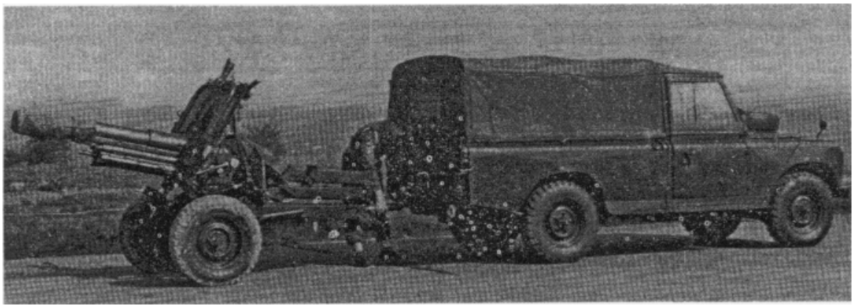


Figure 5. The Italian 105-mm pack howitzer in towing position.

(2) The "air-portable" field regiment supports the parachute brigade group, as well as elements of the Strategic Reserve. The 105-mm Italian pack howitzer is its armament.

(3) The field regiment (RA), with one battery of 5.5-inch guns (fig 6) and two batteries of 25-pounders (fig 7), supports the infantry brigade groups in the British Army of the Rhine. The present version of this regiment is an interim solution. Primary armament will eventually be the 105-mm SP (Abbot), and the entire regiment will be self-propelled.

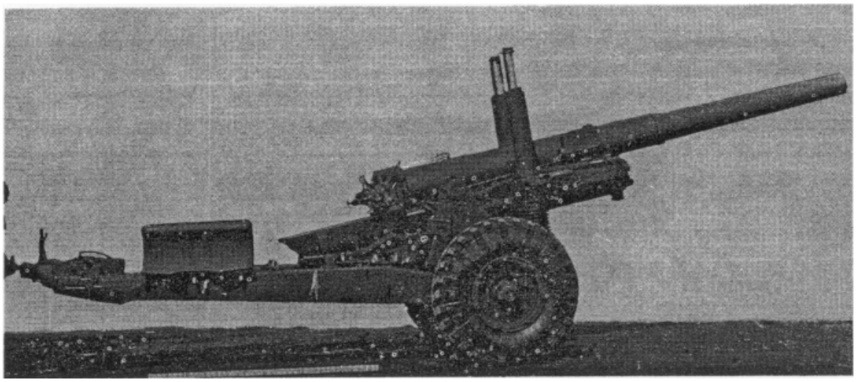


Figure 6. The 5.5-inch gun.

(4) The medium field regiment (SP) for support of the armored brigade employs the US 155-mm howitzer M44 (SP). This regiment is now in Western Europe.

(5) The medium field regiment in support of a division is armed

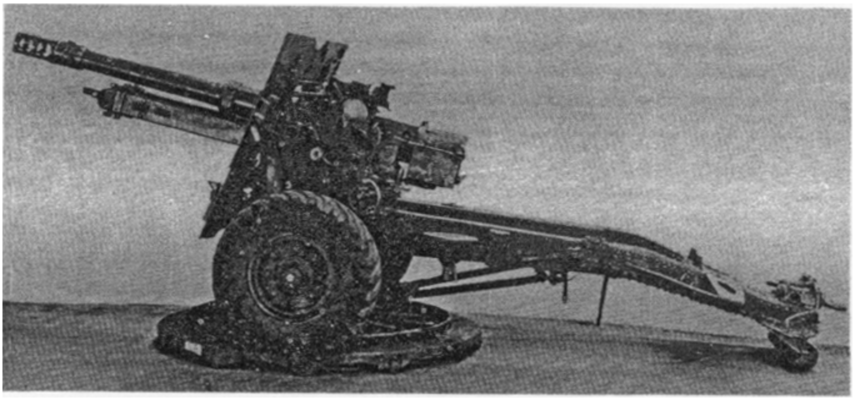


Figure 7. The 25-pounder.

with the 5.5-inch gun. This regiment is today part of the Strategic Reserve and is also located in certain overseas areas.

CORPS LEVEL ARTILLERY

At corps level, and usually in support of two or more divisions, are three other units of the Royal Artillery. Although these units *do* support corps-size combinations, it should be remembered that the basic formation for tactical planning is the brigade group.

(1) The nuclear regiment (fig 8) is armed with the Honest John rocket and the 8-inch howitzer. It supports divisions in corps.

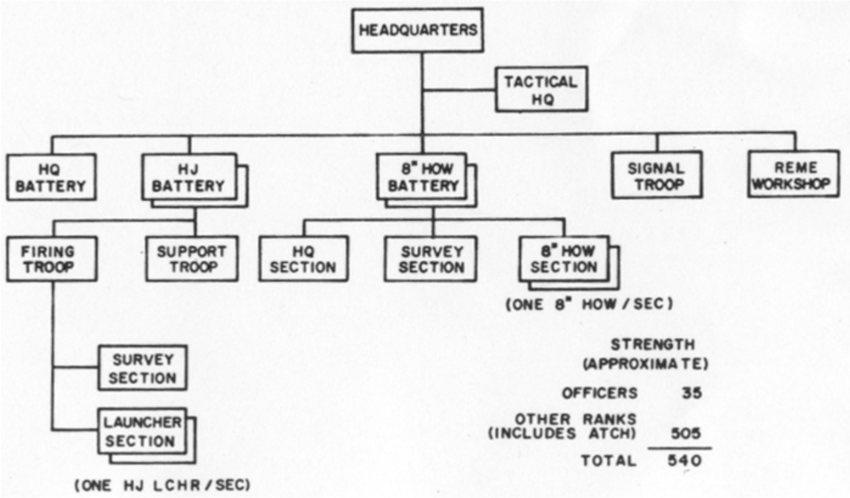


Figure 8. The nuclear regiment.

(2) The guided weapons regiment (fig 9), also supporting divisions in corps, is armed with the Corporal missile. A significant development which will possibly take place in the future is the replacement of the Corporal missile by Blue Water (fig 10), a United Kingdom guided missile.

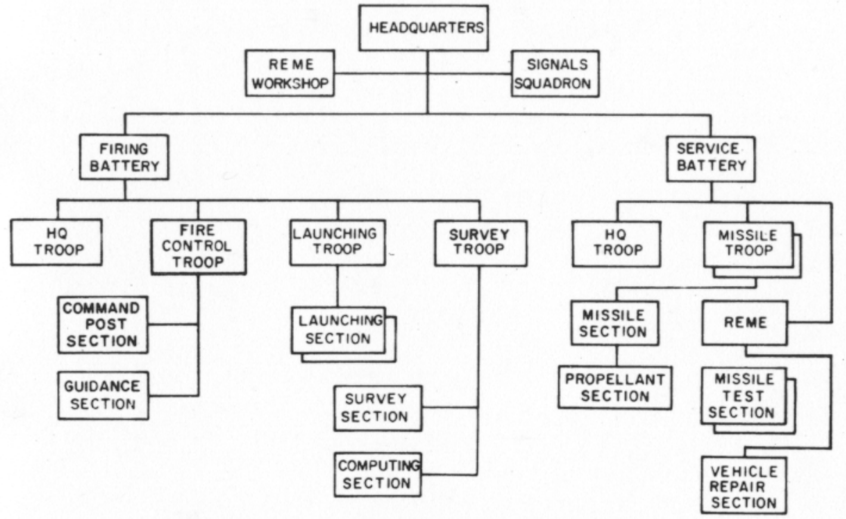


Figure 9. The guided weapons regiment.

(3) The counter bombardment (CB) organization (fig 11) has the tasks of weapon location, survey, meteorology, surveillance, and noncommunication electronic warfare. The CB organization supports a corps of no less than two divisions, each of which must have at least two infantry brigade groups. The equipment of this organization includes the field artillery radar nr 8, MK1 (fig 12) and general support radar nr 9, MK1 (fig 13). In addition, short range devices, including radar and infrared, will be organic to other units and artillery group OP's. Manned aircraft are not considered a part of the CB organization but would be utilized for the overall gathering of general combat intelligence.

THE BRIGADE GROUP CONCEPT

British War Office planners believe that the brigade group concept is the answer to their commitments, which involve the dual capability to fight either conventional or nuclear war. Tacticians and strategists, while depending on this organization, continue to remain flexible in their thinking of the future.

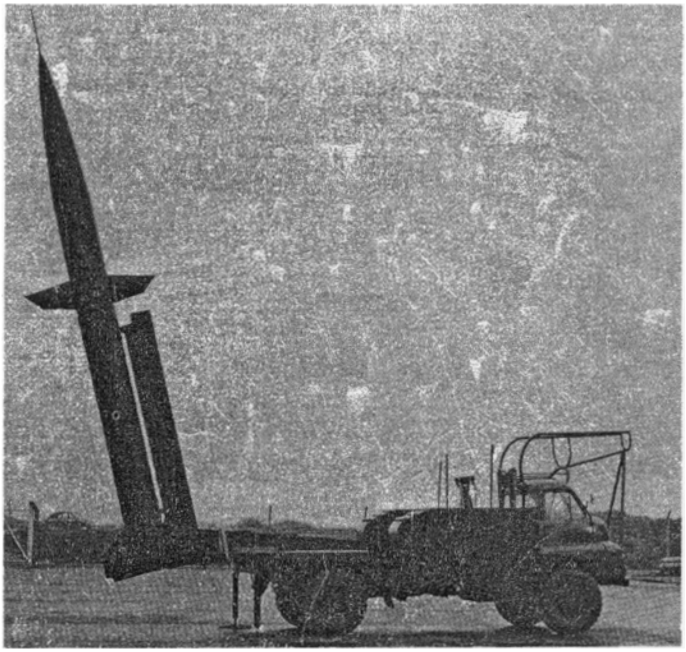


Figure 10. The Blue Water missile (UK) in firing position.

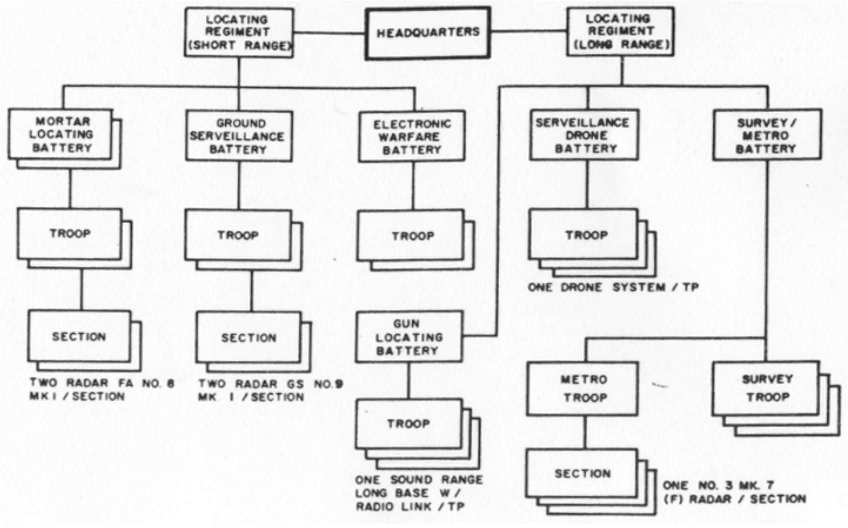


Figure 11. The counter bombardment group.

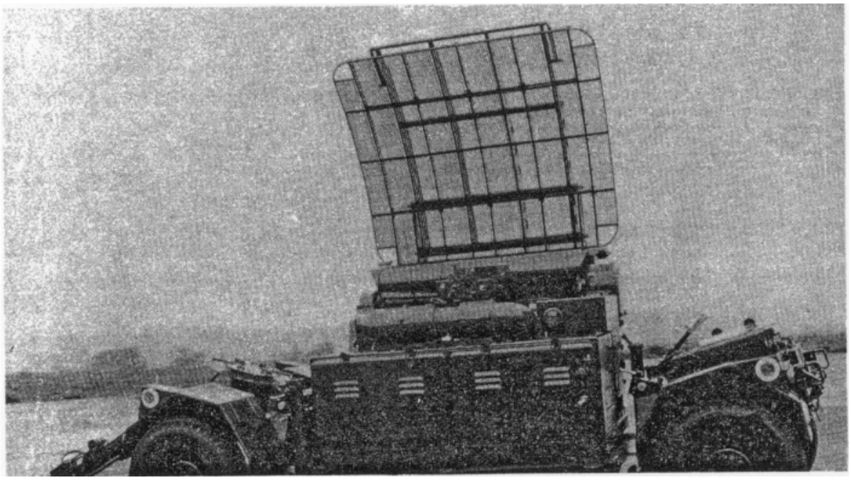


Figure 12. Field artillery radar nr 8, MK1.

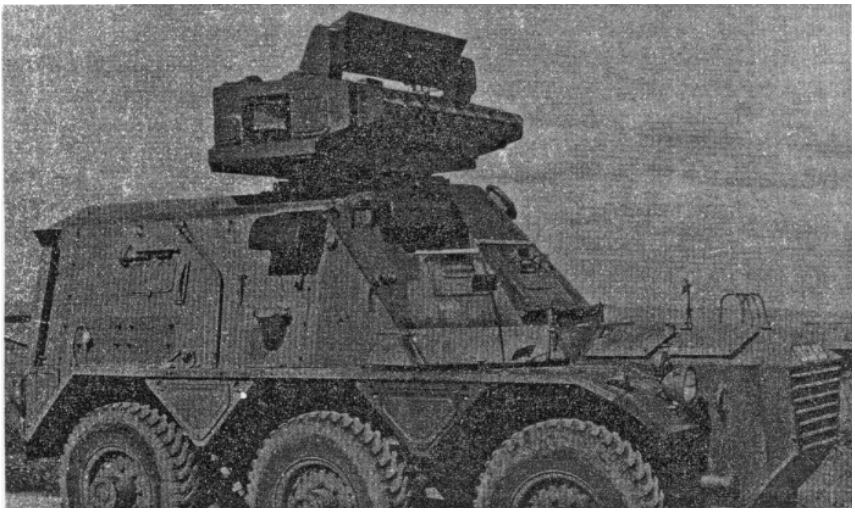


Figure 13. General support radar nr 9, MK1.

At the present time, this concept, backed up by a strong central reserve and sufficient aircraft to carry necessary units rapidly to all parts of the world, seems to suffice. Economy is a large factor in planning and developing materiel and organizations. The Royal Artillery is continuing to play its important part in affording the greatest firepower within the closest economy.

Part I -- the guerrilla . . .

SPECIAL WARFARE

Capt C. R. Leach
Tactics/Combined Arms Department

The dictionary of guerrilla warfare is fully as exciting and dynamic as the terminology of the space age—but less known. The imagination of the people throughout the world has been captured by the recent successes of Soviet astronaut Yuri Gagarin and his American counterparts, Commander Alan B. Sheppard and Captain Virgil Grissom. The world press has converted such technical terms as thrust, propellant, polar orbit, and lunar probes into household words.

The terminology of guerrilla warfare does not create headlines, however. There is no widespread discussion of deception, surprise, cover, and concealment. When the man in the street reads or hears of another country lost to the guerrillas, there are only the unbelieving comments of "How could this be true?" and "Why can't these guerrillas be stopped?"

This article does not set for itself the scope of discussing the political backgrounds and underminings involved in the use of guerrilla tactics around the world today. This article is written with one basic assumption in mind—we, as a country and as an army, will continue to meet the guerrilla as he continues to defy our way of life. The certainty of this assumption means that we must learn to cope with and defeat the guerrilla in any environment.

We have been prone to seize upon the simple definition of a guerrilla as ". . . one who engages in irregular, though often legitimate, warfare in connection with a regular war." This is the historical definition and derivation of the term. *But this definition is not valid today*. There has been no conventional war in those countries where the guerrilla has been most successful.

We must, therefore, develop our capabilities to defend against the guerrilla on the guerrilla's own terms and in his own environs. We must defend by offense. Adopting the guerrilla's principles, improving upon them, and then overcoming him is the only way to defeat him.

THE TACTICS OF THE GUERRILLA

The guerrilla can and will operate in any terrain and under any weather conditions. He has been successful in swamps, amid jungles, atop snow-covered mountains, and on the hot, dry desert. Because of this versatility, the US Army, and especially the US artilleryman, must be trained and prepared to counter the guerrilla in any area.

Guerrilla tactics—no matter what the terrain or weather conditions—*do not change*. The tactics are primitive and follow no formal pattern.

Guerrilla success depends upon mobility, surprise, and deception. Further, he cannot accomplish his mission without offensive action. He must always be on the offensive and he is not likely to engage in a pitched battle with regular troops but will utilize such techniques as the ambush, the raid, and infiltration. The tactics of the guerrilla have been described by the guerrilla himself in this way: "When the enemy attacks, we retreat; when he rests, we attack; and when he retreats, we pursue." The guerrilla firmly believes in the maxim, "He who fights and runs away, lives to fight another day."

ARTILLERY AND THE GUERRILLA

In counterguerrilla action, as well as in conventional war, the artilleryman must be prepared to render effective fire support whenever and wherever needed. The methods and techniques used to accomplish this traditional mission will be anything but traditional.

The newly-published (May 1961) field manual entitled *Operations Against Irregular Forces* has this to say concerning the effectiveness of artillery fire against guerrillas:

> "Terrain and the dispositions and tactics of guerrilla forces usually limit the effectiveness of artillery. However, the demoralizing effect of artillery fire on guerrillas often justifies its use even though there is little possibility of inflicting material damage. Ingenuity and a departure from conventional concepts often make artillery support possible under the most adverse circumstances."

The US artilleryman has displayed real initiative and ingenuity in situations which called for immediate action. However, it is the departure from the conventional artillery concepts which will not be pleasant to the artilleryman, who takes pride in his fire direction procedures, his new concepts of the use of automatic data processing, and his ability to deliver massed fire. Against the guerrilla, these refinements must be put aside to deliver effective fire support.

TWO SITUATIONS TO BE MET

There are two general situations which an artilleryman may face in dealing with guerrillas. The first, and more common is the normal combat situation. In this instance, there is a conventional enemy force, an objective to be taken, or an area to be defended, and the artillery is operating in its normal supporting role. The guerrilla forces are operating in the rear areas.

Here, the artilleryman's problems are traditional. First, he must accomplish his basic mission of support and secure himself at the same time. Artillery is a prime target for guerrillas, naturally. But the security problem is a familiar one to artillerymen. The actions of a conventional enemy combat patrol sent on a mission of knocking out artillery positions are quite similar to those of a guerrilla band. The standard doctrine pertaining to security of the position area is valid, workable, and will, if properly implemented, prove successful. The guerrilla use of surprise will require a more than adequate warning system.

In the training given to artillerymen, more stress must be put on the use of small arms, the mortar, the machinegun, and the rocket launcher. Effective use of these weapons will give the artillery crewman the volume and type of close-in fire support he needs to defend his position area adequately.

The second situation is the one which will cause the artilleryman the greatest trouble in the support role. In this situation, the force to be supported has as its primary mission the task of eliminating a guerrilla band. There are no regular enemy forces to the front—only guerrillas. To provide the effective fire support needed in such an operation will require a reorientation of traditional artillery thinking.

The objectives in this counterguerrilla operation are three. First, isolate the guerrilla force from the rest of the population. Artillery can support this objective by using interdiction fires along exit and entrance routes to the guerrilla base, if they are known. If guerrillas are isolated and encircled, they will attempt to break out by any route, in small bands or even singly. These escapees will not provide lucrative artillery targets, but neither will they be very effective as an enemy.

The second objective is to deny the guerrillas any contact with outside help. Deny the guerrilla his source of supply, and he will have to procure his own food and fabricate his own equipment.

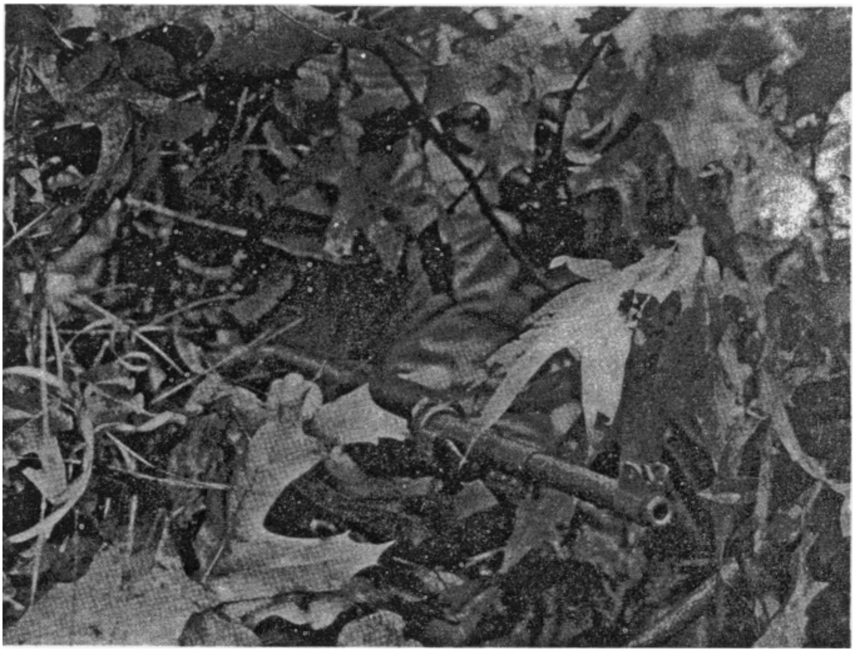
The third objective is to proceed with the destruction of the guerrilla force. In this phase, the artillery will come into its own. There will be more firepower available, as the area dominated by the guerrilla is compressed, and the traditional concepts of targeting and massing of fires can be employed.

Of course, the destruction of the guerrilla force must of necessity be carried on by infantry and cavalry reconnaissance units. The mission of the artillery will be to provide fire support to these forces. Frequently, there will be nothing to shoot at. Targets, if they can be found, will not be so remunerative as artillery likes them to be. There will be no surveying parties, very few wire-laying parties, and seldom will such a target as a vehicular column be discovered. The task of the forward observer will be more difficult. The fire direction officer will have to accept less remunerative targets, and surveillance will be difficult and deceptive at best.

Mobility will take on an added and somewhat different importance in a counterguerrilla offensive. Some of our weapons and equipment obviously cannot be moved through dense jungles, over rugged mountains, or across swampy terrain. In spite of this, we still have to move and displace weapons. The artillery piece that can be transported by man or animal may be the only weapon that can be utilized in some areas of the world where US forces could become engaged in counterguerrilla operations.

The guerrilla must become familiar with *all* the inhabitants of the native country—in this case, jungle animals.

Constant alertness prevents surprise, the prime weapon of the guerrilla.



Ambush is surprise at its most demoralizing. Even one man in ambush can disrupt a whole unit.

The guerrilla must learn to live in and with the land. He must often expedite his fighting with unwarlike material—such as the machete.

The helicopter may provide a partial answer to this problem of mobility. Artillery has made tremendous strides forward in perfecting the technique of reconnaissance, selection, and occupation of position by helicopter. Unfortunately, however, even a helicopter cannot land its cargo everywhere, and we may be forced to fall back upon the old methods of man-and-mule transported weapons.

The artillery battery may be attached to a company-size unit engaged in clearing operations. Often, the battery may have to be broken down further into platoons or even a single howitzer section. Fire direction procedures must be altered to permit control at the platoon or section level. The technique of direct fire may be the answer if one section or platoon is operating in support of an infantry company.

Communications will be a much greater problem if the battalion is parcelled out in this manner. Radio will become more important as a means of communications, and less reliance will be put on wire. Wire can be cut almost at will by a guerrilla band.

The responsibility of the noncommissioned officers of the artillery battery will be increased under such a system. The emphasis will be on leadership at the section and platoon level. The chief of section would, in effect, become the fire support coordinator, the fire direction officer, and the battery executive officer all in one.

The logistics problem will be complicated even if the battalion is operating as a unit. To further attach the batteries and/or sections will complicate the resupply of ammunition, food, and other items. The answer may well be the use of helicopter or light plane aerial resupply. Some quantities of ammunition can be transported by hand, but the limitations on this method of resupply are obvious unless native personnel can be utilized. The resupply problem will probably necessitate the rationing of ammunition.

NIGHT OPERATIONS

The guerrilla is in his element at night. Utilizing the cover of darkness, he can approach a position area with less likelihood of being discovered. When every shadow assumes a human form and every human form can melt into the shadows, the sentinel on post is likely to become jittery, and his initial lack of confidence can become naked fear. Even with the most seasoned troops, the constant threat of guerrilla attack will be unnerving. Consider your courses of action should you discover that the guerrillas have penetrated your defensive perimeter and have established strongpoints inside your rear area. It could happen.

Combine the difficulties of forward observation, the problems of survey, and the lack of adequate ammunition supply with the constant threat of guerrilla attack, and the difficulties which the artilleryman will face are readily apparent. In spite of these difficulties, the effect of artillery justifies the effort spent to produce one round "on the way."

Perhaps the most important ingredient for success is flexible thinking. Certainly flexible thinking will aid the artilleryman in surmounting his multitudinous problems of rendering effective fire support. History is replete with accounts of defeated armies whose leaders failed to accept the challenge of new situations and change their tactics accordingly. If we are to be successful against the guerrilla, we must use his own methods to combat him. We cannot rely on sheer weight of numbers.

Guerrilla operations are a very real part of the military environment of today. They will be staged in the future, in such diverse regions as the jungle, the desert, the plains, and the mountains. The traditional role of the US artillery will remain that of providing effective fire support for the forces engaged in counterguerrilla operations. Equipment can be tailored and men can be trained to do the job, but the effectiveness of the support which the artillery will be called upon to provide will be directly proportional to the leadership and flexible thinking of the artillery commander at all levels.

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SPECIAL WARFARE

Major Richard M. Jennings
Tactics/Combined Arms Department

Most of the "hottest" trouble spots in the current cold war between the free world and the Communists are located in tropical regions. Bitter fighting has occurred during recent months in the tropical countries of Laos, Vietnam, Cuba, and in the Congo, and there are indications that further conflicts may spring up in other parts of the world where the jungle abounds.

Future deployment of the US Army in combat operations might well be into one of these jungle regions. The portions of the earth covered by tropical vegetation are shown on the map in figure 14. These areas are characterized by dense foliage, hot and humid climate, marshy terrain,

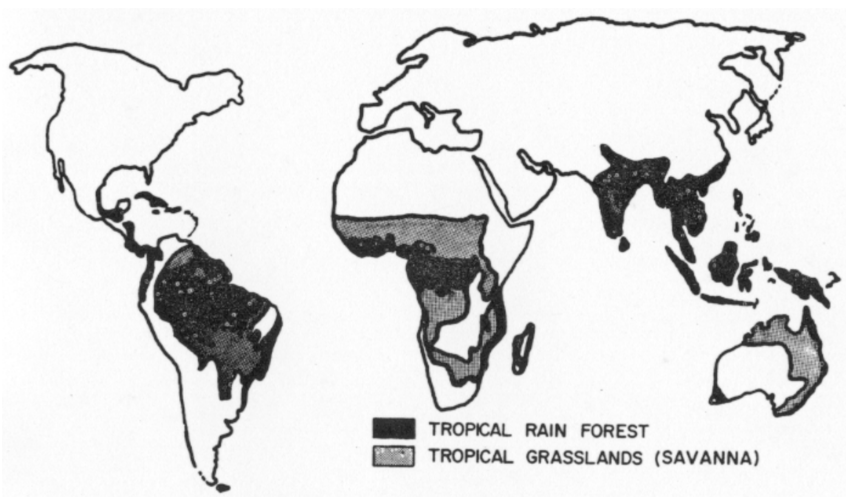

Figure 14. The jungle world.

and heavy rainfall. The rain forest often forms a closed canopy at heights 80 to 150 feet above the jungle floor, while the savanna grasslands are characterized by extensive areas of grass rising to heights of 12 or more feet, with scatterings of palms and small forests.

Many of these regions are familiar to veteran US military men who participated in the jungle campaigns of World War II. In the Pacific

Theater, the US Army fought through the jungles of Burma, New Guinea, the Solomon Islands, and the Philippines on the road to Tokyo.

The Artillery must be prepared to participate in jungle campaigns and to provide close fire support for the Infantry despite the obstacles imposed by terrain and climate. The employment of field artillery in the jungle is difficult, but it is definitely necessary. As artillerymen, let us consider the problems imposed by the jungle and the variations in tactics and techniques necessary to conquer them.

THE INDIVIDUAL ARTILLERYMAN

Inexperienced soldiers may have developed a psychological fear of the jungle (snakes, etc.) that can be dispelled by proper orientation and training. They must be taught the principles of jungle living and to make use of its animals and plant life. Once familiar with junglecraft, the American soldier can apply his natural talents of improvisation and resourcefulness.

Demands of the jungle on the body are severe, and the artilleryman, as well as the infantryman, must be in top physical condition in order to combat the fatigue resulting from labor in the tropics. The artilleryman must be familiar with all aspects of medical care, such as first aid, personal hygiene, and sanitation, to avoid the hazards of tropical diseases and heat exhaustion. He must be prepared to fight with minimum vehicles and heavy equipment and to be self-sustaining for long periods. Individuals should be adept in camouflage, in the use of small arms, and in hand-to-hand combat, since contact with the enemy is often close and unexpected. The machete should become a veritable extension of the jungle artilleryman's arm.

Figure 15. The jungle artilleryman and his machete are inseparable.

Each artilleryman should be proficient in navigation by compass, for in the tropical forest, landmarks which can guide the observer, survey party, or wire crew are rare.

ARTILLERY POSITIONS

The density of jungle vegetation hinders the movement of artillery units and makes the occupation of positions difficult. Batteries must usually go into position near roads or trails, and, frequently, the fields of fire for the pieces are hacked or carved out of the jungle. The aid of the engineers with their power equipment is invaluable, but care must be taken not to cut an excessive slash in the jungle that could be picked up by enemy aerial observation. Positions should provide for a 6400-mil, all-round fire capability, for jungle targets may appear in any direction. In some cases, positions may be found along streams or on adjacent islands that will provide better fields of fire for the weapons.

Since enemy infiltrators can often approach artillery positions in the jungle undetected, artillery unit commanders must stress local security. In 1943, the primary counterbattery weapons of the jungle enemy in the Solomons were "raiding demolition units," which had the mission of slipping through Allied lines and knocking out artillery batteries by close assault. Positions should be more concentrated than in normal terrain, often with the administrative elements in the same area as the firing battery. A tight perimeter defense should be set up, bounded by barbed wire set out beyond hand grenade range and supplemented with booby-traps, trip flares, and sharpened stakes. Shown in figure 16 is a schematic diagram of a perimeter defense that proved successful for artillery batteries operating in southeast Asia.

Within the howitzer position, paths or trenches should be cut to connect each howitzer section with other battery installations and with foxholes which can be occupied to support the perimeter defense. Lanes of fire for the machineguns should be cut in the form of tunnels through the jungle and should interlock with those of adjacent machineguns. One man should always be alert at each machinegun. Wire entanglements may also be placed around each howitzer section to prevent close-in bayonet charges. All personnel should have foxholes readily available, and at least two men should be alert at each howitzer at all times. Listening posts and patrols should be used beyond the perimeter, and vehicles and convoys operating outside the position should be protected against ambush.

MOVEMENT

The lack of roads in jungle areas restricts the mobility of artillery units. Much of the ground is constantly marshy, and the few roads or trails available often become muddy quagmires when used by heavy vehicles. Turn-around areas are practically nonexistent, and, off the road, the jungle is impenetrable for artillery vehicles. Pieces must often be manhandled into position. Tractors and bulldozers are invaluable and

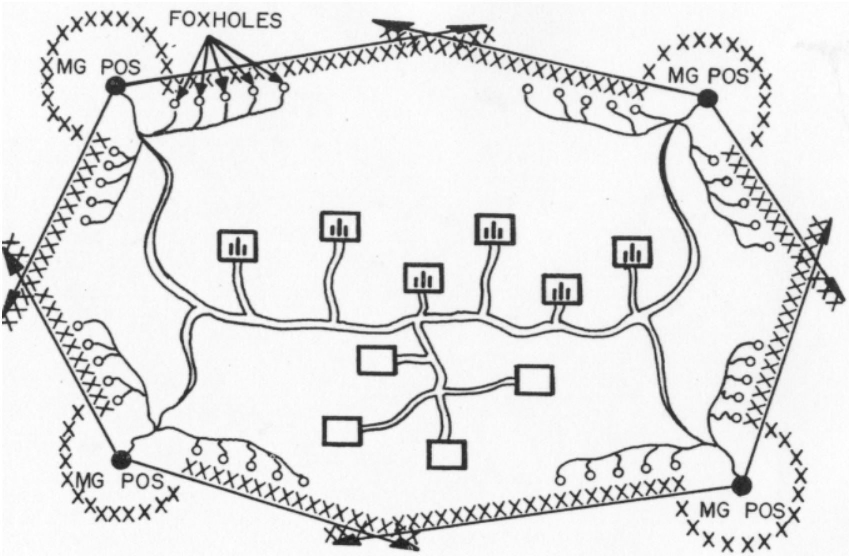

Figure 16. A position area defense.

winches on vehicles are advisable. Vehicle maintenance requirements increase because of spring failures, the overheating of engines, the failure of electrical and fuel systems, and the corrosive effect of the humidity on exposed metal and canvas. Since jungle areas abound in waterways, artillery should be capable of moving expeditiously by boats or rafts.

The use of helicopters for airlifting artillery will prove a significant development in providing mobility on a jungle battlefield. Batteries will hop from one firing position to another, bypassing impassable areas. It should be remembered, however, that helicopter performance is adversely affected by high temperatures and that unobstructed clearings for landing zones may not be available.

TARGET ACQUISITION

Observation is restricted in the jungle; in some cases, visibility may be limited to five meters. Artillery forward observers must remain well forward, in close contact with the supported unit at all times. Since it is difficult to establish exact locations, forward observers must carry control forward by compass and pacing, if necessary, and must coordinate with the observation aircraft or helicopters. Aerial OP's are invaluable in acquiring targets, but are hampered by the tree canopy. They are most useful in observing cleared areas and locating enemy bivouac sites and mortar and artillery positions.

The use of target acquisition equipment is limited, since the sound and radar equipment is restricted by the dense growth, by difficulties in moving heavy equipment over jungle trails, and by the necessity for

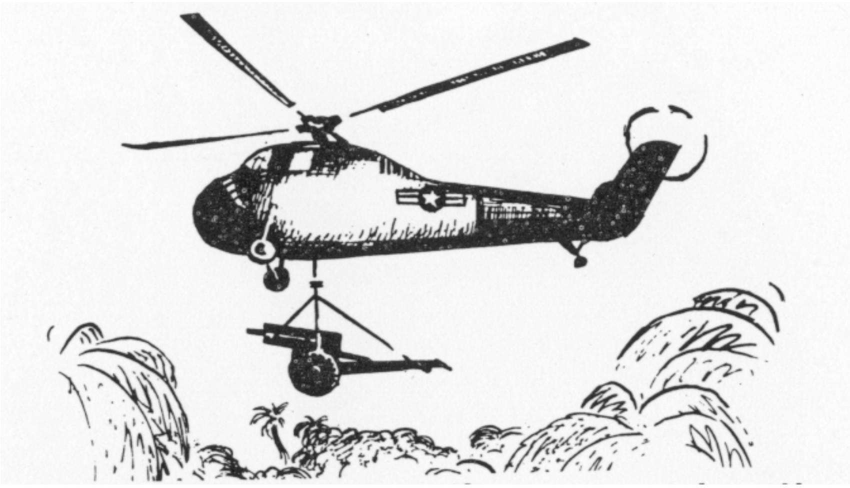

Figure 17. Helicopters may provide an answer to the problem of difficult movement.

clearing fields of operation for the radar sets. Once installed, however, the sound ranging bases and counterbattery or countermortar radars can operate efficiently though their effective range may be reduced. On the other hand, ground surveillance radars and flash ranging bases are almost useless. When it is possible to use sound and radar, installation of the equipment with appropriate wire nets may be accomplished by helicopter.

DELIVERY OF FIRE

The delivery of accurate massed artillery fire is difficult in jungle operations. Unobserved or predicted fire must often be used. The excessive masks caused by tall tree lines force the extensive use of high-angle firing. Accurate maps are scarce and photomaps will often be relied on. Because heavy growth limits the effective burst radius of artillery shells, an observer may bring his rounds in closer proximity to friendly lines; however, caution should be exercised in adjusting low-angle fire to insure that rounds do not burst in the trees above friendly troops.

In the South Pacific, American FO's often adjusted on unseen enemy targets by sound, "creeping in" their rounds for close-in targets. These sound adjustments can be refined by using a combined adjustment with two observers. Location of friendly frontlines is a constant problem, since maneuver units have trouble in reporting their locations accurately and are often but a few meters from enemy troops. Such situations demand very accurate initial data and careful adjustment.

High explosive shells are effective in the jungle, though the choice of fuze is influenced by the nature of the vegetation cover. Fuze quick is effective in a low tree canopy or grassland, often giving tree bursts at a desirable height with the bonus effect of splintering. VT fuze and time fuze are difficult to sense in adjustment and lose some of their fragmentation effect in the tree canopy. VT fuze may prove erratic because of the excessive moisture. Fuze delay, activated by the trees, usually

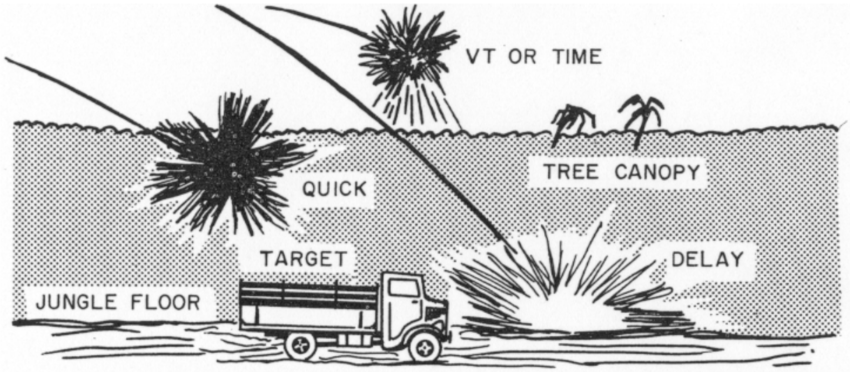

Figure 18. Fuze actions in the jungle.

will give a burst on or near the ground and should be used in greater proportion than usual. White phosphorus shell is valuable because its burst can be easily identified, and WP or base ejection rounds are useful in marking air strikes. Care must be used in the storage of ammunition, since exposed powder charges and metal surfaces deteriorate rapidly in the jungle humidity.

SURVEY

Since adequate maps do not exist for most areas in which jungle warfare techniques would be employed, the establishment of survey control becomes a primary consideration. Though survey through jungle growth is time consuming, survey control is usually feasible because the advance of the infantry is hindered by the terrain. Control should be carried up to individual FO positions, but target area survey is usually impossible. Common direction can be obtained by astronomic observations or with azimuth-gyro-surveying instruments. Coordinate control will often be based on an assumed grid.

Triangulation, resection, and trilateration techniques are useless since lines of sight are extremely short or nonexistent. Each survey party must be augmented by brush cutters to clear the lines of sight. However, due to the lack of adequate roads, using such items as azimuth-gyro-surveying instruments and tellurometers for survey operations will require considerable backpacking of heavy equipment. In addition, much of the electronic distance-measuring equipment will be inoperable through dense foliage and undergrowth. The use of elevating masts may make it possible to measure distances at normal ranges.

The use of reference marks for marking survey stations will be extremely limited. The rapid growth of the vegetation often swallows up these marks in very short periods of time. The maintenance of survey equipment is of the utmost importance, since condensation within telescopes, rust, and the growth of fungi and molds can render equipment inoperable within 24 hours.

TACTICAL EMPLOYMENT

Decentralization of artillery units is often necessary because of difficulties in control and communication, and, as a result, batteries must often operate alone. Thorough reconnaissance is necessary to locate future positions. It may be desirable to have a single piece near the head of a column to place direct fire on enemy roadblocks, tanks, or bunkers.

Jungle action is sudden and calls for very quick reaction times from the artillery. Therefore close liaison must be maintained with the supported troops. In the attack, artillery concentrations and preparations should be short but intense, and attacking infantry should follow the fire closely.

Light artillery is most appropriate for jungle warfare. The 105-mm howitzer is an excellent weapon, particularly in view of its airmobile capability. The pack 75-mm howitzer has greater mobility, but lacks punch and high-angle fire capability. Medium and heavy artillery are valuable for their long-range and heavy fires, but can be used only if a good road net is available. The Little John rocket will be valuable against a large-scale enemy force in the jungle, and longer range rockets and missiles may be used against enemy supporting bases.

COMMUNICATIONS

Artillery communication may be very difficult in the jungle. Wire is the most reliable means, but it is difficult to install and even more difficult to maintain. Wire lines should be constructed overhead as soon as possible to prevent cutting by tanks, bulldozers, or enemy infiltrators. For planning purposes, the capabilities of wire equipment should be based on wet ranges (e.g., WD-1, 12 miles wet; 20 miles dry). Wire crews should be augmented to speed the wire laying and to protect the crews against snipers. In jungle areas, wire can be laid rapidly by fixed wing aircraft or helicopters.

Radio reception is difficult because the normal operating range is reduced by the dense foliage, but reception can often be improved if operators change the sites of their sets or antennas. AM equipment is usually more reliable than FM radios. Army aircraft can assist greatly as radio relay stations. Since radio batteries deteriorate rapidly due to moisture, about twice the normal battery requirement may be anticipated. They should not be removed from their waterproof wrapping until time to be used. Electronic equipment is highly susceptible to tropical fungus, insects, and corrosion. It should be moisture-proofed by spraying with a fungus-resistant varnish prior to arrival in the jungle. Vehicular radio sets should be operated for longer periods to help keep them dry.

TRAINING

To overcome these problems facing the Artillery, what type of training should your artillery unit conduct prior to a jungle operation? If possible, cadre personnel should attend the Jungle Warfare Course at the US Army Jungle Warfare Training Center, Fort Sherman, Canal Zone. Some appropriate training subjects for individual and unit training are listed below:

Individual training	**Unit training**
Physical fitness	Camouflage
Medical aspects	High-angle firing
Sanitation	Adjustment by sound
Jungle living	Perimeter defense
Small arms	Use of aerial photos
Hand-to-hand combat	Helicopter movement
Camouflage	Movement by boats or rafts
Navigation by compass	Convoy security
Reporting battlefield information and shelreps	Defense against ambush
	Maintenance in the tropics

NEW DEVELOPMENTS

The new equipment now under development should facilitate the employment of artillery in the jungle. The lightweight, self-propelled, 105-mm howitzer XM104 (see page 3) is designed to combine the advantages of tracked maneuverability, amphibious movement, and helicopter transportability. Its towed counterpart, the XM102, weighs scarcely more than one-half as much as the present 105-mm. The newer self-propelled versions of the 175-mm gun and the 8-inch howitzer, with their lighter chassis, should prove more appropriate for jungle conditions than the present versions. A lightweight, helicopterborne model of the Lacrosse missile, which will be available soon, may prove useful if high ground is available for the guidance station. In regard to cargo vehicles, the low ground pressure of the M116 carrier may prove as useful in the jungle as in the arctic; the Gama Goat appears excellent for swampy country; and the GOER vehicles should function well for the transport of heavy supplies. Target acquisition may be improved by infrared devices which are used for picking up heat-emitting objects and by the visual airborne target locator system when it is perfected.

The Artillery must be prepared to participate in jungle warfare although the delivery of close supporting fires is complicated by many problems in target acquisition, movement, selection of position areas, security, and communications. However, the same general tactical principles apply equally in the jungle or in other types of terrain; and through the application of special techniques, the Artillery can do its job. If artillery units are properly trained in jungle fighting, artillery fire support will be fast and accurate and will contribute decisively to the success of the battle.

GUERRILLA, JUNGLE INSTRUCTION INCREASED

Resident courses at the US Army Artillery and Missile School are now in the process of being revamped to include more instruction on guerrilla and jungle warfare.

All courses will receive basic instruction on guerrilla warfare; it will include doctrinal foundations of communist guerrilla warfare, characteristics of communist guerrilla operations, leadership and organization, historical examples, and defense against guerrilla operations. Jungle warfare classes will cover general considerations of jungle operations, characteristics of weather, terrain, vegetation, service and supply, with special emphasis on medical aspects and personal hygiene, the effects of jungle environment on operations, and the tactical modifications required.

Career course students will have a practical exercise in infantry brigade in jungle operations. It will include planning for and execution of an airlanded operation with link-up with a larger force, and the employment of supporting arms with emphasis on artillery support.

Beginning on page 15 of this issue of ARTILLERY TRENDS is a two-part article on guerrilla and jungle tactics written by the project officers in charge of writing the classes described above.

REORGANIZATION INSTRUCTION

Instruction on the impending reorganization (see supplement to this issue of ARTILLERY TRENDS) at the US Army Artillery and Missile School will be included in all resident courses during FY 1962.

All classes will receive an orientation during the first half of fiscal 62, and in addition, the career courses will be presented with practical exercises (infantry brigade in jungle operations, and mechanized division in mobile defense).

Between December 1961 and May 1962, both organizations will be taught. After that time, the reorganization alone will be presented to resident students.

8-INCH NUCLEAR SHELL DESIGNATIONS

The 8-inch nuclear shell and components have been given new designations. The following table lists the shell or component, its old, and its new designation.

8-in. nuclear shell	T317E1	M422
8-in. training projectile	T349E1	M423
8-in. spotting round	T347	M424
MT fuze for nuc. shell	T316E1, E2, E3	M542
MT fuze for spotting round	T342	M543

new graphical equipment . . .

FT 8-0-3

Captain David A. Hufnagel
Gunnery/Cannon/Rocket Department

Officers and enlisted men who have been involved in lengthy and time-consuming computation of the K-transfer technique for the delivery of the 8-inch howitzer spotting and nuclear projectiles are encouraged to read the following facts on a timesaving new development in the system of computation.

The US Army Artillery and Missile School has recently developed graphical firing tables and graphical site tables based on FT 8-0-3, (ARTILLERY TRENDS. March 1961, page 17), the new 8-inch howitzer tabular firing tables, for the projectile, HES. M424 (formerly designated shell, HES, T347). The new GFT's and GST's have been tested and evaluated by the US Army Artillery Board and have been recommended to US Continental Army Command for immediate issue to 8-inch howitzer units. It is anticipated that issue will be made during the coming fall. It is also expected that the equipment will be introduced into the School's program of instruction late in 1961. Publication of FT 8-0-3 has been delayed until early September 1961.

This is the first time that a GFT and GST have been available for use with the 8-inch howitzer spotting projectile. At the present time, firing data for the spotting projectile and for the 8-inch howitzer nuclear projectile, M422 (formerly shell, T317E1) is primarily determined by the met plus VE or K-transfer techniques which use the tabular firing tables. The latter procedure requires the FDC computer to spend at least 15 minutes determining firing data for the nuclear projectile after registration with the spotting projectile has been accomplished. Now, by using the GFT and GST, firing data for the nuclear projectile can be determined in a few minutes. This is especially important if met and VE data are not available. Part of the timesaving is due to the addition of a ballistic difference table in FT 8-0-3. This section of the new tabular firing tables provides a rapid solution for determining corrections to compensate for ballistic differences between the spotting and nuclear projectiles. A portion of this table is shown in figure 21. When the quadrant elevation to the target for the spotting projectile is determined, the computer uses this value to enter the ballistic difference table to the nearest QE listed. By interpolating the height of burst above gun to the nearest meter, corrections for QE and fuze setting (FS) can be determined. These values are then added to the QE and FS determined for the spotting projectile, and the final QE and FS for the nuclear projectile are then obtained.

K - TRANSFER TECHNIQUE

DATA FIRED: #2, Adj, Shell M424, Lot XY, Chg 1,
Fuze TI, MF #2 ① AMC, Df 2629, Time 16.7, QE 388.

BTRY DATA: Btry B, Prop Temp 65, Proj wt 241, Alt 318.

HB DATA: Alt 493, Df 2633, Rg 3510, Reg pt —.

DETERMINATION OF RANGE K, FUZE CORRECTION AND DEFLECTION CORRECTION

ALT OF HB	493	CHART RG TO HB	3510	QE FIRED	388
ALT OF BTRY	- 318	COMP RG	+/- 55	∠ OF SITE	- +/- 51
VERTICAL INTERVAL	+/- 175	ENTRY RG	3565	EL + COMP SITE	337
CHART RG TO HB	+ 3510	FZ SETTING FIRED	16.7	RG FOR EL + COMP SI	3656
∠ OF SITE (GST)	+/- 51	FZ SETTING FOR EL + COMP SITE	- 16.5	ENTRY RG	- 3565
DF FIRED	2629	FZ CORRECTION	+/- 0.2	TOTAL RG CORR	+/- 91
CHART DF TO HB	- 2633	OLD FZ CORR (IF ANY)	+/- +/-	CHART RG TO HB IN 1000'S TO .1	÷ 3.5
DF CORR	L/R 4	SUM	+/-	RG K = RG CORR / CH RG	+/- 26
DRIFT (AT ENTRY RG)	L 5.1	AVE FZ CORR (SUM / 2)	+/-		

APPLICATION OF CORRECTIONS

ALT OF TGT	333	CHART RG TO TGT	3720	RG K	+/- 26
HB ABOVE TGT	+ 150	COMP RG	+/- 57	CHART RG IN 1000'S TO .1	x 3.7
ALT OF BURST	483	ENTRY RG	3777	RG CORR FOR RG K	+/- 96
ALT OF BTRY	- 318	RG CORR FOR RG K	+/- 96	DRIFT AT TGT (ENTRY RANGE)	L 5.5
VERTICAL INTERVAL	+/- 165	SUBTOTAL	3873	DRIFT AT HB (ENTRY RANGE)	L 5.1
CHART RG TO TGT	÷ 3720	CORR FOR PROJ AND PROP	+/- 16	DRIFT CHANGE	L/R 0.4 OR 0
∠ OF SITE (GST)	+/- 45	CORR RG	3889	DF CORR FOR HB	L/R 4
FZ SETTING (EL + COMP SI)	17.8	EL + COMP SI (FOR CORR RG)	366	DF CORR AT TGT	L/R 4
FZ CORR (REG)	+/- 0.2	∠ OF SITE	+ +/- 45	CHART DF TO TGT	2785
SUBTOTAL	18.0	QE	411	DF TO FIRE	2781
BAL FZ CORR (QE AND VI)	+/- 0.5	BAL QE CORR (QE AND VI)	+ 16		
FZ SETTING TO FIRE	18.5	QE TO FIRE	427		

	KNOWN VALUE	VALUES AT REGISTRATION	VARIATION FROM REG	UNIT CORR (ENTRY RG)	RG CORR
PROPELLANT TEMP	70 °F / 0 F/S	65 °F / -1 F/S	D/I 1	+/- 7.6	+/- 7.6
WEIGHT OF PROJ	243	241	D/I 2	+/- 12	+/- 24.0
				TOTAL	+/- 16.4

FIRE COMD: #2 Adj, Shell NUC, Lot WY, Chg 1, Fuze TI,
MF #2 ① AMC, Df 2781, Time 18.5, QE 427, Conc # AB401.

Figure 19. Solution of problem using K-transfer form.

QIVEN:	**High-Burst Registration Data**	
	Chart Range	3510 meters
	Adjusted Quadrant Elevation	388 mils
	Adjusted Time	16.7 seconds
	Adjusted Deflection	2629 mils
	Chart Deflection	2633 mils
	Deflection Correction (2633 minus 2629)	Right 4 mils
	Altitude of High-Burst	493 meters
	Altitude of Battery	318 meters
	Lot XY	
Step 1:	**Determine GFT Setting**	
	a. Adjusted Quadrant Elevation	388 mils
	b. Vertical Interval to High-Burst (493 minus 318)	+175 meters
	c. Site to High-Burst (+175/Charge 1, TAG, Range 3510 meters)	+57 mils
	d. Adjusted Elevation [(388) minus (+57)] GFT "B": Charge 1, Lot XY, Range, 3510 meters, Elevation 331.	331 mils
Step 2:	**Determine Fuze Correction**	
	a. Adjusted Elevation	331 mils
	b. Site to High-Burst (Step 1, c)	+57 mils
	c. Angle of Site to High-Burst (GST, C & D Scales, +175/3510)	+51 mils
	d. Complementary Angle of Site [(+57) minus (+51)]	+6 mils
	e. Elevation plus Complementary Angle of Site (331) plus (+6)	337 mils
	f. Fuze Setting corresponding to Elevation plus Complementary Angle of Site	16.5 seconds
	g. Adjusted Time (From High-Burst registration)	16.7 seconds
	h. Fuze Correction (16.5 to 16.7)	+0.2 seconds
Step 3:	**Construct Deflection Correction Scale on GFT**	
QIVEN:	**Firing Data to Target**	
	Chart Range	3720 meters
	Chart Deflection to Target	2785 mils
	Altitude of Target	333 meters
	Height of Burst above Target	+150 meters
	Altitude of Burst	483 meters
Step 4:	**Determine Quadrant Elevation**	
	a. Chart Range to Target	3720 meters
	b. Range Correction for Projectile and Propellant (See bottom of K-transfer form)	+16 meters
	c. Corrected Range (3720 + 16)	3736 meters
	d. Elevation for Range 3736 (3740)	359 mils
	e. Vertical Interval to Height of Burst (483 minus 318)	+165 meters
	f. Site to desired Height of Burst (+165/Charge 1, TAG, Range 3720)	+52 mils
	g. Quadrant Elevation for Projectile M424 [(359) plus (+52)]	411 mils
	h. Ballistic Correction—See Ballistic Difference Table [15.2 +65/100 (15.9 - 15.2)] = 15.66 or Quadrant Elevation for Projectile M422 (411 + 16) 427 mils	+16 mils
Step 5:	**Determine Fuze Setting**	
	a. Angle of site to desired Height of Burst (GST, C & D Scales, +165/3720)	45 mils
	b. Site to desired Height of Burst (Step 4, f)	+52 mils
	c. Complementary Angle of Site [(+52) minus (+45)]	+7 mils
	d. Elevation for Range 3736 (3740)	359 mils
	e. Complementary Angle of Site plus Elevation [(+7) plus (359)]	366 mils
	f. Fuze Setting corresponding to Elevation 366	17.8 seconds
	g. Fuze Correction (Step 2, h)	+0.2 seconds
	h. Fuze Setting for Projectile M424 [(17.8) plus (+0.2)]	18.0 seconds
	l. Ballistic Correction—See Ballistic Difference Table [0.4 + 65/100 (0.5 – 0.4)] = 0.465 or Fuze	+0.5 seconds
	Setting for Projectile M422 (18.0 plus +0.5)	18.5 seconds
Step 6:	**Determine Deflection**	
	a. Chart Deflection to target	2785 mils
	b. Deflection Correction from GFT (Step 3)	Right 3 mils
	Deflection to Fire (2785 plus Right 3)	2782 mils

Figure 20. Solution of K-transfer technique using GFT and GST.

Because FT 8-0-3 has only three charges, sufficient space was available on the GFT to add a minimum elevation (ME) scale. This scale provides all tabular firing data necessary to determine the ME for all

QUADRANT ELEVATION MILS	−400	HEIGHT OF BURST ABOVE GUN – METERS 0	+100	+200	+300	+400	+5	+1000
380 ΔQ		12.8	13.3	13.8	14.2	14.7	15.	
ΔFS		.4	.4	.4	.4	.4		
385 ΔQ		13.0	13.5	14.1	14.8	15.5		
ΔFS		.4	.4	4	.4	.5		
390 ΔQ		13.3	13.8	14.4	15.2	15 9		
ΔFS		.4	.4	.4	4	.5		
395 Δ Q2		13.6	14.2	14.8	15.6	16 3		
Δ FS		4	.4	.4	.4	5		
400 ΔQ		13.9	14.6	15.2	16.0	16.8		
ΔFS		.4	4	.4	4	5		
405 ΔQ		14.2	14.8	15.5	16.4	17.3		
Δ FS		.4	.4	.4	.4	.5		
410 Δ Q		14.6	15.2	15.9	16.8	17.7		
Δ FS		.4	.4	.5	.5	.5		
415 Δ Q		14.8	15.6	16.3	17.2	18.2		
Δ FS				.5	.5	.5		

Figure 21. Ballistic difference table, FT 8-0-3.

charges for ranges from 100 to 2000 meters. A portion of the minimum elevation scale is shown in figure 22. To permit a quick distinction between graphical rules for FT 8-0-3 and those for FT 8-J-3 (the HE tabular firing tables), the weapon, charge, and firing tables designations are printed in red instead of black. All other data on the FT 8-0-3 GFT and GST are in the same format as data for the FT 8-J-3 GFT and GST. Quadrant elevation limits are shown on the back of the GST as a guide to insure that the determination of site with the GST is within 1 mil of true site for vertical intervals ranging from –400 to +1000 meters. These limits are 550 mils for charges 1 and 2 and 585 mils for charge 3.

A problem in the delivery of fire of the 8-inch howitzer spotting and nuclear projectile is presented to show the comparison in accuracy and speed between the K-transfer and graphical techniques.

The common starting point is the known high-burst registration data. Figure 19 shows a completed K-transfer form which required about 18 minutes to solve. Figure 20 shows the problem as solved by the GFT and GST. *Less than 5 minutes were required to determine the final quadrant elevation, fuze setting, and deflection correction*. Note that the solution of both procedures yields the same quadrant elevation and fuze setting. The difference in the deflection correction obtained from the GFT (right 3 mils) is only 0.2 mil when compared to the true deflection correction of right 3.6 mils in figure 19. The value of left 0.4 mil (change in drift between high-burst registration and target height of burst) is rounded down to 0 mil for a total deflection correction of right 4 mils, while the GFT solution shows a total deflection correction of right 3 mils.

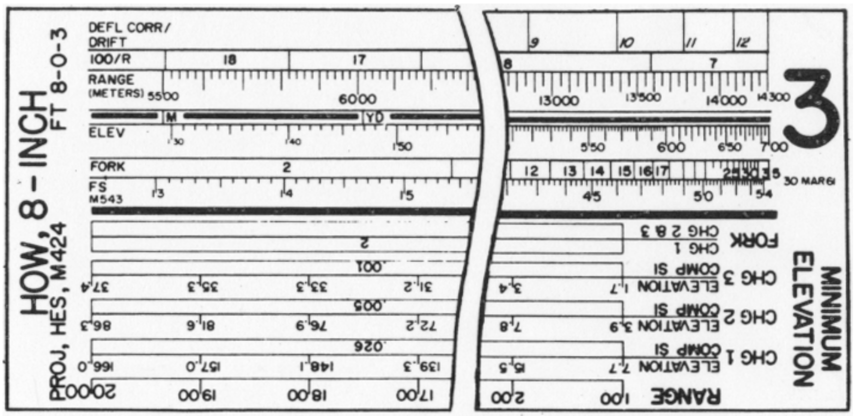

Figure 22. The new FT 8-0-3, GFT.

LARGE VERTICAL INTERVALS ARE IMPORTANT FACTOR

The graphical solution is similar to the conventional HE delivery technique. The only difference between the two methods is in the steps leading to determination of fuze setting. Because of the large vertical intervals which must be considered in the solution of this problem, the complementary angle of site should be considered before the determination of the fuze setting. This complementary angle of site is added to the adjusted elevation to the target (as determined under the elevation gageline), and the fuze setting corresponding to this sum is the fuze setting for the spotting projectile. The ballistic correction is then determined from the ballistic difference table (fig 21) and applied to obtain the final fuze setting for the nuclear projectile.

The US Army Artillery and Missile School believes that this graphical equipment will greatly increase the delivery speed for both the spotting and nuclear projectiles without loss of noticeable accuracy. It is anticipated that the graphical solution will soon be taught at the School.

Both the GFT and GST are available for purchase at the School Book Department for $1.35 and $2.25, respectively.

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ARMY SCHOOL CATALOG

DA Pamphlet 20-21, *The Army School Catalog,* May 1961, has been published and is available. This new edition supersedes DA Pamphlet 20-21, May 1957 with Changes 1-141.

Lacrosse TSS

Captain James P. Maloney
Guided Missile Department

The Lacrosse trajectory safety system (TSS) allows the Lacrosse missile to be fired on limited ranges. The system uses a warhead separation feature that causes the missile body and warhead to fall in a predictable area.

The TSS equipment (fig 23) consists of a missile nose section, a ground station, two radar sets, an optical "skyscreen," generator sets, and a practice warhead section test set.

THE RADAR INSTALLATIONS

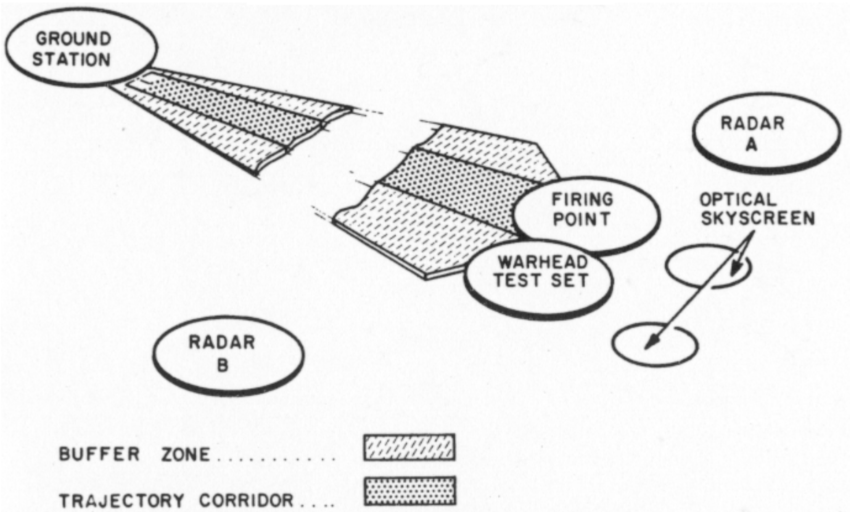


Figure 23. A typical TSS installation.

The two radar installations are identical. Each consists of an M33A1G radar (fig 24), a remote destruct transmitter and a skyscreen indicator panel. M33A1G is the designation given to a standard M33 radar when a target selector is connected to it and the plotting boards are modified. The target selector is an optical instrument mounted on a stand and connected by a servo mechanism to the radar antenna. When the radar is operating in *automatic,* control may be transferred to the target selector by pressing the target selector button on the operator's control panel. The

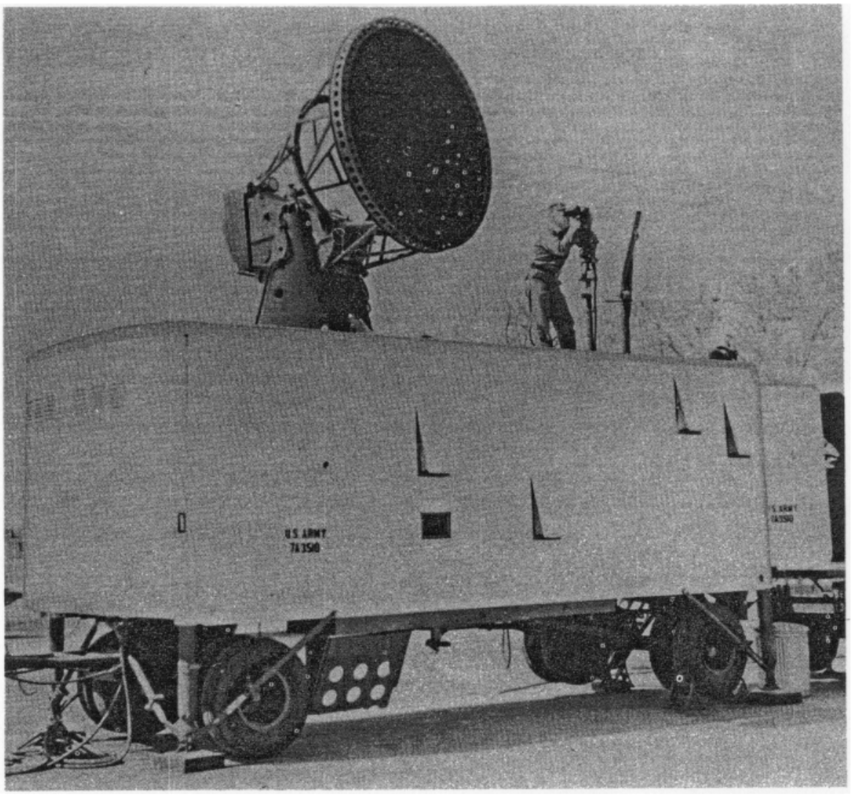


Figure 24. The M33A1G radar.

target selector then can be used to assist in acquiring the missile or reacquiring it if the missile is lost during flight.

The M33A1G radar horizontal plotting board displays two present position plots. These plots are in X and Y coordinates, one to a scale of 1:25,000 yards and the other to a scale of 1:50,000 yards. The safety diagram, drawn to scale, is superimposed on the plotting board. The vertical plotting board plots to a scale of 1:50,000 horizontally and 1:12,500 vertically, giving an exaggerated altitude plot for easy reading.

The remote destruct transmitter (fig 25) which is remoted from the ground station by wire, consists of a signal generator and a destruct switch on which are mounted two destruct buttons wired in series.

The trajectory safety officer is stationed at the transmitter in radar A. He must depress both buttons simultaneously to transmit the destruct signal. At the same time the safety officer gives a verbal command by wire to the operator at the ground station, who acts upon this verbal command by throwing a switch which insures destruct. If wire cannot be

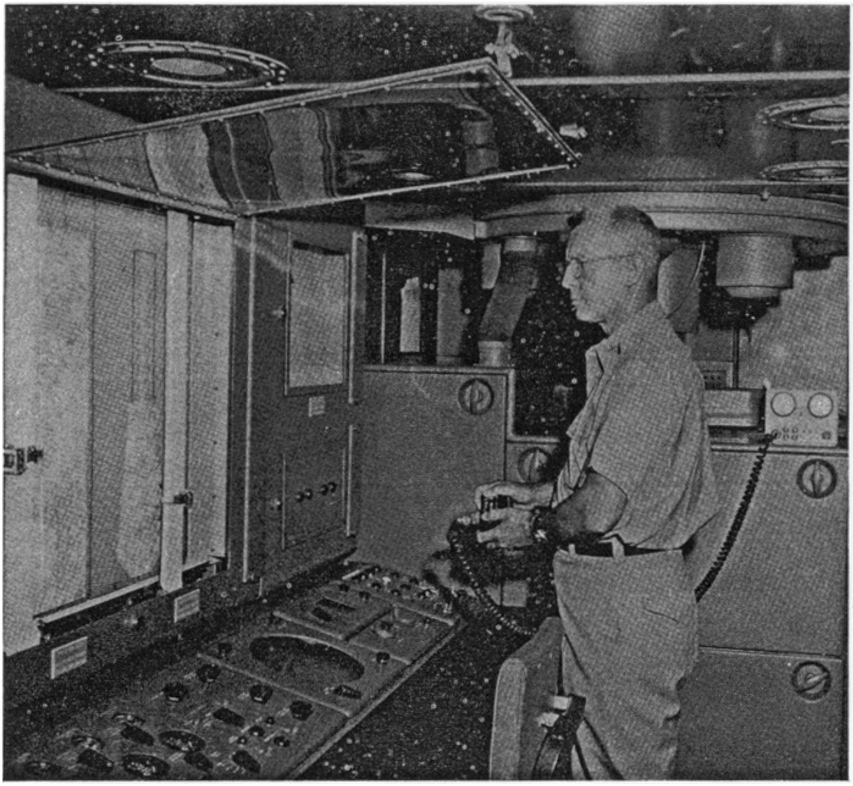


Figure 25. The destruct switch causes separation of the warhead from the missile.

laid to the remote destruct transmitter, the destruct command is verbally transmitted by radio or other means and is acted upon at the ground station.

The skyscreen (fig 26) is a visual backup for the TSS radar. It consists of two observing instruments, near either side of the flight corridor. Each observing instrument operates a switch connected to a set of red and green lights. When the instruments are pointed into the flight corridor, a green light is displayed; but if the right instrument is pointed to the right of the flight corridor or the left instrument to the left of the flight corridor, the green light switches off and a red light is switched on. The two observing skyscreen instruments are mounted on tripods which contain the switch for the skyscreen lights.

The ground station consists of two command transmitters and checkout equipment installed in a standard M109 van (fig 27) and the generators are transported in a standard 1 1/2-ton trailer. The antennas are mounted on tripods on the top of the van during operation.

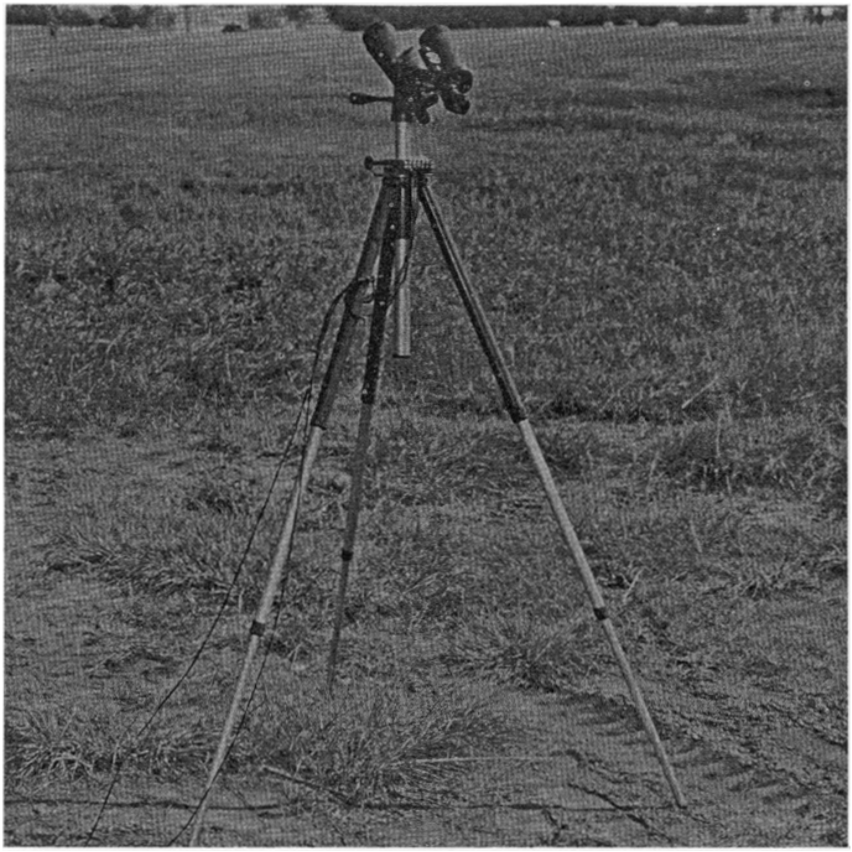


Figure 26. Skyscreen equipment of the Lacrosse trajectory safety system.

Each transmitter has its own antenna, power supply, and generator to permit independent operation. If one transmitter fails, the other is automatically switched on.

The warhead (fig 28) is identical in shape and weight to the other warheads of the Lacrosse system. It contains two completely separate receiver systems, three explosive bolts, and a nylon rope. When the command destruct buttons are depressed, the explosive bolts cause separation of the warhead just forward of the standard splice ring, leaving the nose section connected to the missile body by the nylon rope. The resulting aerodynamic instability causes the missile to fall in the buffer zone.

The warhead test set, mounted on a 3/4-ton truck, checks the practice warhead prior to firing, using the command transmitter frequencies and codes.

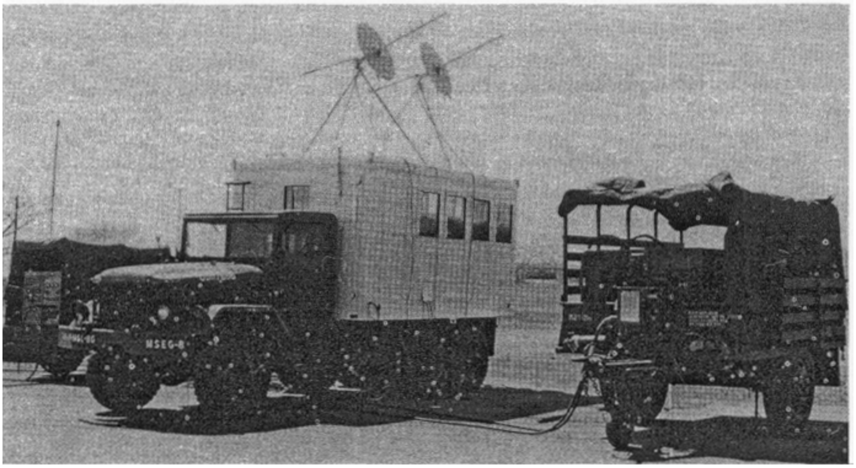


Figure 27. The M109 van and power source.

GENERAL OPERATION

At firing time, the radar is positioned in azimuth, elevation, and range on a point slightly up the trajectory. The azimuth and elevation operators

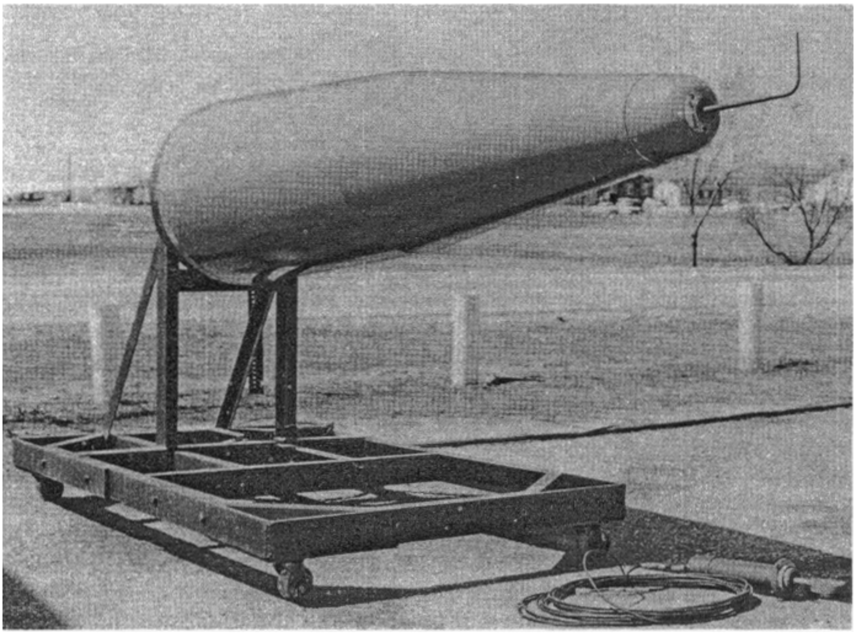


Figure 28. The TSS warhead is ballistically identical to all other Lacrosse warheads.

monitor visually through the radar optics, the range operator monitors the range indicator oscilloscope, and the target selector operator monitors visually through the target selector optics.

When the missile is fired, the azimuth and elevation operators keep the antenna pointed at the missile. When the range operator has the missile blip in the range gate, all operators switch to *automatic*.

The target selector enables the radar antenna to be positioned rapidly by one operator to assist in acquisition of the missile.

The ground station is placed at the far end of the range because of the antenna pattern of its transmission, and because the probe-type receiver antenna is located in the nose of the missile. Positioning the radars as shown in figure 23 provides greater assurance that the missile can be tracked throughout the trajectory. The trajectory safety officer would normally locate himself at radar A, and the TSS decisions would be made by him. If he has reason to question the plot at radar A, he may transfer control to radar B.

The range safety diagram (fig 29) outlines the safety area and flight corridor for the trajectory safety system. The flight corridor is one kilometer right and left of the launcher-target (L-T) line. If a missile should maneuver to either boundary, it would be destroyed by the safety officer and would impact within the buffer zone. A greater safety

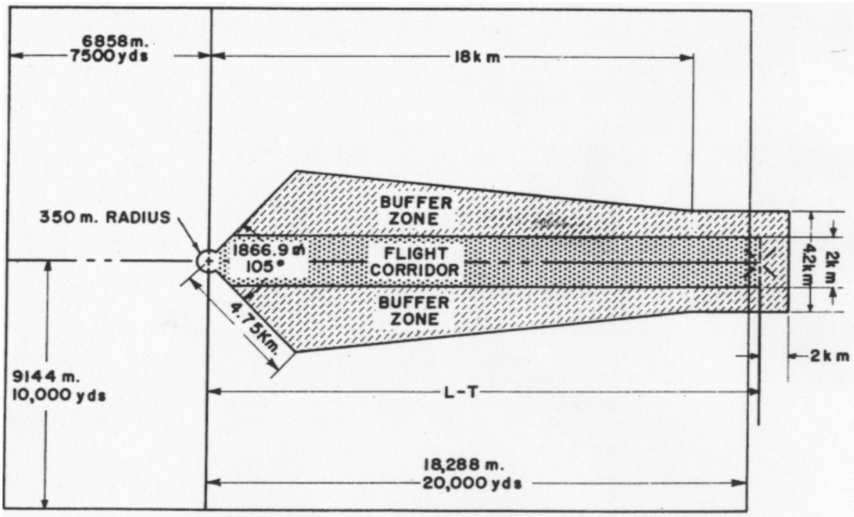


Figure 29. The TSS safety diagram.

Note: there are emplacement limitations due to radar parallax.

zone must be provided for the earlier portion of the trajectory, where velocity is greater and erratic performance more probable, than for the later portion of the trajectory.

PLANNING FACTORS

The M33A1G radars (A and B) are located to insure the best probability of acquiring and tracking the missile. This can usually be accomplished by placing one radar to the left with respect to the L-T line and one radar to the right rear. Line-of-sight to the launcher improves acquisition probability, but it is not necessary.

The radar location is limited by the parallax settings available. Parallax is defined in this system as distance measured perpendicular to and parallel with the L-T line. The maximum settings are shown in figure 29. Note that the radar may not be sited in the flight corridor or the 350-meter safety zone. Parallax settings are in yards due to equipment design.

The ground station is located down range from the target. Since it operates in the very high frequency (VHF) band, it is desirable to have line-of-sight to the missile from firing to impact, but this is not mandatory. The officer in charge should insure that the 40° beamwidth of the transmitter contains the entire L-T line. Tests of the transmitter have shown that ranges out to 40 miles from the firing position are feasible. The officer in charge must analyze the terrain in each situation and must test the equipment prior to firing.

The TSS table of distribution does not include a wire-laying capability. Equipment and personnel must be furnished by the supported organization.

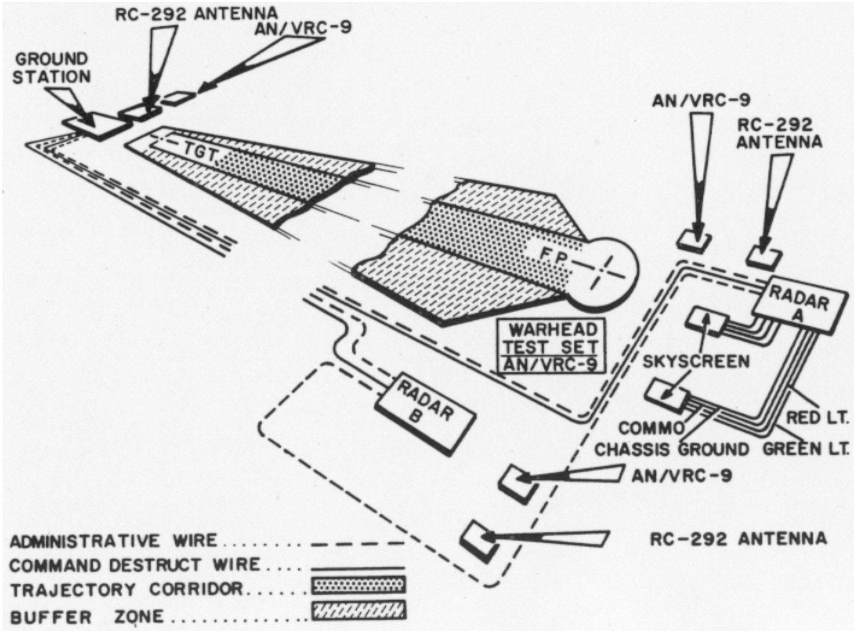


Figure 30. A typical TSS installation wire diagram.

The wire requirements are shown in figure 30. Radio is used in lieu of or as a backup to wire.

The TSS must have clear channel frequencies from 406 to 408 MC to insure noninterference with the operation.

The Lacrosse trajectory safety system has been successfully used in 13 missions. It permits the firing of Lacrosse missiles on limited overseas ranges and at Fort Sill, Oklahoma. While insuring safety, the TSS does not interfere with the tactical realism of Lacrosse missile firings.

INEXPENSIVE ATOMIC BURST SIMULATOR

Confronted with a request for an inexpensive atomic burst simulator, ordnance elements at Fort Sill, Oklahoma, developed two methods, each at a cost below $20.00, and each using common, and often waste materials.

In figure 31 is the test of the napalm method, which provides a better and longer-lasting mushroom cloud and fireball. The initial fireball is about 40-50 feet in diameter and mushrooms at a height of about 100 meters.

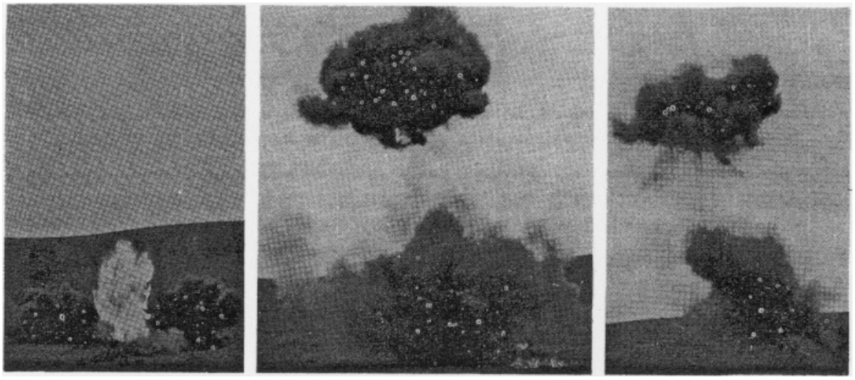


Figure 31. Simulated atomic burst progression.

Commanders and training officers having a requirement for the simulator may obtain detailed information by written request to: Commandant, United States Army Artillery and Missile School, ATTN: AKPSIGCR, Fort Sill, Okla.

Employment of the fabricated simulator by units in the continental US for demonstrations, training, and tactical exercises requires approval of the Commanding General. US Continental Army Command.

—Submitted by Capt Clarence C. Greenhill
61st Ord Det (ED)
Fort Sill, Oklahoma

all weather, night-time . . .

Boresighting Devices

Lt M. A. Battiste
US Army Artillery Board

Boresighting—the alinement of the optical axes of the on-carriage fire control telescopes with the axis of the tube is normally accomplished by one of two means. Gun sections can boresight by the test target method or by using a distant aiming point. Both methods have limitations. The test target method is erratic, time consuming, and often impracticable in tactical situations. The distant aiming point system, on the other hand, requires a suitable aiming point and good visibility; boresighting at night by this method is therefore almost impossible.

Various field solutions of the boresighting problem have been presented to the US Army Artillery Board. The underlying principle in most of these solutions is suspension of a sighting target from the muzzle end of the tube, an extension of the old standard angle system of boresighting, which depended on initial data from one of the other two methods given above.

The Artillery Board is investigating the feasibility of a boresighting device which would permit rapid and accurate boresighting under almost all conditions of weather and terrain, and has requested the US Army Ordnance to develop such a device.

Several proposed devices have already undergone service tests at the Board; the two most promising devices appear in the text and photographs below.

THE T162 BORESIGHTING DEVICE

The T162 boresighting device for the 105-mm howitzer M101A1 (formerly the M2A2) consists of a support ring and a support arm with two permanently affixed sighting targets (fig 32); one sighting target is used to aline the panoramic telescope, while the second alines the elbow telescope. The support ring clamps around the outside of the muzzle and is fitted with two indexes, labeled "panoramic telescope" and "elbow telescope."

To use the T162, a howitzer section would aline the sighting targets with the appropriate telescope during basic periodic tests on the howitzer. At this time (after alinement of the target devices with the telescopes), marks are scribed on the muzzle opposite the labeled indexes. These scribe marks insure proper positioning of the clamp on the tube in succeeding boresights. The T162 can be used interchangeably with all the howitzers in a battery.

Although this device eliminates the disadvantages of the older boresighting methods, it has its own limitation. It cannot be used with 105-mm

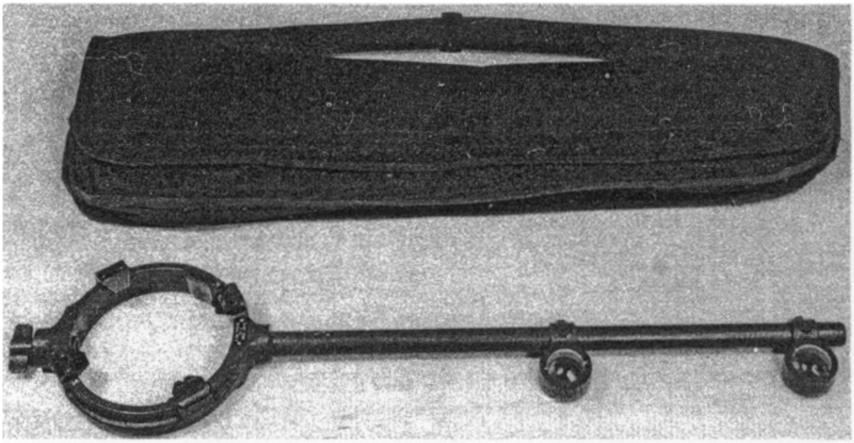


Figure 32. The T162 boresighting device.

howitzers equipped with muzzle brakes. Since future 105-mm howitzers are expected to be equipped with muzzle brakes, this limitation of the T162 is a major drawback.

MUZZLE-PLUG BORESIGHT

One proposal which will overcome this drawback of the T162 is the muzzle-plug boresighting device for use with the M101A2 (formerly the M2A1). In concept, the design is similar to that of the T162 with this major difference—this device fits *inside* the muzzle (fig 33), rather than clamping around the outside.

The muzzle-plug boresight consists of a metal plug, which fits into the muzzle, and two support arms, to which adjustable sighting targets are attached for alinement of the panoramic and elbow telescopes. A hand grip for insertion and removal of the plug from the muzzle of the tube is located on the front of the metal plug. Quadrant seats on the hand grip accommodate a gunner's quadrant which must be used to cant the boresight to the same degree as the trunnions.

The adjustable sighting targets of the muzzle-plug boresighting device are initially alined immediately after the weapon has been boresighted on a distant aiming point. Alinement of the sighting targets is periodically checked in the same manner. This is a limitation of the muzzle-plug boresight; it is convenient for only one weapon.

PRESENT STATUS OF BORESIGHT DESIGN

With these features and limitations in mind, a muzzle-plug boresight for the 105-mm howitzer with or without muzzle brakes is being designed. The redesign employs the muzzle-plug device with a single arm and two sighting targets. It will not require the use of the gunner's quadrant to correct for cant.

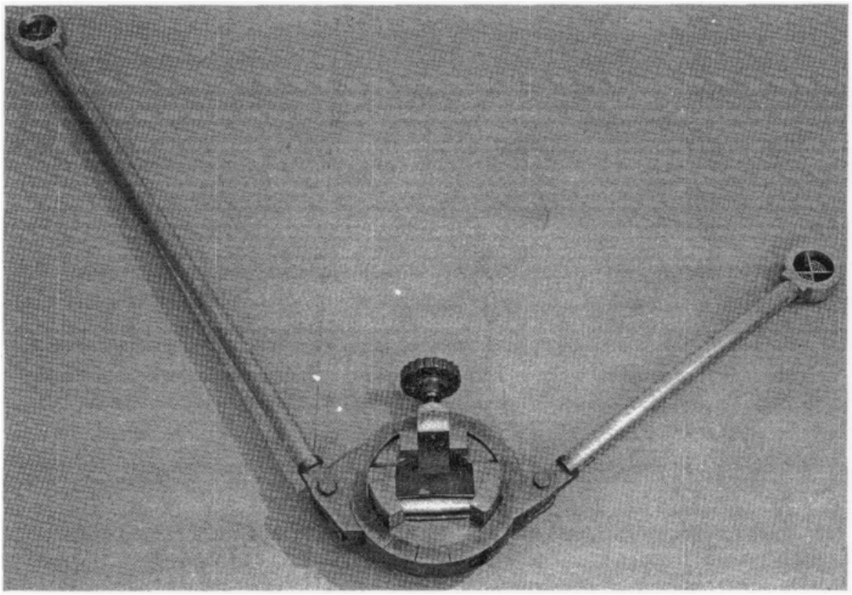


Figure 33. The muzzle-plug boresight.

Further investigations are being conducted to determine the suitability of the muzzle brake orifice as a mount for the muzzle-plug boresight. However, if the muzzle brake orifice fails as an adequate mount, the muzzle brake may have to be removed for boresighting, but this is certainly undesirable.

When a final solution to the boresighting device problem for the 105-mm howitzer has been found, it will be used as a basis for design of similar devices for the 155-mm and 8-inch howitzers and the 175-mm gun.

ARTILLERY TRENDS will publish the progress of further developments as they occur.

MATHEMATICS FOR FIELD ARTILLERY

This text is prepared by the US Army Artillery and Missile School, and is designed as a review in mathematics for all personnel planning to attend one of the general or specialist courses offered by the School. Cost of text is $.20. Remittance must be made by check or money order payable to the Book Store, US Army Artillery and Missile School, Fort Sill, Oklahoma.

"Artillery conquers and infantry occupies."

Fuller

improved accuracy . . .

GEOGRAPHIC COORDINATE SCALE

Capt Clifford N. Laur
Target Acquisition Department

With the increased emphasis on accurate direction in artillery, the use of astronomic observations to determine direction has also increased. A requirement in the computation of these observations is the accurate geographic position from which the observations were made.

The normal method for an artillery surveyor to determine a geographic position is to plot the location on a large scale map with an engineer scale and to compute by ratio. Utmost caution must be exercised in this process, because an error can very easily be made in the computations. In an effort to increase ease, speed, and accuracy in plotting, the "Geographic Coordinate Scale" (see insert) was devised.

HOW TO READ, USE THE SCALE

The scale is graduated in minutes and seconds to permit direct reading of differences in latitude and longitude. One edge of the scale is graduated for use with the 1:25,000 map and the other edge for the 1:50,000 map. The 1:25,000 scale can be read directly to 1 second (1″), while the 1:50,000 can be read directly to 2 seconds and interpolated to 1 second. Each edge of the scale has a double set of figures in two colors. The direction designations, "W" for west and "N" for north, are represented by black and red letters, respectively, for convenience in reading. When reading latitude ("N"), the red numbers should be used; for longitude ("W"), the black numbers should be used.

Since geographic coordinates are spherical, the area of coverage on the map will differ at various latitudes and longitudes. The scale must therefore be tilted varying amounts to obtain good readings.

To use the geographic coordinate scale, it is first necessary to connect the map "neat lines" surrounding the point to be plotted. A plotting pin is then placed in the map at the position to be plotted.

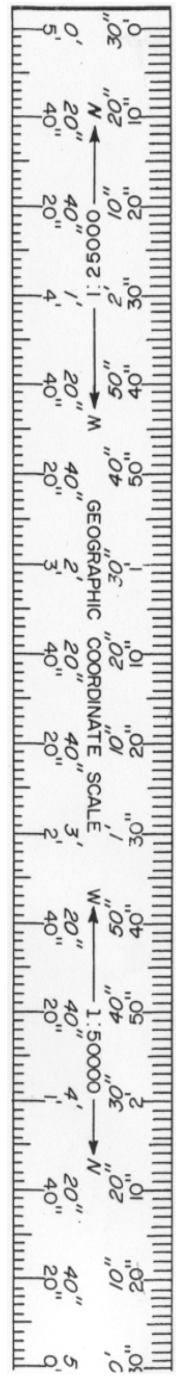


Figure 34 shows the position of the scale in measuring the latitude of a road junction on a 1:25,000 map.

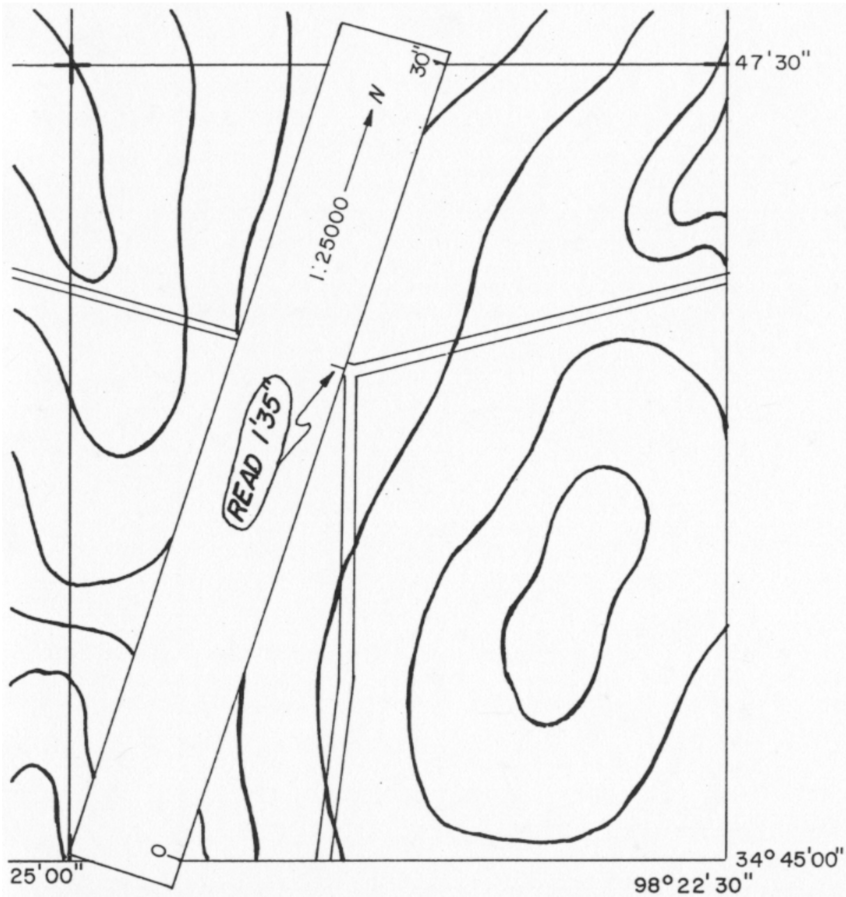


Figure 34. Plotting latitude with the geographic coordinate scale.

(Blocked letters and numbers stand for black and slanted letters and numbers stand for red).

The appropriate edge of the scale is set against the pin and, since we are plotting latitude, the red numbers ("N") are read on the scale. The indexes at each end of the scale must be positioned with the proper tilt so that they are on the extensions of the neat lines. In figure 34, the reading is 1 minute, 35 seconds (1′35″). This value must be added to the latitude value in the margin of the map (34°45′00″), thereby giving a latitude of the road junction of 34°46′35″ North.

Figure 35 is the position of the scale when measuring the longitude of the same road junction.

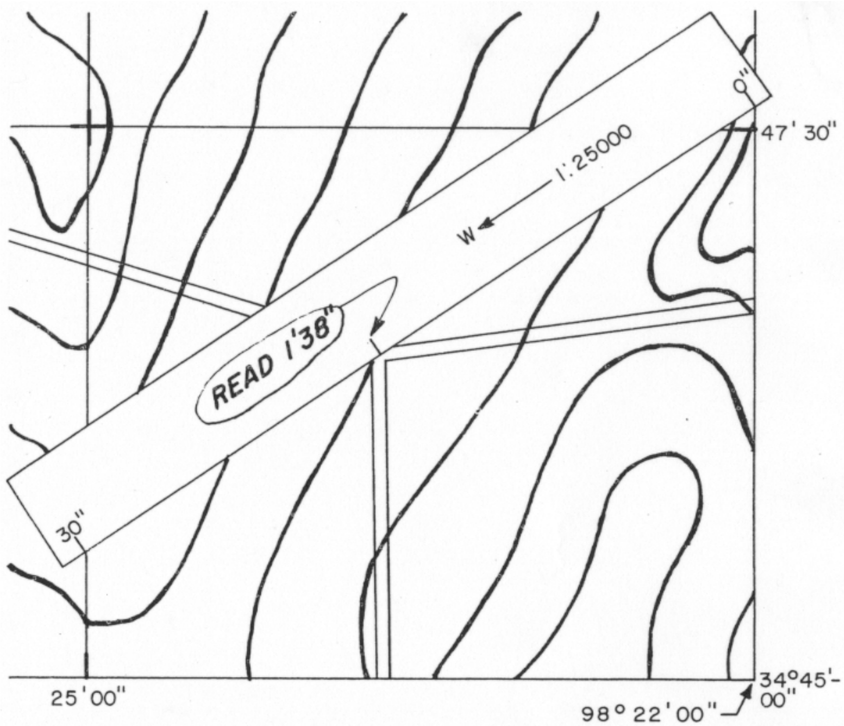


Figure 35. Plotting longitude with the geographic coordinate scale.

(Blocked letters and numbers stand for black and slanted letters and numbers stand for red).

Using the same edge (1:25,000) as for latitude, the scale is placed against the pin, this time with the scale indexes intersecting north-south neat lines. Reading the black numbers ("W"), we obtain the value of 1 minute, 38 seconds (1′38″) W. This value is added to the longitude value in the margin (98°22′30″) for a longitude of 98°24′08″ West. (If plotting in an area of *East* longitude or *South* latitude, the scale reading must be *subtracted* from the margin values.)

The accuracy of the geographic coordinate scale was proved in tests at the US Army Artillery and Missile School. The tests were conducted by two groups of plotters. Group "A," using the new scale, obtained a higher degree of comprehension, speed, and accuracy in plotting geographic coordinates than did Group "B," using the standard method.

ARTILLERY TRENDS calls your attention to the reproduction of the geographic coordinate scale on the first page of this article. It is drawn to scale and can be used. We suggest that you cut out the scale and encase it in transparent tape to preserve it in use. Units may wish to have their draftsmen redraw the scale on more permanent material, using the reproduction as a guide.

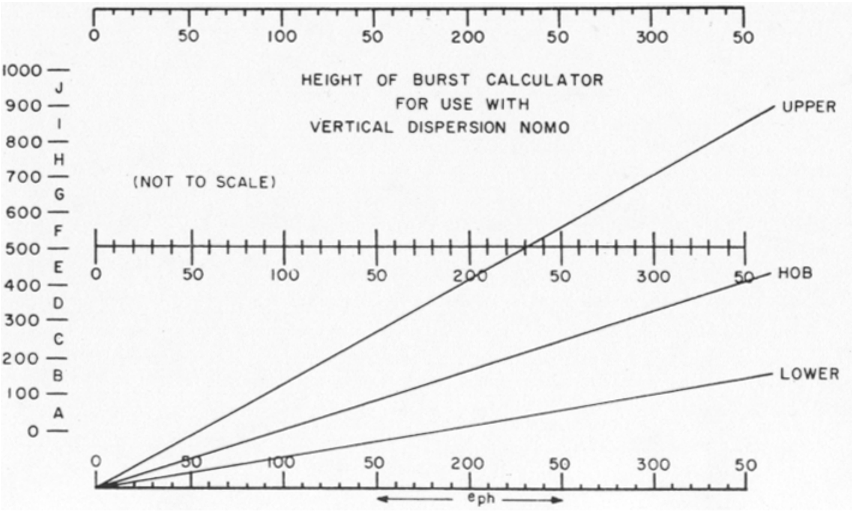
THE HEIGHT OF BURST CALCULATOR

With the inclusion of the Vertical Dispersion Nomograms and associated tables in FM 101-31 came the need for a simple means of utilizing these graphs. The height of burst (HOB) calculator (see figure) is that means. It is easily constructed and employed, and offers ready solution to the problem of height of burst computation. It can be used to compute for: (1) HOB for a 99% assurance of no fallout (HOB_{Min}). (2) casualties to enemy troops and/or damage to enemy equipment (entry row), and (3) troop safety and contingent requirements (entry row).

CONSTRUCTION

Using a 8″ x 10″ sheet of acetate, draw a line 1/2″ from the bottom (long side) seven inches long. Label this line "e_{ph}," and place tick marks 10 meters (M) (light) and 50M (heavy). This line should represent 350M (scale: 1″ = 50M). Draw identical e_{ph} scales 4″ and 7″ above and parallel to the first so that a perpendicular line through the first at any tick mark will intersect the corresponding tick marks on the other two scales.

Place the e_{ph} = 350M tick marks over the V-D Nomo scale with the lower e_{ph} tick mark over HOB = 0M, then mark the intersection of the



(Continued on Page 54)

OUT POPS THE WEASEL

1/Lt Richard L. Addison
Battery B, 1st Howitzer Battalion, 37th Artillery

In tactical operations on terrain as encountered in Alaska, it is often difficult to maneuver towed weapons for suitable employment. Access to a position area where the mission can be accomplished is possible only after roads have been cut through extensive areas of timber, equipment is floated across swamps and/or tundra, and muskeg is bulldozed out of the path.

These problems have made the employment of the towed 75-mm pack howitzer M1A1 increasingly difficult. A battery of six 75-mm howitzers using wheeled vehicles as prime movers is a valuable addition to a tactical commander's wealth of firepower, maneuverability, and shock action. Place those six howitzers inside M59 full-tracked armored personnel carriers (APC) and their usefulness is multiplied.

The M59 APC enables the battery to go anywhere, at any time the commander desires an immediate deadly artillery punch. Its maneuverability is unlimited. The M59 can travel any type of terrain encountered in Alaska. It will navigate through swamps, tundra, muskeg, and deep water and can negotiate in snow to depths of 4 feet.

BEST METHOD OF PLACEMENT

The actual placement and transport of the howitzer inside the troop compartment does not require additional modification of the M59 nor any additional equipment. Tests indicate that the best method of loading the howitzer and associated cargo into the M59 is as follows:

The howitzer and the associated equipment listed in TM 9-319, par 6d (Nov 48), necessary combat equipment, and tentage for a seven-man crew are prepared for placement in the armored personnel carrier. Rucksacks, rations, tents, and stoves are placed well forward in the commander's position and troop compartment. If additional ammunition must be carried, the section and personal equipment may be tied and secured to the top of the APC, terrain limitations permitting, and the ammunition carried inside.

To prepare for loading, the howitzer is placed in the firing position at center of traverse, the breech is closed, and the panoramic telescope is affixed to the mount and set for immediate use. The ammunition paulin, test target, and trail log are lashed securely across the trails.

Before loading the howitzer, the ammunition should be stacked neatly on the floor of the APC, leaving enough clearance for the wheels and axle to pass over it. Tests have shown that 48 rounds of ammunition can be loaded in the M59 APC (fig 36)

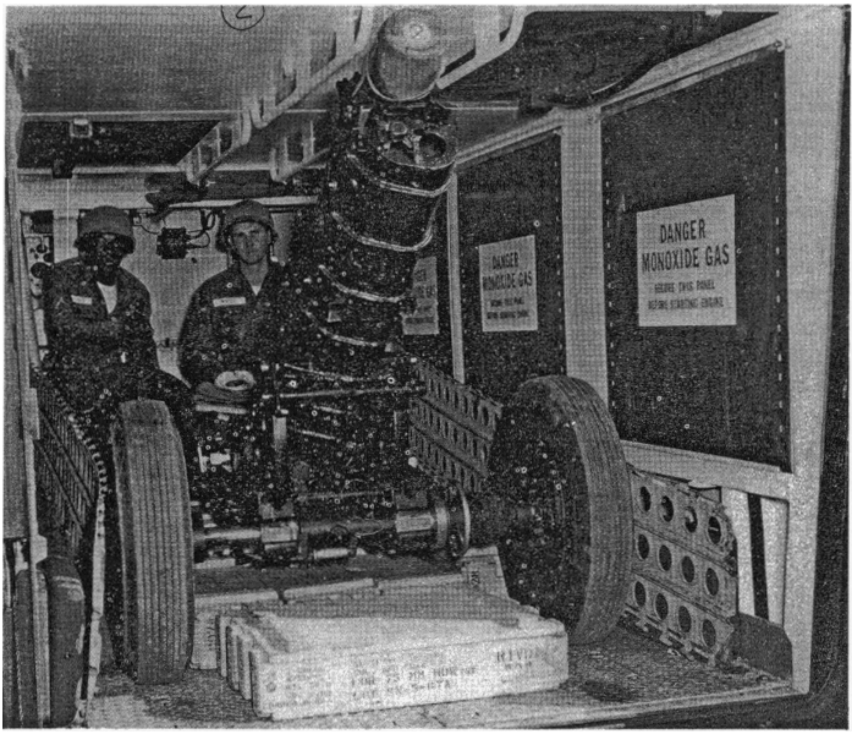


Figure 36. The interior of the M59 armored personnel carrier, containing the 75-mm howitzer.

Two pieces of material, heavy enough to support the weight of the howitzer, are placed across the ramp into the rear of the troop compartment to insure a smooth path from the ground to the compartment and facilitate loading.

HOWITZER MOVED TRAILS FIRST INTO APC

The howitzer, in the firing position, is man-handled trails first into the armored personnel carrier (fig 37) until the trails are flush against the step to the rear of the commander's platform. The tube is then elevated to approximately 976 mils and is cushioned with a piece of hard rubber or three pieces of soft wood. The elevation hand cranks are locked in place, and the sandbags are placed around the wheels to prevent lateral shifting. The ramp is raised and secured. Crew members mount over the ramp, or if the ramp has been closed, through the top hatches.

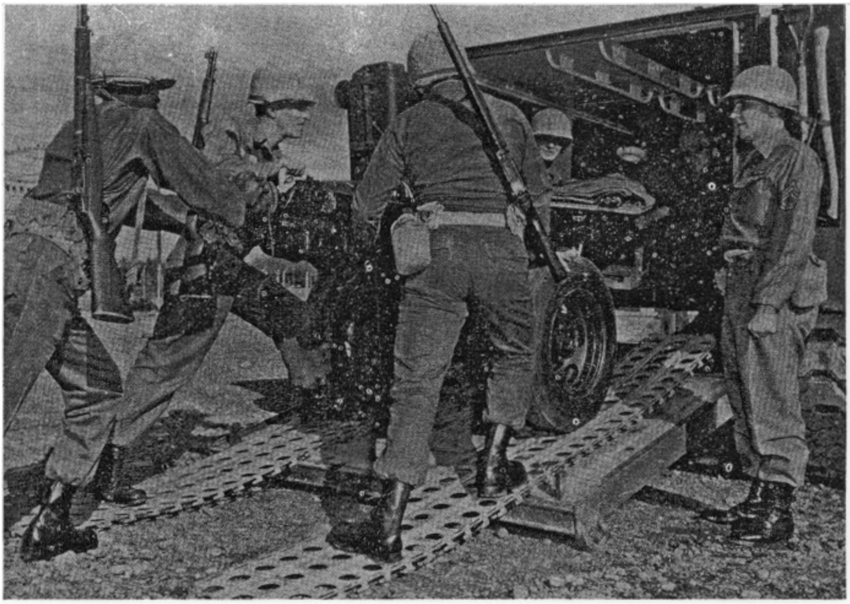


Figure 37. The 75-mm howitzer is loaded trails first into the M59 armored personnel carrier.

Figure 38. The howitzer crew is prepared for action 2 1/2 minutes after arrival in position.

The M59 APC is capable of following any convoy of track vehicles. Recent tests in marches up to 80 miles at speeds of 25 miles per hour have caused no damage to the tube or associated equipment.

To occupy a position, the APC approaches the position opposite the direction of fire and crew members lower the ramp, roll out the howitzer, and immediately start laying the howitzer and preparing for action. The howitzer can be prepared for action in 2 1/2 minutes after arrival into position (fig 38).

This employment shows the versatility of men and materiel, and demonstrates the Artillery's ability to adapt—to go anywhere, any way, to perform its mission.

(Continued from Page 50)

V-D Nomo scale and the acetate at HOB's equal to 525M, 1225M, and 1925M. Connect these points with the "0" tick mark on the lower e_{ph} scale, using a fine line. Label the upper line (1925M) *UPPER;* the lower line (525M) *LOWER*. Finally, add the row entry table on the left margin (0-100 = A, 100-200 = B, etc.). Then label the acetate below the UPPER e_{ph} line, and centered, as follows:

HEIGHT OF BURST CALCULATOR
FOR USE WITH
VERTICAL DISPERSION NOMO.

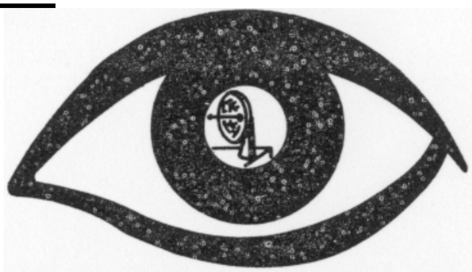
EMPLOYMENT

(1) Place e_{ph} line over HOB fallout safe on HOB scale of V-D Nomo.
(2) Slide HOB calculator to the left, keeping e_{ph} line on HOB fallout safe until appropriate value on e_{ph} scale is over HOB scale.
(3) Read HOB_{Min} under HOB line, on HOB scale.
(4) Under *UPPER* line read row entry for casualties and/or damage. Under *LOWER* line read row entry for troop safety and/or contingent requirements.
(5) With row entries obtained in (4) above, go to associated tables and read data under appropriate column.

This calculator should prove to be a boon as a graphical tool to expedite the use of the V-D Nomo scale. It should be remembered, however, that this calculator is to be used with classified material (FM 101-31 (SRD)) and should be handled carefully.

"There is something very encouraging and comforting to the infantry, when at . . . critical moments they hear their own guns thundering close at hand . . . "

Prince Kraft
"Field Artillery with Other Arms"



OPTICIAN OF ARTILLERY

Captain Garrett B. Farrell, Jr.
Target Acquisition Department

You need radar! Without it, you're blind. With it you are a constant threat, as dangerous as a tiger on the prowl at night, seeing all but never seen, heedless of darkness or weather conditions. You *have* radar. But how dangerous is the jungle cat without eyes? He becomes a starving kitten, prey to all. Don't allow yourself to become a blind cat. Maintain your radar. This last statement is easily made, but not so easily carried out. It must be done with properly supervised school-trained personnel. Radar maintenance specialists are necessary to maintain radar equipment, which consists of some of the most complicated component parts issued in today's artillery.

The following simplified checklist exemplifies the complexity of operation and maintenance of radar equipment. This suggested checklist can serve as a guide to both the commander and the mechanic. It itemizes the requirements of the mechanic. He must have technical knowledge of:

✓ *Emplacement*—how to select a site, emplace, level, collimate, orient, energize, and march order the radar.

✓ *Power Source*—the energization, adjustment, operation, and deenergization of the authorized power sources.

✓ *Operation*—the function of all controls used by operating personnel

✓ *Schematic and Wiring Diagrams*—the mechanical and electrical symbols used to represent components of the radar and signal or data flow through block diagram and circuit levels; location of components represented by these symbols.

✓ *Systems Performance*—the characteristics, instrumentation, and operational system checks which indicate proper functioning of the radar.

✓ *Test Equipment*—the proper use (adjusting, cabling, and employing) of the items of radar test equipment.

✓ *System Adjustment*—the field adjustments within a limited amount of time on all systems of the radar in keeping with his echelon.

✓ *Repair*—the symptom or symptoms indicative of a malfunction; clearance of trouble from the system or systems, provided that such clearance can be accomplished by manipulations of controls and/or adjustments and/or by replacement of components within a reasonable amount of time.

✓ *Unit Replacement*—the testing and replacement of electron tubes, crystals, fuses, cables, and other "plug-in" items, and of "nonplug-in" items, components, assemblies, and subassemblies.

✓ *Administrative Procedures*—the organization and use of the appropriate spare parts catalogs, and the procedures for the procurement and maintenance of authorized spare and replacement parts in accordance with the organization stockage list.

✓ *Preventive Maintenance* (*PM*)—the technical aspects of the daily, weekly, and monthly preventive maintenance checks required; and supervision of operator personnel in performance of nontechnical PM checks (DA Form 11-238).

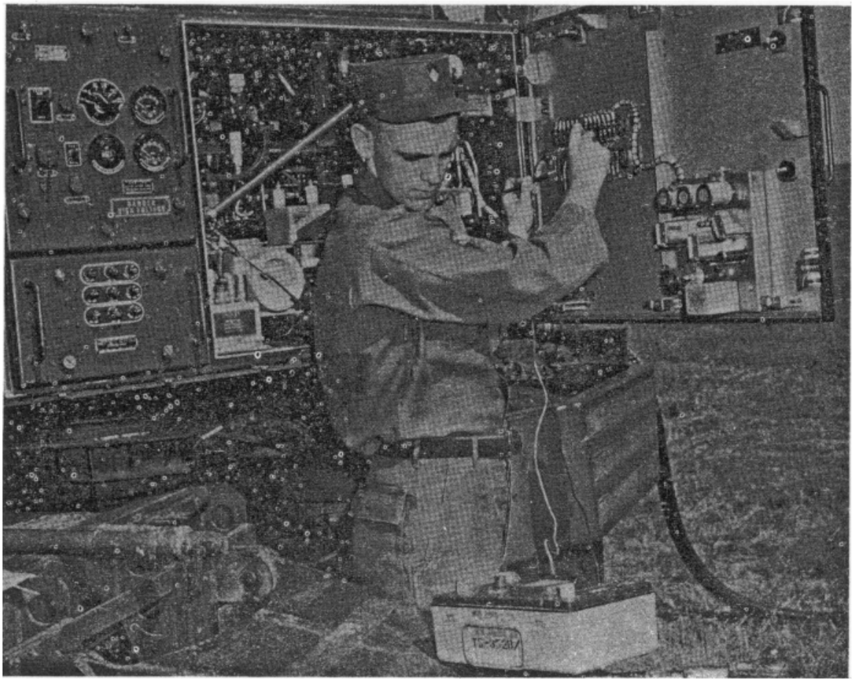


Figure 39. The radar mechanic is the "doctor" of radar.

There is one more ✓ perhaps the biggest, to add to this list. Can your mechanic take this huge responsibility into his own hands? A radar mechanic, like a doctor, must be highly qualified; he must have an understanding of an extremely complex system (fig 39). Be sure you have a proficient mechanic and that your equipment is under his expert *care* at all times. Your "eyes" depend upon him.

CURRENT RESIDENT COURSE SCHEDULE

Listed below are the courses to be given at The US Army Artillery and Missile School during the period 1 Oct 1961 through 31 Dec 1961.

Course	Cl Nr	Report			Start			Close			Input
Arty Officer Basic (6-A-C1C/44-A-C1C)	2-62	26	Nov	61	29	Nov	61	27	Apr	62	146
Field Artillery Officer Orientation (6-A-C20)	6-62	2	Oct	61	6	Oct	61	29	Nov	61	90
	7-62	16	Oct	61	20	Oct	61	13	Dec	61	90
	8-62	13	Nov	61	17	Nov	61	24	Jan	62	90
	9-62	27	Nov	61	1	Dec	61	7	Feb	62	90
Field Artillery Officer Familiarization (6-A-C21)	3-62	22	Oct	61	23	Oct	61	12	Dec	61	63
Arty Officer Career (6-A-C22)	2-62	1	Oct	61	4	Oct	61	12	Jul	62	198
Associate Field Arty Officer Career (6-A-C23)	2-62	9	Oct	61	12	Oct	61	2	Mar	62	104
Division Arty Staff Officer Refresher (6-A-F5)	1-62	1	Oct	61	2	Oct	61	7	Oct	61	60
Corporal Officer (6-A-1190A)	2-62	10	Oct	61	12	Oct	61	15	Dec	61	13
LaCrosse Officer (6-A-1187)	2-62	9	Nov	61	10	Nov	61	16	Dec	61	15
Arty Motor Transport (6-B-0600/0606)	1-62	18	Oct	61	20	Oct	61	15	Dec	61	44
Field Artillery Officer Candidate (6-N-F1)	2-62	9	Oct	61	16	Oct	61	3	Apr	62	53
	3-62	4	Dec	61	11	Dec	61	29	May	62	53
Nuclear Projectile Assembly (6-D-142.0)	2-62	15	Oct	61	16	Oct	61	21	Oct	61	25
	2A-62	12	Nov	61	13	Nov	61	17	Nov	61	14
Rocket Nuclear Warhead Assembly (6-D-147.2)	6-62	22	Oct	61	23	Oct	61	30	Oct	61	19
	7-62	26	Nov	61	27	Nov	61	4	Dec	61	19
Weather Equipment Maint (6-N-8219/205.1)	3-62	8	Oct	61	10	Oct	61	26	Jan	62	16
	4-62	3	Dec	61	5	Dec	61	23	Mar	62	16
Corporal Fire Control System Maint (6-N-1186/215.1)	1-62	2	Nov	61	6	Nov	61	29	Jun	62	15
Redstone Electronic Materiel Maintenance (6-N-1192B/218.1)	2-62	5	Oct	61	9	Oct	61	12	Mar	62	13
Corporal Nuclear Warhead Assembly (6-D-F13)	2-62	23	Oct	61	24	Oct	61	2	Nov	61	12
Artillery Survey Advanced (6-R-153.1)	3-62	4	Oct	61	9	Oct	61	30	Nov	61	66
	4-62	18	Oct	61	23	Oct	61	14	Dec	61	66
Field Artillery Radar Operation (6-R-156.1)	3-62	3	Oct	61	5	Oct	61	13	Dec	61	34
	4-62	8	Nov	61	10	Nov	61	1	Feb	62	34
Cpl Mechanical Materiel Maintenance (6-R-164.3)	1-62	18	Oct	61	19	Oct	61	14	Dec	61	14
Artillery Radio Maintenance (6-R-313.1)	7-62	8	Oct	61	10	Oct	61	29	Jan	62	40
	8-62	22	Oct	61	24	Oct	61	12	Feb	62	40
	9-62	5	Nov	61	7	Nov	61	27	Feb	62	40
	10-62	19	Nov	61	21	Nov	61	13	Mar	62	40
	11-62	3	Dec	61	5	Dec	61	26	Mar	62	40
Artillery Communication Supervisors (6-R-313.6)	1-62	15	Oct	61	17	Oct	61	9	Feb	62	30
Artillery Vehicle Maintenance Supervisors (6-R-631.7/632.7)	1-62	11	Oct	61	13	Oct	61	1	Dec	61	25
Artillery Track Vehicle Maintenance (6-R-632.1)	7-62	29	Oct	61	31	Oct	61	25	Jan	62	35
	8-62	12	Nov	61	14	Nov	61	8	Feb	62	34
	9-62	26	Nov	61	28	Nov	61	21	Feb	62	34
	10-62	10	Dec	61	12	Dec	61	8	Mar	62	34

14.5-mm TRAINER IMPROVEMENT

Because most units, particularly overseas, are limited in area and ammunition for service practices, realistic simulations to include all elements of fire control are a requirement. ARTILLERY TRENDS (July 60) announced and described a new 14.5-mm trainer which reduced the service practice area by a ratio of 1:10. The trainer simulates service practice realistically for the forward observer and the fire direction center. (FDC). A new development enhances the training of the howitzer section. The trainer was mounted on a 155-mm SP howitzer, M44. This was done by modifying a salvage RL-31 to accept the barrel-breech-trunnion group and mount on the rammer-buffer-filler plug cover of the howitzer. With this modification, the trainer can be fired coaxially with the howitzer tube using the on-carriage fire control equipment, thereby providing training for all the members of the howitzer section.

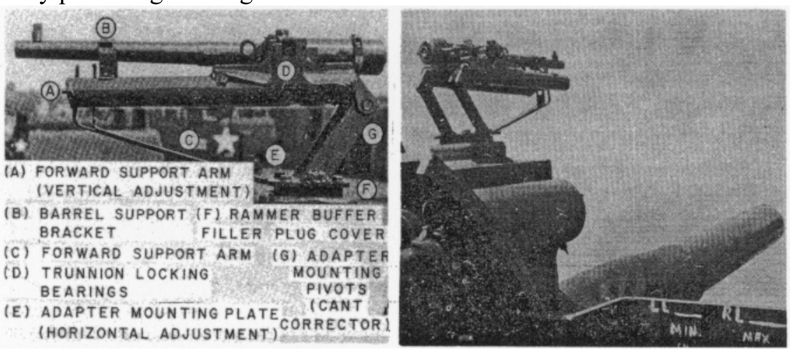


Figure 40. The 14.5-mm trainer mounted on 155-mm SP howitzer, M44.

The adapter mounting plate was constructed with elongated holes to permit boresight in the horizontal plane; the forward support arm is slotted at the junction with the bracket cross-member to permit boresight in the vertical plane; the pivots at the rear of the trunnion locking bearing brackets are slotted to permit corrections for cant.

The trainer may be easily removed from the adapter by loosening a screw at the barrel support bracket and unlocking the trunnion bearings.

No modification of the howitzer or the trainer is necessary, although the brass elevating are was removed from the trainer to prevent damage.

To add more realism to FDC training, a ballistic scale for the GFT fan can be constructed from information contained in the 14.5-mm trainer firing table.

"No matter how highly trained the infantry and other branches may be, there is no action until the artillery is ready."

Brigadier General William J. Snow
"A Message to the Field Artillery"

NEWS NOTES FOR ARTILLERYMEN

NEW ANTITANK WEAPON

The purchase of the French ENTAC guided missile by the Army as a substitute for the current SS-10 is expected soon. ENTAC weighs only 37 pounds with launcher, which makes it suitable as an infantry weapon for defeating armor.

It is guided to a target by the operator with a stick system which transmits corrections to a cluster of fine wires streaming out from behind the missile. The warhead uses a shaped charge and is powered by a solid-propellant rocket motor. It is designed throughout for maximum effectiveness against tanks.

NEW, LIGHT HELICOPTER

The Army is considering a new helicopter based on the winning designs of the recent light observation helicopter design competition. Some of the features of the two winning designs which will be incorporated into the helicopter are its light weight, single-rotor, 4-place cockpit, turbine engine, and 400-pound payload. A speed of 110 knots is capable—as fast as the L-19 airplane and faster than the H-13 and H-23 helicopters.

The winning designs in the competition were submitted by the Bell Helicopter Company and the Hiller Aircraft Corporation.

MOBILE COMMUNICATIONS UNITS

The Army Signal Corps was recently delivered three new radio communication systems, designed for mobility and transportability by current aircraft. The systems, capable of ranges of 2,500, 5,000, and 7,000 miles respectively, can be set up and made operative in isolated areas in four hours or less. This is a significant advance over the fixed stations previously necessary to accomplish this job, which required months to install.

Both voice and teletype messages are possible worldwide, and can communicate directly with the Pentagon. The systems are particularly valuable to the Strategic Army Corps for these reasons.

The following table lists the three systems, and their characteristics:

Designation	Range	Simultaneous Transmission Capabilities	Transportability
1. AN/TSC-18	7,000 miles	3 telephones 16 teletype channels	3 C-124 airplanes
2. AN/TSC-19	5,000 miles	3 telephones 16 teletype channels	2 C-124 airplanes
3. AN/TSC-20	2,500 miles	1 telephone 4 teletype channels	1 C-124 airplane

NEW, MOBILE GROUND UNIT

The Hazeltine Corporation has developed the first mobile radar capable of travel over ground and water. The new radar is a modification of the current AN/TPS-25 radar. It will be capable of detecting and distinguishing moving targets at 20,000 yards.

Present plans call for the radar to be installed in the M-257 armored personnel carrier, which can achieve speeds of 40 miles per hour on land, and 4 mph in water.

The radar is provided with a telescoping antenna mast which affords "quick-look" capability and long-range surveillance of moving targets. It has all-weather capability in accomplishing its purpose of detecting ground movement in combat areas.

175-mm SP COMPLETES TESTING

Artillery's new 175-mm SP gun, M107 (formerly T235) ARTILLERY TRENDS, June, 1958-February, 1960) recently completed service testing at the Army Artillery Board, Fort Sill.

A prototype weapon weighing 30 tons and measuring 35 feet long was fired, and the Board reports that the 148-pound HE projectile attained ranges greater than the 280-mm gun.

A unique feature of the gun carriage is its standard mounting for the 175-mm, 8-in., and 155-mm gun tubes, any one of which can be installed on the carriage in about 30 minutes. The 8-in howitzer has been designated M110 (formerly T236).

EXTENSION COURSE CONFERENCE

Fort Sill played host to the recent USCONARC Army Extension Course Conference. Seventy representatives from Headquarters, Department of the Army, Headquarters, US Continental Army Command, the continental US Armies, and 23 service schools participated in the conference. Army-wide standardization and modernization were the goals discussed during the conference.

The conference ended with a number of recommendations being turned over to committees for further study. It was generally felt that these recommendations were gratifying and worthwhile results, and provided a strong basis from which to attain the conference goals.

MOHAWK PASSES RIGOROUS TESTS

Grumman Aircraft's Mohawk (ARTILLERY TRENDS, November, 1960) has recently survived its most stringent test—1,000 hours, or the equivalent of 3 years of actual duty performance. The twin-turbo-prop plane was put through the paces it will be asked to perform daily in line of duty, including high speed (the Mohawk is capable of speeds of 230 mph), and actual observation missions using its modern aerial surveillance observation camera equipment.

STATUS OF TRAINING LITERATURE

1. The following training literature is under preparation or revision by the US Army Artillery and Missile School:

A. FIELD MANUALS (FM):

6-10	Field Artillery Communications
6-15	Artillery Meteorology
6-20-1	Field Artillery Tactics
6-20-2	Field Artillery Techniques
6-40	Change 1, Field Artillery Gunnery
6-58	Change 1, FA Rocket, Honest John, with Launcher XM33
6-59	Change 1, FA Rocket, Honest John, with Launcher M386
6-60	Change 1, FA Rocket, Honest John, with Launcher M289
6-61	Change 2, FA Missile Battalion, Honest John Rocket
6-121	Field Artillery Target Acquisition
6-140	The Field Artillery Battery
6-( )	Field Artillery Graphical Firing Equipment
6-( )	Operation and Maintenance of Field Artillery Data Automatic Computer (FADAC)
6-( )	Radar Set, AN/TPS-25
6-( )	115-mm Multiple Rocket Launcher M91, and Toxic Rocket M55
6-( )	FA Missile Battalion, Sergeant
6-( )	FA Missile Battery, Sergeant

B. TECHNICAL MANUALS (TM):

None

C. ARMY TRAINING PROGRAMS (ATP):

6-100	Field Artillery Unit
6-302	FA Rocket Units (Honest John, Little John)
6-545	Field Artillery Missile Battalion, Corporal
6-555	FA Missile Battalion, Sergeant
6-558	Searchlight Batteries
6-575	FA Target Acquisition Battalion
6-585	FA Missile Battalion, Lacrosse
6-630	FA Missile Battalion, Redstone

2. Training literature submitted to USCONARC:

ATP ( )	Training Program for non-unit obligors
FM 6-120	FA Target Acquisition Battalion and Batteries
ATT 6-( )	Field Artillery Missile Battalion (Battery), Little John Rocket

3. Training literature at the Government Printing Office:

FM 6-2	Artillery Survey
FM 6-45A	FA Missile Battalion, Lacrosse, Gunnery

FM 6-56	FA Missile Battalion (Battery), Little John Rocket
FM 21-13	The Soldiers Guide
TM 6-300-62	Army Ephemeris for 1962
TM 6-( )	Logarithmic and Mathematical Tables

4. Training literature recently printed:

FM 6-16	Tables for Artillery Meteorology
FM 6-57	The FA Rocket, Little John, w/Launcher XM34
FM 6-81	155-mm Howitzer, M1, Towed
FM 6-90	8-inch Howitzer, M2, Towed
FM 6-161	Radar Set, AN/MPQ-4

5. Artillery training films currently under production and scheduled for release during calendar year 1961:

Laying the Field Artillery Battery
Ground Surveillance Radar, AN/TPS-25
Part I. Theory, installation and operation
Part II. Moving target detection
The 762-mm Rocket
Part I. Introduction to the system
Part II. Mechanical assembly and electrical checkout
Part III. Loading, preparation for action, firing, and march order
Countermortar Radar AN/MPQ-4A
Part II. Preparation and performance checks

6. Artillery training films currently under production and scheduled for release during calendar year 1962:

318-mm Rocket
Part I. Introduction to the system
Part II. Description of equipment
Part III. Loading, preparation for action, firing, and march order
Field Artillery, RSOP
Part I. Deliberate
Part II. Rapid

7. Artillery training films production completed and scheduled for release in calendar year 1961:

Lacrosse Battalion Assembly Section—Crew duties in prepare for action, checkout and assembly, and march order (25 minutes)
Lacrosse Battalion—Firing Section—Crew duties in prepare for action, firing, and march order.
Lacrosse Battalion—RSOP

8. Artillery training films scheduled for production and release during calendar year 1962:

Field Artillery Sound Ranging
Field Artillery Target Acquisition Battalion

The Infantry Division Artillery Forward Observer

9. Artillery training films recently released:

Countermortar Radar, AN/MPQ-4A

Part I. Operation (TF 6-3096) (25 minutes)

10. Status of Army Subject Schedules (MOS):

A. UNDER PREPARATION OR REVISION BY THE US ARMY ARTILLERY AND MISSILE SCHOOL:

ASubjScd 6-104	MOS Technical Training of the Field Illumination Crewman
ASubjScd 6-156	MOS Technical Training of the Radar Crewman
ASubjScd 6-166	MOS Technical Training of the FA Missile Crewman (Lacrosse)
ASubjScd 6-167	MOS Technical Training of the FA Missile Fire Control Crewman (Lacrosse)

B. SUBMITTED TO USCONARC:

ASubjScd 6-154	MOS Technical Training of the FA Flash Ranging Crewman
ASubjScd 6-155	MOS Technical Training of the Sound Ranging Crewman
ASubjScd 6-164	MOS Technical Training of the FA Missile Crewman (Corporal)
ASubjScd 6-168	MOS Technical Training of the FA Missile Crewman (Redstone)

C. AT GOVERNMENT PRINTING OFFICE:

ASubjScd 6-103	MOS Technical Training of the Ballistic Meteorology Crewman

C. RECENTLY PUBLISHED:

ASubjScd 6-142	MOS Technical Training of the Heavy and Very Heavy FA Crewman
ASubjScd 6-147	MOS Technical Training of the FA Rocket Crewman
ASubjScd 6-152	MOS Technical Training of the FA Operations and Intelligence Assistant
ASubjScd 6-153	MOS Technical Training of the Artillery Surveyor
ASubjScd 6-165	MOS Technical Training of the FA Missile Fire Control Crewman (Corporal)

11. Status of Army Subject Schedules (Non-MOS):

A. UNDER PREPARATION OR REVISION BY THE US ARMY ARTILLERY AND MISSILE SCHOOL:

ASubjScd 6-8	Counterbattery Operations
ASubjScd 6-9	Countermortar Operations
ASubjScd 6-10	Field Artillery Radar Operations
ASubjScd 6-11	Defense of Artillery Position Areas
ASubjScd 6-17	Liaison

B. SUBMITTED TO USCONARC:

ASubjScd 6-3	Cannoneer and Rocketeer Instruction
ASubjScd 6-21	Operation of Meteorological Section

C. RECENTLY PUBLISHED:

ASubjScd 6-6	Communication Exercise for Artillery Units

ARTILLERY INFORMATION LETTERS

The following artillery information letters containing items of technical nature have been published by the US Army Artillery and Missile School since the JUNE 1961 issue of ARTILLERY TRENDS. Distribution is made *only* to the units and their controlling headquarters which are authorized the equipment discussed in these letters:

HONEST JOHN INFORMATION LETTER NUMBER 26
dated 26 June 1961

HONEST JOHN INFORMATION LETTER NUMBER 27
dated 21 July 1961

LACROSSE INFORMATION LETTER NUMBER 14
dated 24 May 1961 (C)

LACROSSE INFORMATION LETTER NUMBER 15
dated 12 June 1961 (C)

METRO INFORMATION LETTER NUMBER 8
dated 16 May 1961

Reflections . . . .

Lest we get discouraged or complacent, let us occasionally stop and look back over our shoulder and see how far we have come . . . .

ARTILLERY IN WORLD WAR I . . .

Speculation on the new German long-range artillery, which was capable of dropping shells on targets 75 miles from the gun, ran rampant. One theory held that a secondary shell was ejected from a primary shell to continue on the unprecedented length of trajectory . . . One of the gravest internal problems that artillerymen had to face was artillery's motorization problem—were the tractor and truck in an adequate stage of development to replace the horse? . . . Farsighted artillerymen were predicting and even designing self-propelled weapons—cannon (3.3 to 4.7 calibre) mounted on caterpillar wheels and tracks, weighing 10,000 pounds, with a cross-country speed of 16 mph . . . A discussion grew up as to whether or not artillery's open warfare principles of tactics were outmoded in view of the new, different, "unconventional" warfare—trench warfare . . . Observation ladders were discovered to be dangerous "shell traps" and observers began digging in to depths of seven feet, peeping out with the aid of two-foot periscopes . . . "Aeroplanes," which could fly at speeds of 45 to 75 miles per hour were fast becoming the field commander's greatest means of strategic observation, and authorities believed that before long, artillery regiments would be furnished with airplanes permanently.

L 1136 ARMY-FT. SILL, OKLA.