A Military Encyclopedia
Based on Operations in the Italian Campaigns, 1943-1945.

[p. 195]

Chapter Five
ARTILLERY

Section 1. Adjustment of Artillery Fire by High Performance Aircraft (Arty/R)

The Spitfire and P-51 Mustang, of Reconnaissance Squadrons, were used quite successfully for observation in adjusting artillery fire, primarily fire of long-range artillery. They were used to supplement, and not to replace, organic Field Artillery air observation. The principal advantage of the high performance plane is its greater security against enemy fighters and anti-aircraft artillery. This advantage permits its use in adjusting artillery fire on targets deep in enemy territory and/or in areas protected by anti-aircraft artillery, which the organic artillery plane cannot observe with a reasonable degree of security. However, the Arty/R plane has several obvious disadvantages, such as its fast cruising speed and the necessity for the pilot to act also as observer. It should be employed only on those missions which cannot be successfully accomplished by the organic artillery plane.

The employment of Arty/R aircraft varied with the tactical situation. Its use in support of the attack during the Rapido crossing and at Cassino was quite different from its employment under static conditions. At Cassino a form of continuous patrol and area search was used. On the front south of Bologna, Arty/R was used only on special, prearranged missions against known targets, mostly hostile batteries.

To reduce the danger of surprise by enemy fighters, missions were flown by two planes, one to adjust artillery fire (observer) and the other to observe for hostile aircraft (weaver). The weaver is also responsible for warning the observer of enemy anti-aircraft batteries and friendly aircraft. In spite of our air superiority, the weaver was still considered essential on all missions. Both pilots were briefed as to the missions, furnished maps and photos, and instructed that if the observer failed to obtain radio contact with the artillery battalion, and the weaver did obtain contact, then the weaver would take over the mission.

[p. 196]

Pilots were briefed from 1:50,000 maps and photographs which they carried with them during the mission. Normally, the photographs used were the basic cover photographs taken daily, weather permitting. The target or target area, target code taken from the Hostile Battery List, map reference of target, and gun-target line were marked on the photograph in china graph or ink. In addition to the above information, special annotations were used to assist the pilots in locating targets and adjusting artillery fire. One method was to mark the photo with range and deflection lines at 100 yard intervals. The range lines wer placed over and short of the target and perpendicular to the line of fire. The deflection lines were marked to the right and

left of the target, parallel to the line of fire. Another system was to place concentric circles, at equal and known intervals, around the target.

The SCR 522 was used for communication between the Corp Artillery FDC, appropriate artillery battalions, and the Artillery/R planes.

Everything possible should be done to facilitate observation of the burst (which is more difficult from a high performance plane) and to complete the mission in the shortest possible time. Some of the measures taken to accomplish this were:

a. Use of single rounds of smoke, or HE battery volleys, by caliber smaller that the 8-inch, during the adjustment on a target.

b. Use of battery volleys, with a converged sheaf during fire for effect on precision fires for destruction. Range and deflection differences were corrected during the adjustment by firing salvos.

c. Correction of range and deflection differences of the individual pieces prior to opening fire.

d. Use on the most precise initial firing data, including metro [meteorological] corrections computed for the individual targets rather than the check points.

[p. 197]

Accurate initial data not only speeds up the adjustment but also facilitiates marking the target for the observer, which is often necessary.

e. Use of only one weight of projectile and one lot number of powder charge on the same mission.

f. Having the battalion FDC give the observer a warning "stand by", five seconds before and "splash" at the instant the round lands.

g. Firing all rounds on command of observer.

The operations of Arty/R aircraft during the Rapido crossing and Cassino were an outstanding success. The following is an account of the organization and employment of those aircraft during the first four days of the battle, before the breakthrough. When the battle became fluid, the normal methods of requesting sorties were reverted to.

A Reconnaissance Squadron was assigned to each corps and each worked directly with the corps counter-battery officer. Although there were some differences, the procedure was generally the same for all corps.

The main enemy gun areas were grouped into sectors and each sector was given a reference letter. These sectors were made to coincide with the fighter-bombing areas, so that it was possible, through ROVER JOE, to bomb them quickly if necessary. Each hostile battaery in these sectors was given a reference letter, as were some batteries too far afield to be included in any sector. Certain reference points were also chosen. All this information was marked on 1:50,000 maps and photographs, and a copy of each given to each pilot, including the weaver pilot.

Some squadrons maintained continuous Artillery/R cover from about 0800 to 1900 hours, daily. Others sent up sorties at prearranged times.

The pilot, on getting over the target area, first of all spotted and adjusted fire on any active hostile battery. If there were several batteries active in one sector, he call for fire on all known hostile batteries in that sector. If no hostile batteries were firing, he would search the whole squadron area, with particular attention to known hostile batteries, and would take those located under fire.

[p. 198]

Pilots sent down all inforamtion immediately, whether of interest to the artillery only or of general interest. The counter-battery officer passed this information on to ROVER JOE and to Corps Headquarters. This dissemination of general information by Artillery/R sorties was most important and was the main reason why the whole squadron could be used on Artillery/R. When the pilot landed, he was interrogated and a complete Tac/R report was sent to Army Headquarters.

One squadron was able to send up a larger number of sorties than the others because its weavers were provided by a fighter squadron.

One squadron had the added commitment of adjusting naval gun fire. A separate radio frequency was alloted for this purpose. The only change from normal procedeure was that prior to the shoot, a puff of black smoke was emitted to indicate the ship which was to fire the mission.

Section 2. Centralized Control of Artillery Air OPs

AOPs should normally be centralized under division artillery or group control; however, they should remain organically a part of the battalion to facilitate decentralization when battalions are sent on independent missions. Battalions should be permitted to call upon their planes when desired.

The group or division artillery air OP officer should be respomsible for the administration and operation of the Artillery AOP. This procedure has the following advantages:

a. Fewer landing fields are required.

b. Exchange of information between pilots and observers of different battalions is facilitated. Such information as the location of targets and the location and presence of enemy fighter aircraft and anti-aircraft units should be disseminated without delay.

[p. 199]

c. Pilots and observers become familiar with more enemy territory and installations, are more familiar with the enemy and friendly situation in general, and can more readily maintain uniform methods and procedures. Thus, they can work with one battalion as easily as with another.

d. A continuous patrol of the enemy area can be maintained. This is highly desirable at all times to permit detection and fire upon any enemy movement, active hostile battery, and any other activity. This is particularly desirable during a fast moving situation, because it is essential to maintaining contact with the enemy and to preventing his withdrawal by bringing fire on every movement.

e. The group or division artillery air OP officer can be of more assistance to the battalions.

Section 3. Night Observation with Artillery Air OPs

Air observation at night was desirable, but could be obtained only on bright moonlight nights, when there was sufficient light to permit identification of terrain features. On call from the pilot, the air strips should be illuminated with floodlights or improvised equipment. A vertical light beam to guide the pilot in was often desirable.

Experimental flights by Fifth Army Air OP Officer indicated that the artificial moonlight produced by the searchlights near the front was not sufficient to permit adjustment of artillery from the air for two principal reasons:

a. The reflected moonlight falling into the eyes of the pilot and observer more than counteracted the illumination of the ground.

b. The lights were so far in the rear of the front that the enemy territory was not illuminated sufficiently and to a great enough depth to permit identification of target and adjustment of artillery fire.

[p. 200]

To place the lights farther forward would benefit the enemy as much as our own troops.

Section 4. Reconnaissance with Artillery Planes

The liaison plane is one of the big developments of the present war. Its use for tactical reconnaissance to a greater degree is justified and should be adopted. Though its use, Corps, division, and lower unit commanders can be kept immediately informed of enemy movements that might endanger them.

Artillery liaison planes have been used for reconnaissance by commanders of all echelons down to the company. They were acclaimed by all as a superior reconnaissance agency. Their successful use for this purpose has included:

a. Locating targets.
b. Selecting position areas, bivouac areas, assembly points, and lines of departure.
c. Reconnoitering objectives, approaches thereto, and locating enemy strongpoints.
d. Reconnoitering routes.
e. Guiding armor units across country.
f. Preventing tank and tank destroyer units from running into traps.
g. Locating demolitions.
h. Following enemy movements in pursuit.
i. Locating front line units in rapidly moving situations.
j. Communication in emergencies.

Preparatory to several of the close-in bombardment missions by medium and heavy bombers, bomber flight leaders and navigators were given thorough orientation flights by artillery pilots in the vicinity of the objective. Artillery aircraft were used to avoid arousing the suspicion of the enemy of the coming bombardment. Because of their slow speed, the artillery planes permitted the airmen to study the terrain in greater detail.

[p. 201]
Also, the Germans were more reluctant about firing on an artillery plane than on a lone bomber.

On one occasion a battalion commander actually commanded and directed a two company raid from his seat in an artillery plane. He had radio communication direct to his ground commander and also with the regimental commander.

The very presence of the AOP in the air neutralized, to a great extent, enemy mortar and artillery fire.

Artillery liaison planes are used to accomplish many of the above missions because liaison planes of the Army Air Force were not available. The organic field artillery Air OP planes are required for and should be employed only on artillery missions, if possible. Their use for other missions would be obviated by the assignment to division and corps headquarters of organic liaison planes.

Section 5. Position of Air OP for Observation

The primary mission of the Artillery Air OP was to locate targets and to adjust artillery fire thereon. To accomplish this mission the air observer continually concentrated on obtaining the best observation possible and at the same time maintained a reasonable degree of safety. The best position from which to accomplish this mission depended on many factors and it varied, horizontally, from a position above or to the flank of the friendly battery, to one in front of our front lines, and vertically, from 600 to 11,000 feet.

The best observation could be obtained when flying at a low altitude above the target; however, the AOP should fly beyond the range of enemy small arms.

To adjust fire on targets deep in enemy territory or well defiladed, it was frequently necessary for the AOP to fly several miles beyond our front lines.

The best security from enemy fighters was obtained when flying at a low altitude. Several artillery planes shot down in rear areas were hit by German fighters who came from behind and below.
[p. 202]
Our pilot should not give the enemy fighter a chance to get under him. His safety depends on maneuverability and the speed with which he can dive for the ground and fly contour or effect a landing. Furthermore, our planes were difficult to see from above, but stood out conspicuously when silhouetted against the sky. Two planes from one division artillery came back with holes through their wings and lift struts. The Germans used a new trick. Two fighters came in from above. The Cubs dived and found two other planes waiting for them below. All four fighters joined in chasing the Cubs most of the way to their home field.

Section 6. Artillery Air OP Landing Fields

Due to the mountainous terrain and bad weather in Italy, it was frequently desirable and necessary to call upon the Engineers for assistance in constructing or improving landing fields. Fields should be prepared as well as possible to prevent accidents, to eliminate wear and tear of planes, and to facilitate air observation to the maximum extent even under adverse weather conditions. Due to our superiority in the air, the importance of a well constructed landing field was usually given priority over camouflage.

Matting for runways was used to good advantage. Pierced steel planks made the best runways. Sommerfeld and Coir matting, or a combination of the two were also used.

Floodlights to illuminate the field and a vertical beam to guide the pilots were used successfully. With this field lighting equipment, planes can take off earlier in the morning and return later in the evening. With air observation at dawn and dusk, enemy artillery activity, which is usually most prevalent at these times, is greatly decreased. Field lighting equipment also facilitates night flying which is possible on bright moon-light nights.

In selecting a position for an artillery landing field, the following points should be considered:

a. Other conditions permitting, the landing field should be located near the artillery command post to facilitate exchange of information, communications, and supply.

[p. 203]

b. The field should be located out of enemy light artillery range, not only to prevent casualties and damage to equipment, but also to enable the pilots and observers to obtain the maximum amount of rest.

c. The planes must be out of range of enemy small arms while gaining proper altitude.

The group or division artillery air officer must be constantly familiar with the situation and make reconnaissance well in advance for new fields.

Section 7. Operations Sergeant for Air OP

An operations sergeant can be used to good advantage at the landing field in keeping a situation map, providing pilots and observers with proper maps and photos, checking communications, obtaining and consolidating intelligence information, etc.

Section 8. Artillery Air OP Pilot and Observer

Although it was not common practice, some units developed Pilot-observer teams using regularly assigned observers. The observers were given some flying instruction in order that they might land the plane in case the pilot became a casualty. Parachutes were worn by both pilot and observer when flying combat missions.

Section 9. The L-5 Liaison Plane

Experience in the Italian campaign indicated that the L-5 was normally a better plane than the L-4 for use as an artillery air OP due to the following advantages:

a. Greater weight carrying capacity. The L-5 carried the desired weight of equipment and personnel without having its performance seriously affected.

[p. 204]

b. Greater speed and faster climbing. Time was saved in going from the field to the observation position.

c. Could be flown in wind of greater velocity.

d. Fewer maintenance problems. Many more hours of flying time could be obtained before the engine needed overhauling. 250 hours were obtained with the L-5. 75 hours was about the maximum with the L-4.

e. Greater fuel capacity with increased cruising time.

f. Better instruments. Turn and bank indicator is particularly desirable for night flying.

g. More room for pilot and observer.

h. Observation from front and rear seat was much better.

i. Equipped for night flying.

j. Greater security from hostile fighter aircraft and anti-aircraft guns due to its greater speed and stouter construction which permitted faster dives.

However, because the L-4 can land on muddy terrain and operate from smaller air strip that the L-5, a certain percentage of the artillery liaison planes should be of that or similar type.

Section 10. Air OP and the 4.2" Mortar

Artillery Air OPs have successfully adjusted 4.2" mortar fire. The firing was primarily on a counter-mortar campaign. A SCR 610, with Division Artillery frequency, was placed with each mortar platton for direct communication. In addition to counter-mortar fire, the 4.2" mortars can be adjusted on MGs and other targets that are firing from positions so close to our front line that they lie within the "no fire" zone of the artillery.

Section 11. Air OPs and the Variable Time Fuze

Danger to the Air OPs from the random bursts of the VT fuze necessitated devising a system of clearing the area in which the fuze was to be fired.

[p.205]

In many cases the VT fuze was not used on targets od opportunity, which are the ideal target for this fuze, because of the difficulty and the length of time required to clear the AOPs.

The following system was devised and found to be highly satisfactory. The first time it was tried it took an hour and a half to clear the air. Refinements to this system reduced the time required to less than 5 minutes.

a. A no Cub line is established parallel to the front.

b. Centers of gun areas indicated by codeword (in clear) and grid square in which the target is located, are sent to all pilots so they can get at least 3,000 yards on either side of the trajectory.

c. All missions for VT fuze clear through Corps FDC.

d. A series of Code words were developed to indicate the following:

(1) Request permissions from Corps to shoot VT.

(2) Order from Corps to clear air along trajectory.

(3) Permission granted by Corps arty.

(4) Missions completed to Corps arty.

(5) All clear from Corps Arty to all battalions.

Sentinals are posted in each battery position when using VT fuzes to watch for friendly aircraft flying in or near the trajectory. As friendly aircraft approaches the danger zone, "cease firing" is given. Firing is not resumed until the aircraft has safely cleared the line of fire.

Section 12. Tanks as Artillery

Mountainous terrain greatly handicapped tank warfare in Italy. Tanks, therefore, were repeatedly used in the secondary role, the reinforcing of artillery fires. Their advantages and problems when used in this role were much the same as those of the self-propelled Tank Destroyers.

Section 13. Tank Destroyers as Artillery

In the Italian theater, the Tank Destroyer battalion was used a great deal in its secondary role of reinforcing artillery and of direct support artillery.

[p. 206]

Various methods of attachment for artillery missions were employed successfully. Some of them were as follows:

a. The battalion was attached to a field artillery group or to division artillery and operated its own FDC.

b. The company was attached to an artillery battalion and either operated its own FDC or was fired by the artillery FDC.

The company was usually divided into two six-gun batteries rather than three four-gun batteries because:

a. It was possible to remove a gun for maintenance without disrupting fire.

b. The small caliber of the gun made a greater mass of fire desirable.

c. Best possible use was made of limited personnel, particularly officers.

d. It speeded up and simplified fire direction.

e. It is usually easier to find positions for two six-gun batteries than for three four-gun batteries.

On the self-propelled gun it was found necessary to lower the rear end of the vehicle to get maximum elevation. This was accomplished by:

a. Digging the rear end in lower than the front.

b. Raising the front end by running vehicle on an improvised ramp.

c. Selecting a position on a favorable slope.

Observed fires were habitually conducted by forward observer methods.

The azimuth indicator on the self-propelled TD proved a handicap in the delivery of artillery fires, owing to inherent mechanical defects and the lack of cross leveling devices. Unless the TD was absolutely level, inaccurate fires were delivered.

[p. 207]

Initial laying with an aiming circle was much more difficult because the instruments had to be in the same plane as the gun. Reciprocal laying was virtually impossible.

The proven advantages of using Tank Destroyers as artillery were as follows:

a. Greatly increased artillery fire.

b. Freed heavier artillery of many harassing and interdiction missions.

c. Out-ranged divisional light artillery.

d. Obtained economical use of weapons and manpower otherwise idle.

Section 14. Tank Destroyer Reconnaissance Company

Experience in Italy indicated that the Reconnaissance Company, as such, was of little value to the Tank Destroyer Battalion.

Some of the reasons are as follows:

a. The Reconnaissance Company was frequently detached and used by higher headquarters.

b. It was rarely responsible for giving warning of the approach of enemy tanks. This was given by Air OPs, Artillery OPs or the anti-tank warning net.

c. It presented a difficult administrative problem, because in many cases the company was not employed together.

The Reconnaissance Company was used in the Battalion for:

a. It furnished personnel to man artillery OPs. Gun company personnel, if available, would be better for this purpose.

b. Elements were attached to gun companies to supplement the work of the T/O personnel therein.

[p. 208]

c. Elements were used for area and route reconnaissance but very seldom to select gun positions.

d. It formed a pool of replacement personnel for labor, communications, liaison, and to man captured equipment.

This made it a general reserve rather than a reconnaissance company, and it was of great value as such, and contributed much to the efficiency of the battalion.

Many officers felt that an Air OP Section similar to that of the artillery battalion would be of more value for general and distant reconnaissance than the Reconnaissance Company. Many of the present functions of the Reconnaissance Company could be performed more efficiently by the gun companies if additional personnel were assigned to the gun companies.

Section 15. Towed VS Self-Propelled Tank Destroyer

Experience in Italy indicated that the towed TD gun was less satisfactory and generally inferior to the self-propelled.

The towed gun had the single major advantage of being easier to conceal initially.

Some of its disadvantages were:

a. It could not be effectively manned in the forward combat area. Casualties were excessive.

b. Lack of communication made control and coordination difficult.

c. While reasonably satisfactory as a defensive anti-tank gun, the towed gun, due to its lack of mobility and armor had little value in an attack, in pursuit, in supporting infantry or armor in local engagements, or in many of the other roles tank destroyers were called on to perform.

d. While satisfactory as an artillery piece, it required a larger crew [than] a self propelled gun.

The self-propelled Tank Destroyer's advantages over the towed gun were:
[p. 209]

a. More mobility for continuous support in fast moving situations.

b. Armored protection for gun crew.

c. Radio in each carrier made communication problems simple.

d. It was ready for action on the move or when it pulled into position.

Section 16. Use of Reduced Charge with 3" TD Gun

In order that tank destroyer guns might be employed more efficiently in indirect fire missions supplementing Field Artillery, a reduced charge, low muzzle-velocity HE shell was developed.

This ammunition was used in the Fifth Army very successfully. It better enabled to TD to fire close in missions and proved to be very accurate. The 3" gun being a flat trajectory weapon forced the TDs to occupy positions with very little defilade when serving in the artillery role and using their normal ammunition. The RC shell permitted the occupation of much better positions. The dead space was greatly reduced.

The main disadvantage was that the propelling charge was not great enough to recoil the tube its full length, causing the powder casing to remain in the breech, and requiring that it be extracted manually.

A more complete firing table was required. The table used was fairly accurate, but included data for neither metro corrections, time of flight and drift, nor most of the data required for accurate unobserved fires.

Section 17. Employment of the Tank Destroyer as an Assault Weapon

Tank Destroyers were used repeatedly as assault guns in close support of the Infantry both in rapidly moving situations and during static periods.

[p. 210]

Many TD officers felt that this was their most valuable and effective employment. In this role, they were used for the direct support of infantry patrols and for the neutralizition and destruction of strong points, pill boxes, houses, and anti-tank guns.

Section 18. Use of the 3" Illuminating Shell

During the action on the Anzio Beachhead need was found for an illuminating shell, and orders were placed for the 3" illuminating shell for the tank destroyer guns. Although it arrived too late to be of any assistance in that operation, it was profitably used later.

Some of the uses were:

a. To illuminate objectives for friendly patrols.

b. To illuminate targets for artillery adjustment.

c. To expose enemy activity.

Tests proved that from 1000 to 1200 feet was a better height of burst than the prescribed 1500 feet. The shell was ineffective in a fog, and it did not work satisfactorily for distant illumination (10,000 yards or over from the observer) because the flare blinded the observer.

Conclusions from test firing indicated that the following would be other appropriate uses:

a. Surveillance of "Nite Serenades" (massed artillery fire).

b. Furnishing direction for infantry units for night attacks. When so used, the flare should be placed sufficiently far in advance of the infantry as not to expose them.

c. Marking an area for night photography.

d. Marking bomb safety line for night air attack.

e. Harassing of enemy installations.

Section 19. Fire Plans

1. General

It was found essential to consult the artillery commanders of all echelons early in the planning of an operation, as time was required for the development of adequate and flexible fire plans in support of an operation. Timely warning enabled the artillery commanders of Army and Corps to coordinate the fires between corps and divisions, to make plans for ammunition supply, and to balance the amount of artillery available so that fire power was properly distributed.

Fire plans were governed by the terrain, the amount of artillery available, and our knowledge of enemy dispositions. They were varied, whenever, to insure surprise. Some of the variations were: a false preparation, 24 hours more or less in advance of the attack, no preparation, a preparation in one sector and an attack in another, a long preparation, and a short highly concentrated preparation. It was felt that the enemy could recognize the attacking division by its continued use of similar fire plans.

2. Offensive

Fire plans for the attack were developed in close coordination with the infantry commanders. Plans were made as simple as possible to afford the flexibility necessary to meet rapid changes in the situation. A preparation was used when there was sufficient ammunition and when the element of surprise could be sacrificed without hazarding the success of an operation.

Supporting fires usually consisted of either successive concentrations or a rolling barrage. Successive concetrations were used when the knowledge of the enemy installations was such that they could be effectively neutralized. They were fired on a prearranged schedule or on call. On call was controlled by the forward observers or liaison officers.

[p. 212]

The rolling barrage was used only when no definite intelligence concerning enemy installation in the path of the attack was available and there was an adequate ammunition supply. A rolling barrage controlled by an artillery observer in position to watch the progress of the attacking infantry was most successful.

In order that counter attacks might be replulsed, defensive fires were prearranged and prepared in depth for each phase line and objective of an attack.

In addition to firing on known enemy artillery installations, Corps long range artillery interdicted routes of approach in order to isolate the battlefield. Medium artillery units of the Corps were also used to thicken organic divisional artillery fire.

3. Defensive

Defensive fires were planned in depth. Concentrations were selected by map study, terrain study and by request of regimental commanders, to cover all avenues of approach by the enemy on the

divisions front back to the infantry regimental reserve lines. The resulting plan was published to all units down to and including battalions. In addition to the overall defensive fire plan, a system of close-in defense was prepared by each direct support battalion to cover its regimental sector. These were the normal barrages. Each battery covered one sector and adjacent battalions were given emergency barrages in the same sector. These barrages were fired in and checked frequently to ensure pin point accuracy. The replot data was sent to Division Artillery which disseminated it to other battalions. Thus the fire of the entire division could be concentrated accurately on any point threatened.

In a static situation elaborate counter-mortar programs were established. Corps Artillery coordinated a comprehensive counter battery program. These are discussed at great length under "Counter-mortar" and "Counter-battery".

[p. 213]

Section 20. Deployment of Artillery in Mountain Terrain

Every effort must be made to disperse gun areas to decrease enemy counter-battery effort and effect. The natural tendency in mountainous terrain is for numerous batteries to become grouped in the few obviously accessible areas. This tendency was defeated by more thorough and detailed reconnaissance and the application of engineer work to develop additional areas for occupation.

Section 21. Artillery Concentrations and Methods of Attacking Targets

Various combinations of projectiles and fuzes were used successfully in concentrations. Smoke mixed with HE percussion and Time shells assisted our infantry in following supporting fires because they could see definitely where our fire was landing. It also had a terrorizing effect on the enemy and led him to believe that concentrations were heavier than they actually were. WP smoke proved to be valuable as a casualty producing and incendiary agent. In one incident, a time adjustment by an artillery battalion forced the enemy into his fox holes. The adjusted coordinates were furnished to the 4.2 chemical mortars which smoked them out. This was followed by a combination of time fire from the artillery and HE percussion from the infantry howitzer company to produce maximum casualties.

The delay fuze was used against houses and prepared positions to force the enemy out into the open where he could be hit with time or instantaneous percussion fire. The technique adopted by one battalion was to attack a building with precision fire and to have the non-adjusting batteries follow the data. When a one-C bracket was split, the two non-adjusting batteries, were loaded for time fire. Then when the building was hit with the adjusting gun, those two batteries were fired immediately, catching the Germans leaving the building by surprise.

[p. 214]

Well camouflaged fortified positions, in which individual fortifications and positions were not visible, were best attacked by massed concentrations containing an appreciable percentage of delay fuze. This

type of fire did most to disorganize the position and destroy camouflage so that individual positions were made visible and could be attacked singly.

When time permitted, enemy installations such as pillboxes, buildings, bunkers, dugouts, and artillery pieces were best and most economically attacked with a precision adjustment of one gun. A caliber and fuze capable of destruction were used.

Massed surprise Time fire effected by firing volleys timed so that the shells arrived simultaneously on the target (TOT) was the most effective method of inflicting heavy casualties on personnel in the open.

Fire on main enemy roads was most effective when a large portion of the road was covered simultaneously with a TOT at a time when it was known to be most active. A linear portion of each road was assigned to each artillery unit, and data was computed to place the fire evenly over that portion of the road. In this manner the organic division artillery could cover about three kilometers of a road in one shoot. This method was more effective against enemy traffic than the practice of confining fire to a single road junction or point on the road, and, in addition, obtained results on military installations and activity to the sides of the road.

Section 22. Maps for Artillery

In the very early stages of the Italian campaign the supply of maps for artillery use was inadequate, but after the crossing of the Garigliano the 1:25,000 map was sufficiently accurate for the securing of artillery fire data. The Engineers also published lists of constant values for each sheet to be applied to the coordinates taken from these maps, in order to come as near to standard grid coordiantes as possible.

Slight variations between sheets of the 1:25,000 map of Italy made it impractical to use this map directly for horizontal control.
[p. 215]
However, excellent horizontal control was obtained when the map was used in conjunction with the 1:25,000 grid sheet.

Later an uncontrolled mosaic covering the same area as the map was printed on the reverse side of each sheet.

Due to the need for speedy map production and to a lack of adequate facilities for multi-color reproduction, the 1:25,000 map was printed in one color only. This made more difficult the securing of vertical control.

Approximately 25 sheets were issued each battalion, covering its area of operation. This number was sufficient. However, when in a static situation for a prolonged period, a few more were required for replacement.

Section 23. Counter-battery

I. INTRODUCTION

The mission of counter-battery is the destruction or neutralization of enemy artillery. This mission is accomplished by reducing the enemy's fire capabilities through the destruction of his artillery weapons, equipment, and personnel. Those hostile batteries not permanently destroyed were neutralized (forced to cease firing) by placing fire on them as soon as they became active, or in the case of an impending attack by our troops, immediately prior to the time when they were certain to become active. Counter-battery was the primary mission of corps artillery, and its functions were centrally controlled by the Corps Artillery S-2 Counter-Battery Section. Division medium battalions assisted in counter-battery fire when necessary.

Counter-battery was, and must be, continuous. It functioned 24 hours daily, and was not organized merely to support a particular operation, although counter-battery fire was increased, through special counter-battery programs, when supporting an attack.

Although corps artillery fired most of the counter-battery missions, particularly during the static centralized situations, all artillery was held responsible for the location and destruction or neutralization of enemy artillery, and it must be so trained.

[p. 216]

II. ORGANIZATION

The following was the organization for counter-battery in one corps artillery headquarters. The organization in other corps artillery headquarters was similar.

From experience gained in Sicily and Southern Italy, and upon reorganization of the corps under the new T/O while in action at S. Vittore, near Cassino, it was decided to combine the S-2 and counter-battery functions into one section. Experience has proven that general intelligence and counter-battery intelligence are so closely related as to be practically inseparable. Since its reorganization, the section proved to be a smooth-working, close-knit organization, and the combination was considered to be a most satisfactory utilization of the personnel available.

The Headquarters and Headquarters Battery operated in the following echelons:

a. At Fire Direction Center

Artillery commander, executive, and aide; S-2 (CBO), S-3, S-4 sections; Headquarters Battery.

b. At Corps CP.

Assistant artillery officer, an assistant S-2, assistant S-3, assistant S-4, and necessary clerks.

c. At Corps artillery air strip.

Corps artillery air officer and the air observation section.

d. At Army Photo Interpreation Center.
Assistant S-2 and clerks.

Personnel and principal duties were as follows:

a. Lt. Col., S-2 (CBO): Supervised and coordinated all activities of the section. Kept abreast of the tactical situation and the plans for future operations.
[p. 217]
Assisted in formulating the artillery fire plans and coordinated counter-battery programs with adjacent corps.

b. Major, Assistant S-2: Executive of section. Made a thorough and continuous study of the enemy artillery situation. Wrote the Enemy [Artillery] Disposition paragraph of the Daily Intelligence and Counter-battery report. Responsible for technical intelligence and files.

c. Captain, Assistant CBO: Responsible for the completeness and accuracy of the hostile battery files and the hostile battery chart. Grouped hostile batteries under code names for defensive fires. Evaluated "shellreps" and conducted normal CB functions. Wrote paragraph 4, Additions and Deletions to Hostile Battery List, and paragraph 5, Miscellaneous (Survey data, outstanding CB missions, etc.) of the daily report.

d. Captain: Stayed at artillery section at Corps CP, and was liaison between Corps G-2 and Artillery S-2 section.

e. Captain, LNO: Remained at Army Photo Center. Assigned priorities to sectors of enemy territory for photographing. Marked all photographs of daily coverage with known and suspected hostile batteries, located new targets, and determined effectiveness of our CB fire and changes in known positions. Secured photos for organic AOP and Arty/R missions. Made damage assessment for each "precision shoot" and distributed photos showing the results to the artillery unit and Air OP that fired the mission.

f. 1st Lt.: Responsible for procuring and distributing maps and aerial photos, including basic cover and HB (hostile battery) photos to all corps artillery. Coordinated ground and air zones of observation. Selected targets for night harassing missions. Gathered, evaluated, and disseminated all general intelligence information. Wrote paragraph 1, General Intelligence Information, of daily report. Prepared HB photos for precision shoots by AOPs. Kept S-2 situation map and intelligence bulletins files.
[p. 218]

g. 1st Lt. (Aide): Evaluated "shellreps" and performed routine CB duties. Responsible for accuracy of "fire mission" journal and plotting of "shellreps". Made a study of the technique and tactical employment of artillery by the enemy and wrote paragraph 2, Enemy Artillery Activity, of the daily report. Specialized in identification of enemy shells and weapons. Selected hostile batteries for AOP and Arty/R precision shoots and those for bombing by fighter bombers.

h. Enlisted Personnel: There were nine enlisted men in the section, including intelligence sergeants, draftsmen, typists, clerks, etc., two of whom worked at the Army Photo Center.

The section operated twenty-four hours a day. All personnel were qualified to perform the duties of several positions.

The Daily Intelligence and Counter-battery Report contained:

a. Paragraph 1 - General Intelligence Information.

b. Paragraph 2 - Enemy Artillery Activity.

c. Paragraph 3 - Enemy Artillery Disposition.

d. Paragraph 4 - Additions and Deletions to Hostile Battery List.

e. Paragraph 5 - Miscellaneous (Survey data, outstanding CB missions, etc.).

III. OPERATIONS

A. LOCATING THE TARGET

1. Locating the Target - General

The first step in counter-battery was the location of hostile artillery. This was the primary duty of the corps counter-battery officer. All hostile battery locations, or information relative to their location, were reported to him. The following were sources of information:
[p. 219]

a. Photo interpretation.

b. Observed missions (targets of opportunity) by grounp OPs, Air OPs, and flash observers of the observation battalion.

c. Sound ranging.

d. "Shellreps" based on analysis of craters and shell fragments, observation of gun flashes or smoke, or sound of shells in flight.

e. Prisoners of War.

f. Partisans and civilians.

g. Captured maps and documents.

h. Radio interception

i. Hostile Battery files (Recurring and confirming information).

2. Hostile Battery List

The corps counter-battery section prepared and distributed a list of hostile batteries to all subordinate, adjacent corps, and higher artillery headquarters. This list was revised daily through the medium of the Daily Intelligence and Counter-battery Report. The list was divided into two general sections. One section consisted of those hostile batteries (assigned three-letter names) that were definitely located or verified by photo interpretation. The other section consisted of those HBs (assigned two-letter names) that were located by other means, but not yet verified by photo interpretation. A reference name, map (PI) coordinates, number of guns, caliber classification, whether field or anti-aircraft artillery, accuracy of location, and status were given for each target. Ordinarily the corps artillery S-3 assigned counter-battery fire missions by names of enemy gun positions taken from this list.

3. Photo Interpretation

Each day, weather permitting, the photo reconnaissance squadron photographed the enemy territory to a depth of approximately 20,000 meters. Sets of these vertical photos were sent to the Army Photo Interpretation Center. An officer (Interpreter) and two enlisted assistants from corps artillery headquarters worked at this center.

[p. 220]
They received information from the CBO relative to known and suspected targets. A list of these was maintained, and they were plotted on a map overlay and marked on the photos daily for interpretation. Information from the numerous sources available to the CBO greatly assisted the interpreter in locating new targets. He furnished the CBO with accurate coordinates (1:25,000 map checked by radial plot) of identified locations. He not only searched for new locations, but also checked known positions to determine whether or not they were still occupied, whether the number of guns had increased or decreased, and the effect of our CB fire.

To assist the photo interpreter in the location and identification of observed hostile batteries, the following procedure was followed by Air OPs. Immediately after a flight mission on which an air observer had observed a hostile gun not previously reported by PI, that observer pin-pointed the location on a 1:25,000 map and on an air photo. He reported the location and a description of the target and the time he observed it. Locations were reported by map coordinates and by photo coordinated using a standard photo template (Template "B"). The photo used was identified by number. The following is an example of such a report:

121300A 2/G/L Map coordinate 8235 - 4046
(12 PR) (4M1266) 171 D34 - 624
On east side of small building.

4. Reporting of CB Fire Missions

All counter-battery fire missions not assigned by corps artillery headquarters were to be reported to the corps artillery S-3 as soon as possible after the battalion commenced firing, so that additional fire could be placed on the target if desirable. The adjusted coordinates and altitude of the target were reported as soon as they were obtained. In addition, all fire missions were reported immediately upon completion. This report included, when applicable, a description of the target, type of fire (precision or bracket), number of rounds fired, effect on target, and name of observer.

[p. 221]

Air observers made a report on fire missions similar to the ones they made on hostile batteries located but not fired on. (See Photo Interpretation.)

5. Shellreps

The primary purpose of artillery intelligence was to secure all possible information dealing with the disposition, composition, and characteristics of fire of the enemy artillery. A source of important information was enemy shelling. Shelling reports assisted in identifiying the source of the shelling. With data obtained from artillery observers, sound ranging and flash ranging units, aerial photograph interpretation, and other sources, these reports gave an accurate summary of the enemy artillery activity, an indication of the apparent importance of hostile batteries, and provided the information necessary for the selection of CB targets. A standard form was used in recording and transmitting (usually

by telephone) shelling reports. Active enemy batteries were reported by observation of their flash, sound, smoke, or shell craters. As much of the following information as could be obtained was reported:

a. Direction of enemy battery from observer. (Furrow, sound, flash, or smoke azimuth measured from grid north).

b. Estimated range to guns, angle of fall of projectiles, time setting on time fuzes, or flash-bang (number of seconds from time flash is seen until explosion of propelling charge is heard).

c. Location of observer.

d. Location of area shelled.

e. Time shelling began and ended.

f. Number of guns.

g. Number of shells.

h. Caliber of shells.

[p. 222]

i. Type of shells (HE, smoke, etc.).

j. Type of fuzes (quick, delay, time, ricochet).

k. Type of fire (registration, destruction, neutralization, harassing, interdiction).

l. Target (Infantry, battery, CP, road, etc.).

m. Damage.

n. Name of observer or unit making the report.

It was a responisiblity of all personnel to report all available information about enemy artillery activities. Many units organized shellrep teams, equipped with aiming circles and gunner's quadrants when available, which specialized in reporting enemy shelling.

B. ATTACKING THE TARGET

1. Attacking the Target - General

The second step in counter-battery was to neutralize or destroy the enemy artillery that had been located. Based on information obtained from the CBO, the corps artillery S-3 assigned counter-battery fire missions, except for targets of opportunity.

It was desirable to place fire on hostile batteries while they were active for the purpose of forcing them to cease firing thus maintaining neutralization, and to cause the maximum number of casualties by firing on the personnel while they were in the open. For this reason, the counter-battery organiazation, while centralized, permitted artillery observers to take active hostile batteries (targets of opportunity) under fire immediately without referring them to the CBO. Information relative to the location of hostile batteries from sources other than artillery observers who could place fire on the targets, was transmitted to the CBO immediately, so that he could collate information from several sources, definitely locate the HB, and when possible get artllery fire on it while it was still active. If time permitted, observation on targets so located was obtained. If not, and the target was accurately located, unobserved fire was

placed on it. It was desirable that all counter-battery fire, except on targets of opportunity, remain under centralized control of the corps artillery CBO.
[p. 223]
With his multiple sources of information, he was better able to determine which HBs were active, which had offered the most opposition in the past, and which were likely to offer the most opposition to future operations. This centralized control also eliminated the waste of ammunitiom which results when two or more units try to neutralize enemy shelling by process of elimination based on limited information.

When the corps sector was of abnormal width, provision was made for decentralizing counter-battery by the use of sub-sections with the divisions on the flanks.

2. Basis of Counter-Battery Fire

a. Observed:

(1) Targets of Opportunity (active HBs) by artillery air and ground observers.

(2) Prearraged precision shoots for destruction.

b. Unobserved:

(1) Flash intersections on known locations.
(2) Sound plots on known and unknown locations.
(3) Counter-battery programs in support of attacks.
(4) Night harassing.

3. Methods of Attacking Hostile Batteries

a. *Neutralization:* The enemy was a master of dispersion and of the use of good cover to protect his life. It was found that our artillery concentrations, observed or unobserved, seldom destroyed enemy artillery weapons, and caused few casualties unless the personnel were caught in the open, out of their splendid shelters. Therefore, in static situations artillery concentrations were seldom fired except against *active* hostile batteries.
[p. 224]
Continuous air OP patrols, sound ranging, flash ranging, and rapid shelling reports made surprise fire possible.

Counter-battery preparations were fired on all known positions when there was sufficient ammunition and when surprise could be sacrificed without endangering the success of the attack. After H-hour, neutralizing fire was employed on a time schedule against all known positions and against all active hostile batteries.

Concentrations on active hostile batteries were followed by precision fire for destruction when the gun pits could be observed. After the completion of an observed mission, neutralization was maintained for approximately an hour, by platoon or battery volleys at irregular intervals.

Each day the counter-battery section selected the most appropraite hostile batteries for night harassing. These missions were usually assigned to heavy anti-aircraft artillery units.

b. Destruction: Examination of aerial photos and captured enemy gun positions, and observation by air OP observers revealed the necessity and value of precision fire for destruction against hostile batteries. Many guns, as well as ammunition and equipment near the gun positions, were damaged or destroyed by the type of fire.

Precision fire either followed observed concentrations on active hostile batteries (targets of opportunity) or was prearranged by the corps counter-battery section. Each day the most appropriate HBs for precision shoots were determined by the CB section and assigned, through the corps air officer, to air OPs. Those missions that could not be accomplished with a reasonable degree of safety by organic air OPs, were assigned to high performance aircraft (Arty/R). The air observers were furnished 1:50,000 maps and were given the map coordinates and an aerial photo of each target. The target, target reference name from the Hostile Battery List, map reference of target, and gun-target line were marked on the photo. In addition, special annotations were frequently used to assist the observer in locating the target and adjusting artillery fire.
p. 525]
One system consisted of concentric circles marked at 100-yard intervals around the target. Another consisted of range and deflection lines at 100-yard intervals drawn perpendicular and parallel, respectively, to the gun-target line. After the missions were completed, photos showing the results of their fire, with the photo interpreter's remarks typed on the back were sent to the observers and firing battalions.

4. Flash-Ranging Location and Adjustment

Flash locations by the observation battalion were reported to the corps artillery S-3 and were taken under fire immediately.

Surprise fire for effect, particularly with VT fuze, was most important. If an adjustment was made, personnel were warned, took cover, dispersed vehicles, and most of the effectiveness of the fire was lost.

If the flash location was a known target previously located or verified by photo interpretation, or if it was a new target located by a two-or-more OP base, and was within transfer limits of a recent registration, surprise fire for effect was delivered without delay. If these conditions did not exist, an adjustment was necessary. To obtain surprise, the adjustment was made on an auxiliary target and fire for effect transferred to the target. Frequently a center-of-impact adjustment was fired, or if no suitable adjusting point existed on the ground, a high-burst adjustment was used.

On all flash adjustments, whether on auxiliary or actual targets, the flash officer reported coordinates of single adjusting rounds or center of impact, rather than sensings of "right", "left", "over", or "short" so many yards. This eliminated the necessity for the maintaining of records of the

locations of a large number of firing units by flash centrals in forward areas, and increased the accuracy of sensings.

5. Inspection of German Artillery Positions

a. The artillery commander of one corps initiated inspections of German artillery positions overrun in the corps zone of action after the crossing of the Arno River.
[p. 226]
Hostile battery locations that had been taken under fire were examined with the following findings:

(1) Of all the photo locations that were interpreted as containing guns, physical examination of the positions indicated that 85% had been occupied.

(2) Of the 44 locations inspected, excellent effect had been obtained or the area well covered by fire on 29.

(3) Photo interpretation as to caliber and type of enemy guns located proved to be accurate in 75% of the positions inspected.

(4) The employment of the heavier caliber artillery, 155mm howitzers and guns, 8" howitzers, and 240mm howitzers, accounted for the greatest damage to enemy batteries.

(5) When observers were able to see the enemy guns or pits, destruction of artillery pieces was effected largely by employment of precision methods on visible portions of the target. In the average case where area fire was used, it was evident that little damage had been inflicted on materiel or emplacements.

(6) Excellent weather conditions existing during the period under consideration permitted extensive use of air OPs for the adjustment of counter-battery fire. Planes flying over the enemy lines at an altitude of 5,000 feet facilitated rapid and accurate adjustments. However, inspection of targets revealed that in many cases when observers had reported "area well covered" such was not the case. These erroneous sensings were probably due to the difficulty of observing from high altitudes and to an over-optimistic attitude on the part of the average observer.

(7) During the investigation only two dummy positions were found.

(8) Civilian reports and examination of gun positions indicated that enemy batteries frequently moved when effective counter-battery fire was placed on them.
[p. 227]

(9) Inspection of shell craters indicated that the destructive effect occasioned by the use of delay fuze was relatively unimportant and resulted only in a loss of effective fragmentation.

(10) Reinforced dugouts and other forms of overhead cover were found in only 50% of the positions examined.

(11) Ammunition pits, slit trenches, dugouts and other battery installations were in general placed 10 to 30 yards to the rear of the gun positions and actually had not been materially affected by the fire.

b. Based on the results of the investigation the following conclusions were drawn and were considered applicable to operations in which only hastily prepared field fortifications are encountered:

(1) Photo locations are sufficiently accurate and dependable to justify adjustment on point locations and expenditure of considerable ammunition without further confirmation.

(2) When guns or gun pits can be observed, precision fire should be used against the individual pieces to effect destruction, followed by battery or battalion volleys consisting of approximately 50% time fire to include fifty yards in the rear of the pieces.

(3) During the evening (dusk to midnight) following an adjustment on an enemy battery, harassing fire on the appraoches to the battery position and occasional TOTs with a proportion of time fire on the position itself frequently will cause damage to transport, increase total casualties, and generally interfere with evacuation of the position.

(4) Delay fuze should not be used against enemy batteries in hastily prepared positions, in view of its lack of effective fragmentation.

(5) The report "area well covered", frequently used by air observers in sensing fire for effect, should be used by them with caution, and only when there are definite indications that such is the case.

[p. 228]

6. Counter-battery Neutralization Group Plan

The purpose of the counter-battery group plan was to place immediate fire on a number of hostile batteries in an area where information from shell reports was not sufficient to determine exactly the offending battery or batteries.

Hostile batteries were grouped according to their proximity and each group was given a name. The groups were assigned to our artillery battalions and firing data was computed and recorded so that fire could be delivered quickly on call.

Section 24. Counter-mortar

I. ORGANIZATION

1. Purpose

The purpose of counter-mortar organization and operations is the location and destruction or neutralization of enemy mortars.

2. Necessity for Counter-mortar System

Although neglected until May, 1944, when the 45th Infantry Division first initiated a divisional counter-mortar program on the ANZIO Beachhead, the necessity for an efficient counter-mortar system was forcefully impressed upon us by the casualty producing effect of enemy mortars.

Approximately 25% of our casualties in Italy were caused by German mortar fire. This is second only to the number of casualties caused by enemy artillery, which was about 40% of the total. As the enemy artillery became restricted due to shortage of ammunition and our counter-battery fire, more and more artillery tasks were alloted to their mortars.

3. Principles and Type of Organization

There was no prescribed uniform organization for counter-mortar; however, the organizations in the different divisions were similar. Counter-mortar organizations and operations were patterned after those of counter-battery, which had been more rapidly and fully developed in the corps artillery headquarters.

[p. 229]

The principal differences derived from the fact that counter-mortar was assigned as a division rather than a corps function.

In establishing counter-mortar organizations, the following principles were adhered to:

a. The essence of effective mortar neutralization is speed. Therefore, part of the counter-mortar organization should be in each infantry regiment where rapid communication exists between the sources of mortar information and the means of immediate neutralization. A complete counter-mortar section that operates in a manner similar to the corps artillery fire direction center, with the means of locating enemy mortars and assigning fire missions, is desirable in each regiment.

b. A central counter-mortar section should be established in each division, preferably at the division artillery CP, to collect, interpret, and disseminate all mortar intelligence, and to coordinate counter-mortar measures within the division and from outside sources.

c. Counter-mortar activities must be decentralized to lower units in a fluid situation.

Our counter-mortar organizations differed from those of the British primarily in that ours were established with existing personnel and equipment, whereas the British T/Os were changed to provide a Divisional Counter-mortar Organization. As one British general stated, "We have on the British side produced an organization with War Establishment, or T/O for a Divisional Counter-mortar Organization. Some of you may think that this is lavish and some may think it is insufficient, but the over-riding fact is that the mortar is a great menace and we must be prepared to meet it, even possibly at the expense, in these days of short manpower, of the leading troops. It would be accepting a false sense of security if we allowed this to lapse, because lives saved must be lives gained, and unless you are going to tackle the problem seriously you are going to go on losing infantry particularly from mortar bombs."

[p. 230]

There was a difference of opinion among American officers as to whether additions to the T/Os were desirable and justifiable. However, it was generally agreed that present artillery and infantry communication facilities were adequate.

The 8th Indian Division recommended using special observers whose sole task would be to report hostile mortar activity because "hostile mortars are seldom heard above the din of battle by infantry or artillery observers." However, the Commander, Eighth Army, made the following comment concerning counter-mortar OPs. "With regard to the problem of counter-mortar OPs, I agree very much with the Brigadier who said that every Battalion of Infantry should do that automatically. They must have special equipment, like compasses, but I do want to rub in the point that if you specialize too much for every task, then the Infantry Battalion fails to do the task itself, the attitude being that the Brigade Mortrep OPs are doing it. We must be on the watch against always trying to develop a special organization for every little job and the ideal is that every Battalion should report accurately mortar fire. I agree, of course, that special training is required."

The British Divisional Counter-mortar organization provided for nine officers and thirty enlisted men, divided into subsections consisting of a counter-mortar officer and staff at division artillery headquarters and an assistant counter-mortar officer (ACMO) and staff at each brigade headquarters, plus personnel and equipment to maintain communication between the CMO, ACMO, and headquarters of supporting units.

The organization within American divisions was similar to that of the British. A division counter-mortar officer (DCMO) and an assistant division counter-mortar officer were appointed in division artillery headquarters. A regimental counter-mortar officer and an assistant were appointed in each regimental headquarters.

[p. 231]

4. Duties of DCMO

a. Supervised the work of the division counter-mortar section.

b. Coordinated the work of the RCMOs.

c. Collected and evaluated information from the RCMOs, photo interpreter, radar battery, observers, adjacent and higher headquarters, and other sources.

d. Prepared and distributed Hostile Mortar Lists and other mortar information.

e. Grouped mortar locations for "group shoots" that were fired when the area, but not the definite location, of an active mortar or mortars was known.

f. Prepared counter-mortar programs, including preparations for attacks, and assigned fire missions.

g. Upon request of the RCMO, secured additional fire to reinforce the regimental counter-mortar weapons.

5. Duties of RCMO

a. Supervised the work of the regimental counter-mortar section.

b. Collected, evaluated, and disseminated mortar intelligence affecting the regimental sector. Reported to the DCMO all activity of enemy mortars within the regimental sector and counter-measures taken (i.e. locations of new positions, known positions that were determined to be active, counter-mortar missions fired, etc.).

c. Indoctrinated personnel of the regiment with the importance of counter-mortar activities, including the prompt reporting of mortar shelling (Mortreps).

d. Coordinated observation on enemy mortars.

e. Coordinated the disposition of weapons under regimental control for use against enemy mortars.

f. Assigned countermortar fire missions to appropriate units of the regiment.

g. Called on DCMO for required assistance (i.e. additional information on locations, additional counter-mortar fire, counter-mortar preparations, counter-mortar programs, etc.).

[p. 232]

II. LOCATING THE TARGET

1. General

Enemy mortars were located by the same means as enemy artillery, with one additional source of information, i.e., our infantry patrols. Ground and air OPs, "mortreps", and aerial photos were the most remunerative sources of information. Artillery forward observers reported all mortar activities to the RCMO through the artillery liaison officer at regimental headquarters.

2. Aerial Photos

Aerial photos were used in locating mortars and in precision shoots for destruction in a manner similar to their use in counter-battery. An expert photo interpreter in the division counter-mortar section was considered essential. Because they were more mobile, smaller, and better camouflaged, mortars were more difficult to locate by aerial photography than were artillery pieces. Oblique photos were helpful in locating mortars concealed from vertical view.

3. Mortreps

Mortreps contained the same type of information as artillery shelling reports (Shellreps), and the same standard form was used for convenience in reporting and recording this information. All personnel were responsible for reporting, at once, information concerning enemy mortar activity. When the RCMO responded quickly to these reports he instilled a high degree of confidence in the value of mortreps that had a far reaching effect and rendered his task much easier.

Plotted reports from one or more observers, based on sound, flash, smoke, or crater observation, enabled the RCMO to locate new mortar positions or determine which known areas were active, and to place neutralization fire on them while the enemy personnel were out of their shelters and manning their weapons.

[p. 233]

Experience in combat has shown that mortars can be dealt with effectively if observers report sound bearings immediately. The fact that other details normally included in Mortreps are not available, should not delay their rendition. On recieving two or more sound bearings, it was frequently

possible by a study of the map and known locations, to place a concentration on the active enemy mortars in very little time.

Mortars were indicated or located by use of the following:

a. Single back-azimuth rays plus analysis of the terrain along the ray.

b. Single rays plus slope of fall.

c. Triangulation (long-base intersection) from back-azimuths determined in different shelled areas.

A mean back-azimuth, obtained from a group of craters which closely match for direction, will pass through or near the responsible mortar position. Even with no means available for ascertaining the range, the single ray will narrow the search for the mortar and focus the attention of all target locating agencies in the division. The capabilities and limitations of the weapons believed employed, as determined by identification of shell fragments, must be considered. The examinination of such areas by air or ground observers or by means of stereoscopic pairs of air photos often disclosed the mortar position.

4. Shell Crater Analysis

a. *General.* An analysis of shell craters and fragments was made to determine the direction and range of enemy mortars. The following characteristics of mortar craters were noted.

(1) The shape of the crater is determined by the angle of impact. A projectile which drops at right angles to the ground will form a circular crater, while one striking at an angle substantially less than 90 degrees will form an oval crater, symmetrical along the line of the trajectory. [p. 234]

(2) The front edge of the crater (farthest from the mortar) has turf undercut.

(3) The back of the crater is not undercut, but is serrated and splintered, and the ground is normally torn and blasted.

(4) When fresh, the crater is covered with loose earth which must be carefully removed to disclose the firm, burnt inner crater.

(5) The ground around the crater is serrated by splinter grooves which form a definite pattern, the form of which depends on the angle of impact. The intersection of these grooves is the point of detonation.

(6) At the bottom of the inner crater, and in front of the point of detonation, the fuze and fins bury themselves to considerable depth.

(7) The splinter grooves are longest at right angles to the trajectory and shortest along it.

(8) The ends of the splinter groves form a line at the rear of the crater that is roughly at right angles to the trajectory.

b. *Direction Determination.* Direction was determined by one of the three following methods, or better, by a combination of the three.

(1) The long axis of the oval was determined, a stick layed along this axis and its azimuth was measured with a prismatic compass.

(2) A stick was place along the line formed by the ends of the splinter grooves at the rear of the crater. Its azimuth was measured and added to or subtracted from 90 degrees.

(3) The point of detonation was determined, the fuze and fin hole located, and the azimuth of a line joining the two was measured.

When time permitted, a number of craters were examined and the mean direction was determined.

[p. 235]

A correction was applied to the direction as determined above to compensate for the effect of a crosswind on the flight of the projectile.

c. *Range Detemination.* The range at which the mortar was fired was determined from the angle of fall and the caliber of the mortar shell.

The angle of the fall was determined by measuring with a protractor and plumb bob, the angle between the horizontal plane and a line joining the point of detonation and the center of the fuze and fin hole.

The caliber of the mortar was determined by an examination of the fins.

The range corresponding to the angle of fall and the caliber was obtained from the proper range table for each charge. These ranges were plotted along the mean direction and probable mortar locations were determined from a study of the map and other information as to known and suspected positions.

5. Firing Chart

The RCMO maintained a firing chart of 1:25,000 or larger. On it he plotted all known enemy mortar positions, friendly OPs, check points, and counter-mortar weapons under his control.

The position of every observer who was likely to submit a Mortrep was plotted on the firing chart. In static situations, OPs were accurately located and instruments oriented for direction according to survey control common to the firing units. Among other advantages, this facilitated accurate reports on azimuth of enemy mortars. Sound, flash, and furrow (crater) azimuths were plotted on an overlay and mortar positions were determined by intersection.

The location of friendly weapons under the direct control of the RCMO were accurately plotted so that deflections and ranges could be measured for fire missions.

[p. 236]

III. ATTACKING THE TARGET

The location of the enemy mortar or mortar area having been determined, a decision was required as to the weapons to be employed for neutralization or destruction. Three types of weapons were available: fighter-bombers, artillery, and mortars. For most rapid results, the RCMO usually employed those weapons under his direct control and called on the other weapons, through DCMO, only when necessary to accomplish the mission.

The RCMO had available for counter-mortar fire, the 81-mm mortars, the 105-mm howitzers of the infantry cannon company, 4.2-inch chemical mortars when attached, and fighter-bombers on request to ROVER JOE. The DCMO had available the division artillery, and corps artillery on request.

Enemy mortars, accurately located, which could not be attacked by other weapons, were assigned to fighter-bombers. A photo of the mortar position was furnished the pilot and the target was marked with colored smoke. The Commander, Eghth Army, made the following comment on the use of fighter-bombers for counter-mortar. "In operations on land you want every form of support you can get. To give an example of how the Air Force must take on targets which at first sight appear sutable for artillery, I think mortar areas are very suitable for bombing. All of you have seen, after occupying ground, enemy mortar positions untouched, and we have seen from diagrams how difficult it is to get at enemy mortar positions. In these deep ravines, in sunken lanes where the enemy alway get their mortars behind high banks, etc,, the bomb is a very effective instrument. Mortar areas, therefore, should be bombed when you have accurately located them."

Artillery was excellent for counter-mortar, but had certain limitations, especially when fire on enemy mortars close to our own troops was desired.

The 4.2-inch and 81-mm mortars were perhaps the best weapons to use against enemy mortars.

[p. 237]

The 4.2-inch chemical mortar units were most effective in counter-mortar when trained in artillery methods, attached to the artillery for fire control, and employed in at least company strength for massed fire.

The 81-mm mortars maintained separate range cards for countermortar fire with all information to open fire upon call from the RCMO giving only the lettered designation of the target. The following is an interesting account of fire control in a mortar platoon [of the 168th Infantry, 34th Division].

"We have been very successful using a method of fire control and direction similar to that of an artillery fire direction center. Our first attempt with this method was an experiment at ANZIO Beachhead and it proved itself so effective that we have been using it ever since. The only items necessary to operate this CP set-up which were not T/E were 1/25,000 artillery grid sheets and a 1/25,000 range deflection fan.

As soon as our mortars are in and their position plotted on the grid sheet, they are registered on a base-point. It is then unbelievably simple for the platoon CP to fire on any given coordinate quickly and accurately by using the range fan which immediately gives the true range of the target and

correct deflection from base point. Therefore, any person in the battalion can call in the map coordinates of a target and the target can be fired accurately and immediately. This method has been extremely valuable in firing targets where observation was difficult and even more so for night firing. All of our NCOs have worked with this method and are thoroughly trainied to take over operation of the CP if the platoon sergeant should become a casualty."

Generally, the principles and technique of attacking eenemy artillery were applicable to counter-mortar fire. Counter-mortar concentrations seldom damaged or destroyed enemy mortars, so they were fired only when the enemy mortars were active, to produce the maximum number of casualties and to force the enemy to stop firing. High angle and time fire were most frquently used for neutralization. A large percentage of counter-mortar fire was unobserved.
[p. 238]
Precision fire for destruction was employed as in counter-battery.

In preparing counter-mortar programs, the DCMO grouped the known enemy mortar locations according to type of weapons and tactical formation, and gave each group a code name. When a Mortrep was received that identifed a certain group as being active, but did not definitely locate the responsible mortar or mortars, the entire group was taken under fire.

Section 25. Six-Gun Batteries for Light Field Artillery

The experience of two divisions of the Fifth Army has proved that the six-gun battery for light artillery is feasible and highly desirable. It is more flexible rather than more cumbersome.

From a tactical standpoint the main advantages are as follows:

a. More effective defensive fires.
b. Wider effective battalion zone of fire.
c. Greater shock action.
d. Greater support during displacements by echelon.
e. Less percentage of loss of fire power when one or more howitzers is out of action.
f. Handling of sheaf simplified by using center platoon for adjustments.
g. Battalion fire power increased by 50%, with less than 15% increase in personnel.
h. More fire missions can be handled simultaneously.

No increase in ammunition expenditure is expected. It was found that often one battalion volley effectively covered the target area when two or more would have been used with the old four-gun batteries.
[p. 239]
The disadvantages that have been encountered are of such a minor nature that they are not worth mentioning.

Section 26. Heavy Anti-aircraft Artillery in Ground Role

Allied air supremacy in Italy made it possible to employ heavy anti-aircraft units on their secondary mission of reinforcing [field] artillery fire. The 90mm AA gun [99mm incorrectly stated in original] proved itself a valuable weapon against ground targets because it has:

a. 360 degree traverse.

b. Comparatively long range (19,000 yards).

c. An extremely high MV [muzzle velocity].

d. A very rapid rate of fire, up to 20 rds./gun/minute, and

e. A solid gun mount which does not lose orientation in firing. Better results would have been obtained, however, had a satisfactory smoke shell been available for this gun.

Fire on ground targets was governed by the following:

a. Firing was not allowed to interfere with primary anti-aircraft missions, unless the battery were assigned a purely FA role.

b. Missions were furnished by the supported Field Artillery unit, normally to the 90mm battalion FDC. Under certain conditions the 90mm battery was attached to a FA Battalion for fire missions. However in this case the AA Battery operated its own FDC.

c. Only targets appropriate to the 90mm were fired. These incluided all targets appropriate for light artillery, but beyond its range.

d. Area coverage, except in unusual cases, was avoided.

e. Whenever practicable all fires were observed.

f. Fuze M67 was not fired on unobserved missions.

[p. 240]

g. Battery positions were accurately located by approved survey methods. Each 90mm battery had trained personnel and the proper equipment to perform its own survey.

Section 27. Artillery Support of Bombers

It was found desirable and effective to fire all counter-battery available on hostile anti-aircraft artillery when our bombers were required to fly within range of these enemy weapons. The amount of flak encountered by our aircraft was thus materially reduced. The targets, number of rounds, and approximate time to fire these missions were furnished to artillery battalions. The battalion then fired on call from our observers who had been alerted to watch for our aircraft. Due to the limited amount of artillery and ammunition available, one target was usually assigned to each artillery platoon. Air OPs performed surveillance missions during the bombardment and took enemy anti-aircraft batteries under fire when they became active.

Section 28. Artillery Training

Battle experience has indicated that field artillery units which were well trained basically, became careless of details under combat conditions, with a resulting loss of efficiency. Training should be continuous whether in combat or not. Schedules should be prepared for periods, rather than for definite days and hours, so that continuity of instruction will not be interrupted by combat duties. Accuracy and precision should be stressed in this training.

Artillery liaison officers and forward observers should be very carefully selected and trained. The importance of their work was frequently underestimated by their commanding officers. Too little attention was paid to the selection and training of these officers. Often, the last officer to join the organization was more or less automatically assigned to these duties.

[p. 241]

The liaison officer and forward observer must be thoroughly familiar with the artillery picture, including corps artillery. They must know what artillery is available and its fire possibilities. It is hard for them to realize how much artillery is backing them up. They tend to think only of division artillery and forget how easy it is with our fire direction system to get additional help. One infantry regimental Commander stated, "The infantry doesn't realize how much artillery is available to them. Until this action (battle for Rome), I thought only in terms of division artillery, but once I found out what I could get, I certainly made use of it. The 8-inch howitzers and 155-mm guns could be brought in to help us without any trouble. This was a revalation to me and I know the other infantry commanders felt the same way."

The need for training in the following subjects was indicated:

a. Counter-mortar and counter-battery.

b. Local security.

c. Destruction of materiel in event of imminent capture.

d. Disarming of anti-tank and anti-personnel mines.

e. Artillery liaison.

f. Use of maps and air photos.

g. Night flying and night adjustment of fire from air observation posts.

h. Close cooperation between air OPs, tanks, tank destroyers, and self-propelled artillery in fast-moving situations.

i. A more thorough understanding of infantry tactics and capabilities of infantry weapons by artillery officers and of supporting artillery by infantry officers and non-commissioned officers. All infantry officers and non-commissioned officers should know how to adjust artillery fire and mortar fire.

[p. 242]

Section 29. Artillery Use of Colored Smoke

Colored smake was used almost exclusively to mark targets for bombers. At times, the enemy confused the air pilot and observer by firing the same color into friendly areas. This made it necessary to use a prearranged code system such as:

a. Ladder: three smoke rounds fired in a line 100 yards apart, the center designating the target.

b. Box: four white smoke rounds designating a two hundred yard square with one colored smoke round in the center designating the target.

c. Alternating white and colored smoke rounds on target.

Several colors were used, however red smoke seemed to be the easiest to see under all conditions. Blue and violet were hard to detect against dark backgrounds. Yellow was not used for marking enemy targets because it was approximately the same color as mustard gas and furthermore had an acrid odor.

Air bursts were essential. Percussion bursts were poor and had the additional disadvantage that shells ricochetted before functioning.

Section 30. Smoke Element in HE Shells

The following points summarize the opinions of a majority of the artillery officers on this point:

a. The addition of a smoke element in all artillery HE shells, to facilitate adjustment of fire, is desirable.

b. Separate smoke and HE shells of comparable ballistic qualities provide a more desirable solution for the 105-mm and 155-mm howitzers. In organic division artillery units, it is believed that the addition of a smoke element would reduce visibility on the battlefield when a great deal of firing was in progress. Any reduction in lethal effect necessitated by the addition of a smoke element is not considered justifiable.

[p. 243]

c. It is not thought that a smoke element is needed for the 155-mm, 8-inch, and 240-mm howitzer shells.

d. The addition of a smoke element in HE shells of long range and comparatively small caliber weapons, such as the 3-inch, 4.5-inch, 90-mm, and 155-mm guns, is desirable.

Section 31. Flash Reducer M1 for the 155mm Gun

The Flash Reducer has proved highly successful in reducing the flash from the 155-mm gun and consequently, the amount of enemy shelling of our gun positions. However, several serious accidents occurred while using the Flash Reducer. In these the tube was sheared off at the breech ring and the rear end of the tube and breech mechanism blown to the rear. Although the tubes may have been defective, the Flash Reducer was probably a contributing factor in that it causes an increase of pressure in the powder chamber. In order to reduce the chances of similar accidents, the Artillery Headquarters of Fifth Army prohibited the use of the Flash Reducer with super charge, using it only with normal charge.

A VE [Vertical Elevation] correction for the Flash Reducer is necessary and should be determined by registration. With a new tube, the correction is approximately -25 f/s for super charge and -10 f/s for normal charge.

Section 32. High Angle Fire

High angle fire added materially to the capability and flexibility of artillery in mountainous terrain. In many instances close support would have been impossible without its use.

High angle fire has proved to be dependable and accurate with no undue dispersion; however separate corrections were determined when both high angle and low angle fire were fired in a given sector.

[p. 244]

The principal advantages of high angle fire were:

a. It practically eliminated dead space.

b. The "nerve wracking" noise of shells passing closely over heads of supporting troops on crest was reduced by high angle fire.

c. Against occupied buildings, 105mm high angle fire with delayed fuzes was more effective than low angle fire with the same shell and fuze.

d. Danger from random burst of the VT fuze was minimized.

Section 33. The 12-inch Graphical Firing Table

Most of the artillery units of the Fifth Army were issued the 12" graphical firing table; however, very few used it for fire direction work. Those that did, preferred it to the 18" graphical firing table because:

a. It was not necessary to change slides when changing charges.

b. It was small and compact.

c. It indicated fuse burning time up to maximum range.

The units not using the 12" graphical firing table, but using the 18" GFT, disliked the 12" rule for fire direction work for the following reasons:

a. The larger M4 GFT was easier for computers to handle and was more easily read, particularly in poor light because the indicator on the 12" rule was lightly frosted.

b. Corrections had to be carried on the indicator of the 12" rule, and where there were several corrections to carry simultaneously, confusion resulted.

c. Having no carrying case provided for the 12" GFT, it was exposed to dirt and damage.

[p. 245]

The 12" GFT was used principally by forward observers. It was ideal for this work because of its smaller size and handier construction.

Section 34. Use of the '17-'18 Ammunition in the 155mm Howitzer M1

During the summer of 1944 an acute shortage of ammunition for the 155mm howitzer M1 developed. However, there was on hand a great deal of ammunition for the 155mm howitzer M17-'18. As there were no firing tables for this combination of weapon and ammunition, test firing to produce tentative tables was conducted by two Medium battalions. One set up a firing range and fired a series of Center of Impact into the sea. About 500 rounds were fired and a table developed for low angle fire. The other battalion used similar methods and produced a table for high angle fire. The Firing Table FT.155-V-1 was used to obtain factors for Metro corrections.

Results were sufficiently accurate to enable other units in the army to use this combination with excellent results.

Section 35. Use of Captured Artillery Materiel

The German 150cm Gun Howitzer and the 88mm AA and AT gun were both used against the enemy. The problems were many and Ordnance officers felt that the results did not justify the efforts put forth to keep the guns in action.

The principal disadvantages were:

a. The lack of spare parts and equipment.

b. Ammunition problems, lack of proper components.

c. Improper prime movers, brakes, pintles, etc.

d. Necessity for adaptions[sic] and improvization to get the piece into action initially and to keep it in action.

These pieces were used mainly for harassing and interdictory fires; however, some observed precision adjustments were fired with good results.

[p. 246]

Section 36. Photo Template "B"

A device for quickly transferring photo references was urgently needed. A transparent template with a grid superimposed on it was developed by the Fifth Army and placed in general use in the Italian theater.

To read a photo reference, the center of the template was placed over the center of the photo; collimating ticks on photos permitted identical positioning. The template could not be used if the photo did not have the ticks.

Inasmuch as all units had like photos and like templates, no great problem was encountered in coordination. Its use was largely to transmit targets by coordinates from Army, Corps or Division to Tac/R squadrons for Arty/R shoots and to AOP fields for their use in target identification and adjustment.

Section 37. Camouflage of Artillery

Our artillery frequently was not camouflaged sufficienly to prevent its location by enemy observers; however, issue materiels were felt to be satisfactory.

Several 105mm howitzer battalions combined weather protection for gun crews and camouflage by pitching a pyramidal tent over the gun and gun pit and placing a camouflage net over the tent. The howitzer was fired through the door of the tent. This arrangement was very satisfactory in keeping personnel and gun pits dry during inclement weather.

Battalions needed additional materiel to assist their snow camouflage. Camopufalge nets were removed and the guns and surrounding sandbags were painted white; however, this was not considered adequate as the footprints of the crew, the blast marks, and the shadow still existed. A white materiel that could be used as a net was suggested. Vehicles and tentage must also be taken into account in considering any modifications or supplementary materiels for winter camouflage.

[p. 247]

Section 38. Artillery Notes from Battle Experiences

1. We shot on too many unremunerative targets. Rounds were wasted on suspected targets. Consequently, the problem of supplying ammunition and new tubes was made more difficult.

2. There was great need for improvement in the accuracy and frequency of meteorological messages.

3. Too many lot numbers of ammunition issued to one battery decreased the accuracy of artillery fire.

4. The rounds fired by the pieces (tubes) within a battery should be distributed approximately equally among them, in order to keep the ballistic effect of wear uniform. Where practicable, the relative erosion effect of different powder charges should be taken into consideration.

5. A network on numbered reference points selected and issued by corps or division artillery commanders down to companies and artillery forward observers simplifies the indicating of targets and reporting of friendly locations.

6. Artillery concentrations against German tanks was effective. Even if direct hits were not obtained, the tanks almost inevitably withdrew.

7. Greater speed and accuracy were obtained in battalion observed fires when the two computers for the non-adjusting batteries followed the sensings and computed their own corrections, each using his own "C" and "100/R" factors. When the command, "Fire for effect" was given, each computer sent his final commands without the necessity of the adjusting computer totalling and announcing his corrections.

8. Convoys should move at the most rapid rate possible when subjected to enemy interdiction fire.

9. During the early stages of combat some units dumped too much ammunition at forward positions which later had to be abandoned. When it was necessary to leave ammunition at old positions, units should have it picked up later or reported its location to the proper ordnance agency.

[p. 248]

10. The issue of maps should be coordinated closely by the Army Artillery Officer. Units must all use the same editions unless the Engineers specifically state that the latest edition can be used concurrently with a preceding issue.

11. Photographic requirements should be anticipated, and requests made for delivery well in advance of the time they will be required.

12. Experience indicated that any attempt to standardize completely communication for all units was in error. Special situations arose constantly which necessitated special equipment. Extra switchboards and radios (SCR 193, SCR 522, SCR 608, SCR 610) should be kept in reserve by Corps and Army to meet special requirements.

13. In a fast moving situation, wire could not be recovered by artillery units with the personnel and equipment authorized by the T/O & Es used during the campaign.

14. The more mountainous and rugged the terrain, the greater the need for Air Observation Posts.

15. Light smoke hazes were successfully used to conceal our movements from ground observation. Care should be taken in siting smoke generators that essential air and ground observation for Anti-Aircraft Artillery and Field Artillery weapons was not seriously curtailed.

16. Experiments with the Firing Platform M1, which provided 360 degree traverse for the 155-mm gun, found it to be impractical in mountainous and muddy terrain. The time required to install and remove it was excessive. Also, two additional 2 1/2-ton trucks were required to transport it.

17. In mountainous terrain and on trails with many sharp curves, the M10 trailer was unsatisfactory. Its added weight and lack of springs were additional factors against it. The M10 trailer could be used only for hauling ammunition and the regular 1-ton trailers could perform that mission without the above deficiencies.

18. The normal procedure of obtaining adjusted (replot) coordinates and altitudes for the massing of additional artillery often resulted in false replot data in mountainous terrain.
[p. 249]
The following method is one suitable solution:

a. Site was not changed during the adjustment unless the observer called for a very large shift. If a large shift was made (500 yards or more), the target was given a new initial plot and a new site was determined.

b. After the adjustment was made, the site and the range and deflection coordinates (computed for the adjusted range) were stripped from the adjusted data, a replot made, and the adjusted coordinates determined.

c. The altitude of the target was determined by multiplying the site (minus complementary angle of site) by the range (in thousands of yards) to the replotted target. This altitude in yards was converted to meters.

d. Others units using this adjusted data selected a charge giving a slope of fall comparable to that of the adjusting unit.

19. A completely developed and coordinated system of ground observation was possible during static phases of operation. It was a great aid in fire control, accurately locating targets, and developing the best possible ground observation across the division sectors. A number of coordinated observation posts across the front, with instruments which had been accurately located and oriented for direction according to survey control common with the firing batteries, offered the following advantages:

a. Possiblity of high burst or center-of-impact registration at night or at other times when poor visibility did not permit observation of regular check points.

b. More accurate reports on azimuths of enemy gun flashes and activity.

c. Possibility of locating targets by intersection.

d. Ability to calibrate artillery pieces from tactical positions.

e. All observation personnel were informed as to the location of all OPs. This kept dead space to a minimum, and various combinations of OPs could be employed to form a base for observing a certain area.

[end of chapter]

[The document as presented here is - within the limits of my vision, alertness, and stamina - an accurate rendering of the original; but it is not a "true copy". Occasional misspellings and typographic errors in the original have been corrected. Further annotations - primarily abbreviation and acronym expansions - and insertions of clearly dropped words appear in 'square brackets'.
- Patrick Skelly, for milhist.net]

[Transcribed 2001-12-24]