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THE GENERAL BOARD
UNITED STATES FORCES, EUROPEAN THEATER

TACTICAL EMPLOYMENT OF ANTI-AIRCRAFT ARTILLERY UNITS,
INCLUDING DEFENSE AGAINST PILOTLESS AIRCRAFT (V-1)

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R E S T R I C T E D

THE GENERAL BOARD
UNITED STATES FORCES, EUROPEAN THEATER

TACTICAL EMPLOYMENT OF ANTI-AIRCRAFT ARTILLERY UNITS,
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PART ONE

INTRODUCTION

1. Purpose. World War II has provided extensive tests of the effectiveness of existing War Department doctrine in the tactical employment of anti-aircraft artillery units. The purpose of this study is to examine the tactics used in the handling of anti-aircraft artillery units in the recent conflict and to make recommendations for such changes in or additions to War Department policy as appear to be indicated.

2. Scope. The scope of the study will be limited to anti-aircraft activities in the European Theater commencing with the OVERLORD appreciation (August 1943) and ending on V-E Day.

3. Changes Will be Recommended on certain policies which at present:

a. Establish certain normal scales for the allocation of anti-aircraft artillery units to armies, corps and divisions and indicate that additional allocations will be made as needed for theaters of operation.

b. Include searchlights among the weapons of anti-aircraft artillery.

c. Have established a doctrine for the tactics and technique of automatic weapons based on the 37mm and 40mm guns, including a brief coverage of ground support missions.

d. Make no provision for landing man-portable barrage balloons or man-portable anti-aircraft artillery fire units from light assault boats in amphibious operations.

e. Prescribe procedures for warning friendly forces of the approach of hostile aircraft.

f. Briefly outline methods of defense against flying bombs.

4. Major Changes in or Deviations From War Department Policy Which Took Place in the European Theater.

a. Scales of anti-aircraft artillery allotted to armies and corps exceeded the scales given in pertinent field manuals.

b. In the Normandy invasion a provisional anti-aircraft artillery machine gun battalion was organized, employing light, man-portable mounts capable of being put ashore by hand. This expediency afforded earlier protection to infantry assault units on the beach than would have been possible by employing only self-propelled or towed automatic weapons as contemplated in paragraph 64e, Field Manual 44-2, December 1944.

c. In the same operation and for the same reason as given above, a technique was developed by improvising man-portable equipment such that barrage balloons could be "walked" ashore with assault waves.

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R E S T R I C T E D

TACTICAL EMPLOYMENT OF ANTI-AIRCRAFT ARTILLERY UNITS,
INCLUDING DEFENSE AGAINST PILOTLESS AIRCRAFT (V-1)

PART TWO

NARRATIVE REPORT OF COMMITTEE STUDY

CHAPTER 1

ALLOCATION OF ANTI-AIRCRAFT ARTILLERY UNITS

SECTION 1

PLANS FOR EMPLOYMENT OF ANTI-AIRCRAFT ARTILLERY

5. Antiaircraft Artillery Organization. The structure of the command of antiaircraft artillery in the European Theater is discussed in detail in the European Theater General Board study on Command, Staff and Administration of Antiaircraft Artillery Units. However, to understand the plans made for allocations, a knowledge of this structure is required. It is summarized in this section.

6. Initial Plan. On 29 July 1943 the following plan was approved by the Theater Commander:¹

"All AA units not scheduled for assignment as organic AA artillery with Army, Corps, and Division will be assigned to the theater and placed under the command of the Chief of the AA Section, ETOUSA, and attached for administration and supply to appropriate administrative units."

7. Overseas Operation Plan. In August 1943 the plans for overseas operations were initially the same as those described above:

"a. Present plans provide for an AA operational headquarters which will come under the big operational headquarters whether it is a group of armies, a GHQ, or the ETO. The other headquarters will be provided with a small AA staff for staff functions only.

"b. The AA units which will be used in the AA defense of ports, lines of communications, installations, airdromes, and other rear area installations will be under the command of the AA officer of the operational headquarters and in this paper will be referred to as theater AA troops.

"c. The general scheme of operations is that organic AA artill-

lery of the armies will be used in providing AA protection for the landing beaches, as occupation of these beaches is expected to be very temporary. Should the beaches be occupied for a protracted time, theater AA troops will take over from Army AA troops and provide the defense until use of the beach is discontinued. On securing ports, airdromes, etc, theater AA troops will be immediately provided for the AA defense.

"d. All theater AA troops really form an area defense under one commander. In cooperation with the Air Force Commander, flying rules will be laid down for gun defended areas and provisions made for the operational control by the proper air commander in various localities and provisions made for the early warning of AA units by the aircraft warning service operated by the Air Force."¹

8. Modification of Plan. Before D-Day, as a result of various studies, the plan was modified to the following extent:

"a. First Army is responsible for planning for the initial phase up to approximately D plus 20. First Army will be responsible for the AA defense of all installations, Army, Air, and Com Z in the First Army area. First Army will provide the lift for necessary AA troops for this operation. Units for the defense of ports, Com Z installations, and airdromes installed by the First Army will be attached to the First Army.

"b. When the army rear area boundary is established, the army retains responsibility for the AA defense of its own area only. The defense of air installations in rear of the army boundary will be delegated to the Ninth Air Force and the AA units defending the installations will be detached from the First Army and attached to the Ninth Air Force.

"c. In the case of Com Z installations, such as ports and depots, responsibility of their defense will be delegated to an AA defense commander under the army group. Units defending the installations will be detached from the army and attached to the AA Defense Command. Until the First Army Group² takes over the American area, the AA defense commander will function under the 21st Army Group.

"d. When the US Communications Zone is established under the Commanding General, Com Z, the AA defense commander will be assigned to the Com Z together with all attached troops and the responsibility for the defense of the Com Z installations will be vested in the Commanding General, Com Z, through the Theater AA Officer."³

This basis of planning was in accordance with Supreme Headquarters Allied Expeditionary Forces doctrine.⁴

9. Change in Rear Area Responsibilities. Early in August 1944, responsibility for anti-aircraft defense in the communications zone was removed from the area commander and placed with the Air Defense Command.⁵

1 P 48 Bibliography Par 2

2 This designation was later changed to 12th Army Group

3 P 48 Bibliography Par 3

4 P 48 Bibliography Par 4

5 P 48 Bibliography Par 5

PLANNED ALLOCATIONS

10. Method of Establishing Theater Requirements. The general method for determining the overall theater requirements was as follows:

a. Adequate scales for field forces and typical rear area installations were determined by a joint planning board.

b. Composition of the field forces was determined and number of rear area installations estimated.

c. The total antiaircraft artillery requisitioned by the theater was the sum of the requirements for the field forces and the rear area missions.

11. Scales of Defense for Typical Installations.

a. Scales for allocation to the field forces, airdromes, supply installations, beaches, and ports, were determined initially by the combined commanders' planning staff (joint planning board). These plans were based on British organizations, and the initial estimate of total American requirements was according to this same scale, and then adjusted to American organization.¹

b. Before requisitions for American antiaircraft artillery units were submitted to the War Department, these scales were altered to the following:²

	90mm	40mm (towed)	40mm (SP)	50 Cal	50 Cal (SP)	Search- lights	Barrage Balloons
<u>Infantry Division</u>		32		32			
<u>Armored Division</u>			32		32		
<u>Infantry Corps</u>	16	64		80			
<u>Armored Corps</u>			64		64		
<u>Army</u>	48	160	32	208	32		
<u>GHQ Reserve (For use with TDs and Armd Corps)</u>			64		64		
<u>Airdrome (one large)</u>	16	32		60		12	
<u>Airdrome (normal)</u>	8	16		30		6	
<u>Beach (approximately 2500 yards long)</u>	8	16		30		6	
<u>Port (one major)</u>	64	64		164		36	135
<u>Supply Installation</u>	8	32		40			

1 P 48 Bibliography Par 6 and 7

2 P 48 Bibliography Par 8

12. Phases of Operation. In determining antiaircraft artillery requirements, two phases were considered. The first plans determined units whose presence was required in the European Theater before D-Day; the second phase, requirements from D-Day to D-plus-240.

13. Phase I Requirements.

a. Antiaircraft requirements for Phase I were based on furnishing protection for the following:

- (1) Overseas operations.
 - (a) Field forces to consist of one general headquarters, two armies, four infantry corps, two armored corps, 12 infantry divisions, five armored divisions, one airborne division.
 - (b) Three beaches.
 - (c) 20 airdromes.
 - (d) One port.
 - (e) Six supply depot areas.
- (2) Air depots and airdromes in the United Kingdom.
 - (a) Six air depots.
 - (b) 16 airdromes.

b. To accomplish these missions, antiaircraft artillery requirements were established as follows:

- (1) Seven brigade headquarters and headquarters batteries.
- (2) 26 group headquarters and headquarters batteries.
- (3) 30 gun battalions (mobile).
- (4) 43 automatic weapons battalions (mobile).
- (5) 25 automatic weapons battalions (self-propelled).
- (6) Five searchlight battalions.
- (7) Five barrage balloon battalions (very low altitude).¹

14. Phase II Requirements:

a. Antiaircraft artillery requirements for the second phase (D-Day to D-plus-240) were based on furnishing protection for the following:

- (1) Army group headquarters with three armored divisions and one airborne division (reserve).
- (2) Three field armies each having three infantry corps

1 P 48 Bibliography Par 9

(three infantry divisions each), one armored corps (two armored divisions each), and army reserve (one infantry division and one armored division).

- (3) Four major and eight minor ports.
- (4) 47 supply depots, 32 class III dumps, 10 class V installations, 44 tank farms, 65 airdromes, and 80 daily trains.¹

b. These missions included those previously considered in Phase I. Total antiaircraft artillery requisitioned to accomplish these missions was as follows:

- (1) 17 brigade headquarters and headquarters batteries.
- (2) 58 group headquarters and headquarters batteries.
- (3) 77 gun battalions (mobile).
- (4) 95 automatic weapons battalions (mobile).
- (5) 54 automatic weapons battalions (self-propelled).
- (6) 15 searchlight battalions.
- (7) Eight barrage balloon battalions (very low altitude).
- (8) Two balloon group headquarters and headquarters batteries.¹

15. War Department Action on Phase I Requisition.

a. War Department made the following changes in the Phase I requirements which were acceptable to the European Theater:²

- (1) Three semi-mobile gun battalions substituted for three mobile gun battalions.
- (2) Seven semi-mobile automatic weapons battalions substituted for seven mobile automatic weapons battalions.

b. War Department reduced the number of very low altitude barrage balloon battalions from five, which were requisitioned, to one. This reduction was not considered acceptable by the Theater Antiaircraft Artillery Officer.

16. War Department Action on Phase II Requisition.

a. Antiaircraft artillery troops requisitioned for Phase II were reduced by the War Department as follows:²

<u>Deleted</u>	<u>Substituted</u>
Two brigade headquarters and headquarters batteries	None
12 group headquarters and headquarters batteries	None

1 P 48 Bibliography Par 9

2 P 48 Bibliography Par 10

19 gun battalions (mobile)	None
19 automatic weapons battalions (mobile)	Five automatic weapons battalions (self-propelled)
Two searchlight battalions	None
Three barrage balloon battalions (very low altitude)	None
Two barrage balloon group headquarters and headquarters batteries	None

b. The troop basis, as revised, reduced the antiaircraft artillery troops planned for the European Theater at the end of D-plus-240 by some 30,000. In discussion of this basis, the Theater Antiaircraft Officer stated:

"The present troop basis provides a lower scale of AAA than is desirable, but it is acceptable in view of the revised air appreciation excepting that the number of barrage balloons should not be below four."

17. Revision in Plan.

a. After the Phase II requirements had been computed, based on the missions listed in paragraph 14 above, additional ground force units were scheduled for the theater as follows:

- (1) One army headquarters.
- (2) Two corps headquarters.
- (3) Two armored divisions.
- (4) One airborne division.

b. In view of the additional ground force requirements and the reduction in antiaircraft troops to be provided, it was planned to reduce the scale of defense of ports and airdromes.

18. Reduction in Scale for Field Forces.

a. In view of the critical manpower shortage in the United States, the need for augmentation of other arms and the reduced capabilities of the German Air Forces, the amount of antiaircraft artillery initially allocated to the European Theater was considerably reduced. On 10 September 1944 the following scales of antiaircraft artillery for field forces were established¹

Division

- (1) One automatic weapons battalion (mobile or self-propelled).

Corps

- (1) One group headquarters and headquarters battery.
- (2) One gun battalion (mobile).
- (3) One automatic weapons battalion (mobile).

Army

- (1) One brigade headquarters and headquarters battery.
- (2) Two group headquarters and headquarters batteries.
- (3) Two gun battalions (mobile).
- (4) Four automatic weapons battalions (mobile).

b. The antiaircraft artillery to be allocated to field forces on the above scale was for four armies (First, Third, Ninth and Fifteenth), 12 corps, 38 infantry divisions, and 15 armored divisions.

19. Reduction in Scale for Air and Service Force Installations.

Allocations of units for protection of installations in rear of army areas were reduced to the following:¹

- a. Six brigade headquarters and headquarters batteries.
- b. 12 group headquarters and headquarters batteries.
- c. Seven gun battalions (mobile).
- d. 12 gun battalions (semi-mobile).
- e. Three automatic weapons battalions (mobile).
- f. 18 automatic weapons battalions (semi-mobile).
- g. Four searchlight battalions.

SECTION 3

ALLOCATIONS ACTUALLY MADE

20. Theater.

a. Units actually in the European Theater on 15 October 1944 and 1 May 1945 are shown in Appendix I. A total of approximately 112,000 antiaircraft artillery troops arrived in the European Theater from the United States by the end of the war as compared with approximately 160,000 initially allotted.

b. In August 1944 the 6th Army Group brought to the European Theater of Operations, United States Army, the following antiaircraft artillery units:¹

- (1) Four brigade headquarters and headquarters batteries.
- (2) 12 group headquarters and headquarters batteries.
- (3) Seven gun battalions (mobile).
- (4) Nine gun battalions (semi-mobile).
- (5) 11 automatic weapons battalions (mobile).
- (6) Four automatic weapons battalions (semi-mobile).

¹ P 48 Bibliography Par 11

(7) Three automatic weapons battalions (self-propelled).

(8) Two searchlight battalions.

Of these, six groups, seven gun battalions (semi-mobile), two automatic weapons battalions (semi-mobile), and one searchlight battalion were scheduled for deactivation early in 1945. The remaining units were divided between the Air Defense Command and 6th Army Group, maintaining essentially the same scale for the field forces as was provided for 12th Army Group.

21. War Department Doctrine on Allocations to Theater.

a. War Department doctrine on allocations of antiaircraft artillery units to theaters is brief and general. Paragraph 27 of Field Manual 4-100, June 1943, states:

"For forces assigned to overseas possessions, bases, defense commands, theaters of operation, and zones of the interior, AAA units are provided as required by the missions of the forces."

This doctrine was followed in determining requirements for the European Theater; that is, the mission to be accomplished was determined and adequate defense scale for each mission established, and total allocations requested were the sum of these requirements.

b. It is impossible to foresee every antiaircraft artillery mission in planning an operation. In this operation some units did not perform missions as planned. For example, the requirements for the defense of Antwerp against pilotless aircraft could not be foreseen during the planning stages, and although plans provided for gun defense of airfields, guns were very rarely used for that purpose.

c. While no great difficulty resulted from the failure of missions to materialize as planned, it is believed a more definite planning guide is needed. At the present time the division is the basic unit for large scale planning. The number of supply installations, ports, trains, airdromes, et cetera, will, in general, depend upon the number of divisions employed. Activations and allocations of antiaircraft artillery units for use in a theater could, therefore, be determined by using the division as a yardstick.

22. Field Forces. The scale of allocation initially planned for the field forces was maintained. Since additional antiaircraft artillery units were received with 6th Army Group, and since Fifteenth United States Army did not receive its allocated antiaircraft artillery, it was not necessary to affect the reduced scales described in paragraph 18. Final attachments of units to the field forces is shown in Appendix I.

23. War Department Doctrine on Allocation to Field Forces.

a. Concerning allocations to field forces, Chapter 2 of Field Manual 4-100, June 1943, states:

"One automatic weapons battalion is the usual allotment to each division . . . Two automatic weapons battalions are the usual allotment of AAA to the corps, as gun protection is normally not necessary. Where, due to its mission, gun protection is needed, one or more gun battalions are attached . . . A

normal attachment of AAA to an army might be one AA brigade of two AA groups, with a total of three gun battalions, three automatic weapons battalions, and two searchlight battalions¹.

b. These scales were exceeded in allocation of antiaircraft artillery units to the field forces in the European Theater.

24. Air and Service Force Units. The chief reduction in allocations within the European Theater was made in units earmarked for air and service forces. Near the end of the war, about 37,000 antiaircraft troops were assigned to missions in rear of the armies as compared with some 125,000 initially planned. Final assignment of units to the IX Air Defense Command is shown in Appendix I.

25. No Scales for Defense of Rear Areas are established in present War Department doctrine. These areas include, in addition to air and service force installations, shipping, ports, cities, and lines of communication.

SECTION 4

SUFFICIENCY OF ANTI-AIRCRAFT ARTILLERY

26. Sufficiency of Allocations to European Theater. In determining the sufficiency of antiaircraft artillery allocated to the European Theater, consideration is given to the following factors:

- a. Experience in the North African and other theaters.
- b. Air situation.
- c. Damage inflicted by enemy air effort.

27. Comparison With the North African Theater. In the European Theater on D-Day the ratio of antiaircraft artillery troops was 4,800 per division. On VE-Day the scale was considerably lower. At that time, for a total of 61 divisions (42 infantry, 15 armored and four airborne) there were approximately 132,000 antiaircraft artillery troops, or approximately 2,200 per division. Scales were considerably higher in the North African Theater. At the end of May 1943, the ratio there was approximately 6,500 antiaircraft artillery troops per division.¹ For the invasion of Southern France, antiaircraft artillery troops were provided on the scale of about 9,300 per division.

28. Air Situation.

a. The light scale of antiaircraft artillery employed in the European Theater can be justified only by consideration of the air situation. The OVERLORD Appreciation, assuming no changes in enemy air strength and disposition between 1 June 1943 and D-Day, indicated that the enemy would have a strength on the western front of 1,740 planes of all types. These planes were dispersed from Norway to the Spanish border. Against this strength, it was estimated that the United States Army Air Forces and the Royal Air Force (British) would have 11,377 planes.²

1 P 48 Bibliography Par 13.

2 P 49 Bibliography Par 14.

b. The OVERLORD Appreciation estimated that the type and number of sorties which could be accomplished to oppose the invasion on D-Day were as follows:

<u>Type of Aircraft</u>	<u>Number</u>	<u>Sorties on D-Day per airplane</u>	<u>Total Sorties</u>
Long range bombers	120	1 ½	180
Bomber reconnaissances	30	1 ½	45
Single-engine fighters	425	4	1700
Fighter bombers	66	4	264
Twin-engine fighters	0	2	0
Army cooperation	<u>14</u>	2	<u>28</u>
Totals	655		2217

An additional 75 single engine fighters were considered as possible reinforcements on D-plus-one.¹

c. Later air appreciations indicated that 1,350 enemy aircraft, consisting of 550 long range bombers, 70 fighter bombers, 220 twin-engine fighters, and 110 reconnaissance aircraft would be available to the enemy on D-Day with a possible reinforcement of 200 single-engine fighters and 100 twin-engine fighters by D-plus-one. Total sorties considered possible were 1,800 on D-Day, falling off to 1,009 on D-plus-six. In total numbers of aircraft available, the Allies had a tremendous advantage. This advantage was reduced by our greater distances from airfields and the necessity of providing standing patrols. Even considering these disadvantages, it was expected that we would be able to maintain considerable air superiority in the daytime. Due to the small number of night fighters available to our air forces, it was not expected that the same degree of superiority could be maintained at night.²

29. Damage Inflicted by Enemy Air Effort.

a. The scale of attacks expected did not materialize and our air superiority was even greater than anticipated. The total number of enemy sorties in the American Sector from D-Day to D-plus-six, inclusive, was 147.³

b. Effects of enemy air attacks are summarized in Supreme Headquarters Allied Expeditionary Forces Air Defense Reviews. An examination of these reports indicates little damage to vital installations and few casualties as a result of enemy air activity in the American sector. Only a small percentage of the total Allied casualties was due to enemy air action.

30. Conclusions as to Sufficiency of Antiaircraft Allotted to the European Theater. In general, antiaircraft allotted to the European Theater was sufficient for the operation as planned and executed. It would be extremely dangerous, however, to conclude that such scales would be sufficient under conditions where such a degree of air superiority does not exist. It is considered improbable that in the initial phases of another war such air superiority will exist. Determination of adequate scales for future allotments to theaters must be based on experience in theaters where the enemy had control of the air.

1 P 49 Bibliography Par 14.

2 P 49 Bibliography Par 15.

3 P 49 Bibliography Par 16.

TACTICAL EMPLOYMENT WITH THE GROUND FORCES

SECTION 1

NORMAL ANTI-AIRCRAFT ARTILLERY MISSIONS

31. War Department Doctrine for the Tactical Employment of Anti-aircraft Artillery Guns in their normal role (as enunciated in Field Manuals 4-100, June 1943, and 44-4, June 1945) has been found to be sound. This conclusion is reached from a study of many "After Action Reports" submitted by antiaircraft artillery gun battalions, and of corps and army field orders¹. There were instances when the doctrine defined in the above field manuals was not rigidly followed. This was because the German Air Force, as has already been stated, had been materially reduced in strength before the Normandy invasion. One noticeable omission in the use of current doctrine was that the main effort in the attack of a corps or army was seldom given a preponderance of antiaircraft artillery gun protection. If the German Air Force had been stronger, corps and army commanders would have been forced to employ their antiaircraft artillery more closely to current doctrine.

32. Automatic Weapons.

a. Towed and Self-Propelled Units.

- (1) Doctrine in General: The doctrine as defined in Field Manuals 4-100, June 1943, and 44-2, December 1944, for the tactical employment of antiaircraft artillery automatic weapons in their normal role was proven to be sound. The statements made in paragraph 31 in regard to non-use of doctrine applies equally as well for automatic weapons.
- (2) Enemy Air Tactics. Immediately after D-Day the enemy started using toe-top tactics and fast speeds for daylight attacks by fighters and fighter-bombers. It was generally found that there was insufficient time to employ properly the M-5 directors against these low-flying, suddenly-appearing, high-speed targets. The First United States Army discarded the directors before D-Day and, later, a number of forward units discarded the directors and employed on-carriage sights exclusively.
- (3) Jet-Propelled Airplanes. When the German Air Force jet-propelled plane became operational, it became necessary for automatic weapons battalions to move observation posts a greater distance than normal from the objective.
- (4) Employment with Divisions. In armies and corps there were considerable differences in the manner in which

1. P 49 and 50 Bibliography Per 19 through 29.

automatic weapons battalions were employed. Some divisions had an antiaircraft artillery battalion attached, while in others, the battalion supported the division and remained attached to the corps. There was considerable variation in the manner in which different divisions employed their antiaircraft artillery. The 1st Infantry Division¹ had its automatic weapons battalion on a straight attachment and seldom used it except in its normal role. The 3d Infantry Division had its automatic weapons battalion attached and, in turn, attached three fire units (M16B's) to each infantry regiment. The remainder of the battalion was attached to the division artillery. The fire units attached to the infantry regiments were employed in both the primary and secondary roles. The 75th Infantry Division¹ attached its automatic weapons battalion to the division artillery. The automatic weapons battalion supporting the 78th Infantry Division¹ was, at times, attached to a corps antiaircraft artillery group, and supported the division under the operational control of the division artillery. There was a deviation from current doctrine by most of the automatic weapons battalions originally assigned to the First Army. All 32 M51's were removed from the battalions and 16 M16B's (personnel half-tracks with an M45 mount) issued in lieu thereof. This action made the battalions partly self-propelled and the M16B's were at times employed as separate fire units. Area defense by automatic weapons within the corps and division areas was not employed extensively. Most of the antiaircraft artillery automatic weapons battalions attached to or supporting a division, were directed to provide antiaircraft artillery protection for the field artillery battalions and have the antiaircraft artillery batteries follow them wherever they went. The procedure resulted in bunched-up, or scattered, "islands of defense" in the corps and division areas. This method of employment left much of the division area exposed to attack. The XIX Corps antiaircraft artillery Officer employed a coordinated area defense system². The system meant the placing of automatic weapon symbols in each 1,000 yard or meter square on a map and then, terrain permitting, placing the guns on the ground as indicated by the symbols. In all movements, except the fastest pursuit, the units occupying the "rear" squares, by leap-frogging over the forward "squares" kept up with the forward movement and gave overall protection to the corps or division area. These tactics provided rest for gun crews, more adequate antiaircraft artillery intelligence service and provided constant protection for the field artillery no matter how much it shifted around in the division and corps areas. The tactics employed by the German Air Force, especially their jet-propelled aircraft, appear to justify the effectiveness of the

1. P 49 Bibliography Par 19.

2. P 50 Bibliography Par 32.

"area defense". Antiaircraft Artillery Intelligence Report Number Seven, Third United States Army, 18 September 1944, states: "This week, the only targets definitely known to be attacked were AAA and field artillery gun positions with other targets being hidden from view. To date, of these targets still being attacked, percentages are as follows:

Bridges	35
Field artillery positions	6
Antiaircraft positions	6
Cities	4
Armored columns, considerable".	

At the present time, Field Manuals 4-100, June 1943, and 44-2, December 1944, do not illustrate how coordinated area defense tactics are used.

- (5) Defending Troop Movements. During the last months of the European campaigns, the German Air Force used its dwindling air strength to make sporadic raids on troop movements. The doctrine of interspersing anti-aircraft automatic weapons throughout an entire column--to counteract such tactics--proved to be effective.
- (6) Employment in Retrograde Movements. The shock of the German Ardennes offensive so seriously interfered with the communications systems that it was difficult to make all withdrawals in a planned manner. Antiaircraft units in several instances were by-passed by the infantry and were in direct contact with the enemy. As the initial shock of the breakthrough began to wane, the anti-aircraft artillery units on the flanks of the Bulge withdrew, and then were employed according to doctrine.
- (7) Amphibious Operations. In planning for the Normandy invasion the Antiaircraft Officer, First United States Army, issued Antiaircraft Bulletin Number Two, "Doctrine for the Employment of Antiaircraft Artillery in Amphibious Operations"². This directive, in paragraph 3c, deviates from current doctrine in that it prescribes that provisional anti-aircraft artillery machine gun batteries will be organized from existing automatic weapons battalions and landed with the second or third assault wave. A provisional anti-aircraft artillery machine gun battalion was organized from the 397th Antiaircraft Artillery Automatic Weapons Battalion (Semi-mobile)³ to provide initial anti-aircraft machine gun protection of assault troops on the Omaha Beach. Because of heavy hostile fire from the beach, only eight of the 36 machine guns in the provisional battalion were successfully landed and employed. This operation was a special case made to fit a special situation and was justified⁴. Another unusual usage

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1. P 50 Bibliography Par 32.
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of automatic weapons was employed by the remainder of the 397th Antiaircraft Artillery Automatic Weapons Battalion (Semi-mobile) plus two batteries from the 481st Antiaircraft Artillery Automatic Weapons Battalion (Semi-mobile) attached. This organization was assigned the mission of providing antiaircraft artillery protection for the artificial port "Mulberry" at Omaha Beach and for the "Gooseberry" anchorages at both Omaha and Utah Beaches. The mission was divided into two phases: First, the crossing of the channel and second, the operation of the "Phoenix" and "Gooseberry" units after they had been set down on the far shore. The first phase consisted of: (1), mounting one 40 millimeter gun on each of 37 "Phoenix" units, a concrete barge designed to serve as a breakwater for the artificial harbor at Omaha Beach, and manning them for the trip across the English Channel; and, (2), mounting 24-40 millimeter guns on 22 old cargo ships and one old battleship (British), to be used as block ships at Omaha and Utah Beaches, and manning them with small detachments for the trip across the English Channel. Two of the "Phoenix" units were lost crossing the channel--one was rammed by its tug and sunk and one was torpedoed. The rest arrived safely soon after D-Day and were sunk in place. Twenty-eight of them were manned, thus providing antiaircraft artillery protection for the harbor. The "Gooseberry" units (blockships) successfully crossed the channel and arrived at their destination on D-plus-one. They were successfully sunk in place on D-plus-three. By D-plus-14 the 40 millimeter guns were manned by additional personnel from the "Mulberry" units. A severe storm on 20 June 1944 wrecked most of the "Phoenix" units and the blockships. Only two "Phoenix" units and five of the blockships at Utah Beach could be manned after 24 June 1944. Between 8 and 16 June 1944 there were 40 hostile air raids in which the antiaircraft artillery defenses of the "Mulberry" and "Gooseberry" units fired on enemy planes. Two enemy aircraft were destroyed and one probably destroyed in this action. An additional role for antiaircraft automatic weapons in an amphibious operation was enacted by the units assigned to the First United States Army. All units whose guns were deck loaded received orders before embarking for the Normandy invasion, to prepare the guns for firing and supplement the antiaircraft weapons of the ship. Many of the guns were partially de-waterproofed and prepared for action.

b. Airborne Units. No airborne antiaircraft artillery batteries or battalions were employed in the European Theater except those antiaircraft-anti-tank battalions integral with the airborne divisions. The antiaircraft and anti-tank battalion of the 82nd Airborne Division was employed as an antiaircraft machine gun battalion during the Normandy invasion on Utah Beach¹.

33. Searchlights.

a. Five United States antiaircraft artillery searchlight battalions saw combat service in the European Theater for periods ending on

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<u>Battalion</u>	<u>Period Beginning</u>
225	19 June 1944
226	15 September 1944
231	21 September 1944
353	13 September 1944
357	30 December 1944

b. War Department doctrine as enunciated in Chapter 2, Field Manual 44-6, indicates the various tactical roles in which searchlights may be employed. For purposes of this study, these roles are treated under normal antiaircraft artillery missions, ground support missions and seacoast missions. An analysis of employment in these roles by percentages is tabulated below (fractions less than one percent have been disregarded):

	<u>Battalions</u>					<u>AVERAGE</u>
	225	226	231	353	357	
Normal AAA Missions	39	12	95	42	60	49.6
Illumination Guns	0	0	0	0	0	None
of Hostile Auto Wpns	0	(10)	(5)	(42)	(30)	(17.4)
Aircraft for Fighter Aviation	0	0	0	0	0	None
Homing Beacons and Illumination of Landing Strips	(39)	(2)	(90)	0	(30)	(32.2)
Ground Support Missions	41	88	1	58	40	45.6
Battlefield Illumination	(21)	(75)	0	(58)	(15)	(33.8)
Illumination for Construction	(20)	(13)	(1)	0	(25)	(11.8)
Seacoast Missions	0	0	1	0	0	0.2
Other Uses -	20	0	3	0	0	4.6
Weather Forecasts, i.e.,						
Coiling Measurement						

This tabulation does not include 18 months' experience of the 353d Searchlight Battalion in the Mediterranean Theater. Percentages for this battalion are estimated from its narrative report and may be subject to considerable error.

c. Tactical employment under normal antiaircraft missions will be considered in this section. Other uses will be discussed in subsequent sections. Searchlights were not used in the European Theater to illuminate hostile aircraft for 90mm guns. The development of radar has advanced to such an extent in its search and gun-laying characteristics that it is considered safe to assume that searchlights can be eliminated from any planning for future use of antiaircraft artillery guns.

d. It is also observed that searchlights were not used on the European Continent to illuminate hostile aircraft for our own fighter aviation. The waning strength of the German Luftwaffe, the great power and offensive tactics of our own air force, the large areas involved, the dispersion of vital targets and to some extent, the development of allied night-fighters, made the use of fighter-searchlight defensive tactics unnecessary and uneconomical.

e. Considerable use was made of searchlights in the illumination of hostile targets for automatic weapons. It is estimated that 17.4 percent of the total effort of antiaircraft artillery searchlights on the European Continent was devoted to this purpose. However, the development of radar for early warning, search, and gun-laying has now reached such a state of proficiency that it is believed that the use of searchlights in connection with antiaircraft artillery of both major and minor caliber may be eliminated from future planning.

f. It is also observed that 32.2 percent of the antiaircraft artillery searchlight effort was devoted to use as homing beacons and illumination of airstrips.

g. A recapitulation and consolidation of the employment of the five antiaircraft artillery searchlight battalions in the European Theater indicates the following, by percentage:

Illumination for guns	None
Illumination for automatic weapons	17.4
Illumination for fighter aviation	None
Illumination at landing strips and use as homing beacons	<u>32.2</u>
Total for normal antiaircraft artillery missions	49.6

h. It is significant to observe that of all the missions classified as normal antiaircraft artillery missions, 65 percent are in connection with homing and landing strip illumination for the air forces, and also that the greater portion of the illumination for automatic weapons was in connection with the defense of airfields.

i. War Department doctrine was generally adhered to, the only notable exception being the small scale in which the lights were used. One platoon or less was found to be sufficient at any given objective, usually an air base or landing strip, with the resulting dispersion of searchlight units to the extent that proper command and administrative supervision by battery and battalion commanders became seriously handicapped.

34. Antiaircraft Artillery Barrage Balloons.¹

a. War Department doctrine on the employment of barrage balloons is enunciated in Field Manual 4-181, June 1943, as amended. The 320th Antiaircraft Balloon Battalion (Very Low Altitude) was the only American balloon unit employed in the European Theater. Its employment followed the tactics prescribed by War Department doctrine as closely as circumstances would permit. Only singly-flown balloons were employed. No use was made of tandem-flown balloons.

b. One noteworthy innovation to meet local conditions was the substitution of Signal Corps RL-31 reel unit with a DR-4 drum, weighing approximately 50 pounds, for the M-1 motor winch, weighing 1070 pounds, or the Mark VII hand winch, weighing 365 pounds. This improvisation proved to be a workable temporary substitute, as it enabled the balloons to be "walked" ashore by balloon crew members from landing craft. Rope leashes were used for this purpose. However, it left much to be desired, as the core of the DR-4 drum is so small in diameter that it kinks the flying wire at times, thereby causing the wire to break when placed under tension. Also the combination will not stand up for

1. P 50 Bibliography Par 36.

continued operation under the severe strain of hauling in a balloon in windy weather.

c. The operations of the 320th Antiaircraft Balloon Battalion (Very Low Altitude) followed procedures agreed upon between the Balloon Command, Royal Air Force, United States Navy, Royal Navy and First United States Army. Balloons were inflated at shore servicing stations and then transported to the various harbors and quays, where they were installed on vessels for cross-channel operations.

d. The battalion established a barrage of 92 balloons on Omaha Beach and one of 53 balloons on Utah Beach on 6 June 1944 (D-Day).

e. On 23 July 1944 one battery was withdrawn from Omaha Beach and established a modified ring barrage at Cherbourg, which was maintained until 19 September 1944.

f. Incident to the initial assault and follow-up, the battalion formed 155 balloon crews of three men each before departure from England. Each crew, with its assigned balloon, was located on a separate vessel. Upon arrival at the designated beach the crew removed its balloon and "walked" it ashore. Intermediate landing craft were used to remove balloons from the large vessels. Replenishment of balloon losses was made by removing one-half of those carried by vessels on subsequent cross-channel trips.

g. Shortly after the first balloons were landed they were ordered to be cut adrift or shot down, as it was thought that the enemy was using them as an artillery aiming point. Later information proved this assumption to be erroneous, as it was found that the enemy had complete fire control data previously prepared.

h. In reviewing the employment of barrage balloons in the European Theater, it is believed that no major change in War Department doctrine is indicated. Once the balloons were ashore, their employment was substantially in accordance with existing doctrine. The mechanics of transporting the balloons from England to France, establishing barrages in Normandy upon arrival, and coordinating the interests of the armies, navies and air forces of two nations must be regarded as a special operation for which special plans were made.

i. It is believed that current tactics should be expanded to include the use of man-portable reels and winches for amphibious operations.

SECTION 2

GROUND SUPPORT MISSIONS

35. Antiaircraft Artillery Guns.

a. As Antitank Artillery:

- (1) Present doctrine emphasizes that the primary mission of antiaircraft artillery guns is the engaging of hostile aircraft and that antitank missions are secondary. However, in the European Theater, antiaircraft artillery guns were often employed in their secondary role. One antiaircraft artillery gun bat-

talion was attached to each of two armored divisions¹ with instructions that a sound doctrine be worked out for the employment of 90mm antiaircraft artillery guns in a tank destroyer role. In the initial assault on Metz, the commanding general of the 90th Infantry Division artillery assumed command of two batteries of the 119th Antiaircraft Artillery Gun Battalion in an emergency, and ordered them into an antitank defensive role near Bricy, France, (WU7073). The antitank role as executed by the 143d Antiaircraft Artillery Gun Battalion² in the German Ardennes offensive is a notable one. This action was coordinated with that of the tank destroyer battalion supporting the 30th Infantry Division² and provided a pivot of maneuver for the employment of the tank destroyer battalion. The 90mm antiaircraft artillery guns were sited in depth from the regimental reserve line towards the rear.

- (2) Although 90mm antiaircraft artillery guns have been used successfully as antitank weapons, they were not designed for dual-purpose. The 90mm M.L.L. is not mobile enough to be considered a suitable frontline weapon¹. It has a high silhouette, unless dug in, and is lacking in protective armor. The gun and its crew are vulnerable to small arms fire unless fortifications are constructed, which in turn adversely affect mobility.

b. As Field Artillery:

- (1) antiaircraft artillery gun battalions were used as field artillery in the Normandy invasion¹. This use increased² in magnitude until VE-Day. The diversion of antiaircraft artillery guns to a field artillery role was made possible by the decrease in activity of the German Air Force.
- (2) There were a few deviations from the doctrine as published in Field Manual 44-4, June 1945, and War Department Training Circular, Number 23, 8 April 1944. Some battalions requested the field artillery to make the position area surveys as well as the target area and connection surveys because of shortages of aiming circles. There were a few instances in which the antiaircraft artillery gun battalions were controlled entirely by the field artillery fire direction center. The 119th Antiaircraft Artillery Gun Battalion devised a method of operating an observation post by the use of radar³.

36. Automatic Weapons.

a. Although antiaircraft artillery automatic weapons were not designed for employment in a primary role as infantry support, they were extensively employed as such in the European Theater. They assisted

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1. P 50 Bibliography Par 33.
 2. P 50 Bibliography Par 32.
 3. P 50 Bibliography Par 31.

materially in the assault against the Normandy beaches¹. From D-Day to VE-Day division commanders, recognizing the fire power of these weapons, used them more and more in infantry support roles. Their employment was planned in advance in some cases¹ but the majority of these were on-the-spot decisions¹. They have been employed on numerous occasions to assist in breaking up counterattacks, in which role they have been very effective¹. Half-tracks have been employed with reconnaissance and screening elements of a corps, providing both antiaircraft protection and ground support¹. All types of automatic weapons have been successfully employed in the support of bridgehead operations and especially those at Hemegen, (F6420) and Oppenheim, (M4539), in Germany¹. Usually, in this type of employment, the ground support for the Engineers is rendered from normal antiaircraft artillery positions¹. Because of the great fire power of the automatic weapons, they were effectively used in clearing out woods¹.

b. The doctrine on tactical employment of automatic weapons in ground support roles, as defined in Field Manual 44-2, December 1944, did not reach the combat troops until early Spring of 1945, and was too late to be fully tested by actual experience. Automatic weapons battalions had to work out their own tactical doctrine for employment in a ground role and these varied between units. The War Department issued a "Tentative Training Circular on Employment of Antiaircraft Artillery Automatic Weapons in a Ground Support Role" in the early part of 1945, which was based on experiences in the European Theater and combined maneuvers². There is a great need for the incorporation of this doctrine in Field Manual 44-2. The lack of adequate War Department doctrine for the employment of automatic weapons in a ground support role was recognized by the Antiaircraft Section, Headquarters 12th Army Group³.

37. Searchlights. Antiaircraft artillery searchlights operated substantially in accordance with War Department doctrine as announced in paragraphs 9, g and h, Field Manual 44-6, March 1945.

a. The illumination of enemy ground forces or terrain, popularly known as battlefield illumination or artificial moonlight, was extensively used and received wide publicity and comment. In the early stages it was regarded with considerable apprehension and some disfavor, but as combat troops gained experience in its use, opinion swung decidedly in its favor.

b. It is noted that 45.6 percent of the searchlight effort in the European Theater was devoted to ground support missions, including battlefield illumination and illumination for construction of engineering projects.

SECTION 3

SEACOAST MISSIONS

38. Preparations Were Made for the Use of Various Antiaircraft Artillery Units in a Seacoast Role should the situation require such action. In this case War Department doctrine was implemented by Operations Memorandum

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1. P 50 Bibliography Par 33.
 2. P 50 Bibliography Par 35.
 3. P 50 Bibliography Par 32.

Number 37, European Theater of Operations, 1944. A number of units which were sited in a primary antiaircraft role along the coast, including the port of Cherbourg, were instructed to be prepared to operate against water-borne targets upon request by the Navy. In the case of antiaircraft artillery guns and automatic weapons, no action in a seacoast role was actually experienced. Four of the five searchlight battalions which saw service in this theater report no employment whatever in a seacoast role. The remaining battalion, the 231st, upon one occasion, at the request of United States Navy personnel, illuminated one water-borne target for purposes of identification. British antiaircraft units deployed in a coast defense role in the SCHELDT ESTUARY had several engagements against water-borne targets¹. On the night of 9-10 August 1944, a British unit, using captured 20mm guns, engaged one enemy human torpedo. The target was illuminated by searchlights but no hits were observed. On the afternoon of 9 January 1945 a British Bofors unit engaged and sank a midget submarine at 900 yards. During the night of 25-26 January 1945 a British 40mm unit, with the aid of searchlight illumination, engaged and sank a midget submarine at a range of 25 yards. It is concluded that the experience gained by antiaircraft artillery units in a seacoast role in the European Theater is negligible and did in no sense constitute a test of existing doctrine, and that there exists no experience upon which to base recommendations for changes.

1. P 49 Bibliography Par 16.

TACTICAL EMPLOYMENT WITH THE AIR AND SERVICE FORCES

SECTION 1

TACTICAL ORGANIZATION

39. Tactical Organization and Command of antiaircraft artillery with air and service forces, during the period August 1943 - May 1945, varied in the United Kingdom and on the Continent.

40. In the United Kingdom newly arrived antiaircraft artillery units were assigned to one of the field armies, or to Headquarters European Theater of Operations, United States Army. (Those units assigned to the field armies are considered in Chapter 2 above.) Those units assigned to Headquarters European Theater of Operations, United States Army, were either placed under the direct command of the theater antiaircraft officer¹ or were attached to subordinate commands² (air force and base section). They were utilized to provide antiaircraft artillery defense for airdromes, air depots, ports, and supply installations. Overall planning for the air defense was not a direct responsibility of United States Forces. England had organized the Air Defense of Great Britain, and the deployment of United States antiaircraft artillery units on operational sites was a supplementary factor only. To provide necessary unity, operational control (the authority to withhold antiaircraft artillery fire, searchlight illumination, and the flying of balloons) of United States units was vested in the Air Defense of Great Britain. On 22 May 1944 the organizational situation was as follows:

a. Under direct command of the Chief of the Antiaircraft Artillery Section, European Theater of Operations, United States Army, were two brigades. The first brigade, with three groups, two gun battalions, and five automatic weapons battalions attached, was deployed on operational sites defending two base air depots, six advance air depots, three Service of Supply depots and five airdromes.² The brigade was attached to the Southern Base Section for administration and supply. The second brigade, with two groups and four gun battalions attached, was on a special operational assignment. Three of its battalions were deployed along the southeast coast providing defense against PAC (see paragraph 64) and enemy raiders, and one battalion was deployed in the London area.² Command, supply and administration were identical in the two brigades.

b. Antiaircraft artillery units were attached to:

- (1) IX Air Defense Command of the Ninth Air Force.² A total of two brigades, three groups, four automatic weapons battalions, and one searchlight battalion were deployed on operational sites providing protection for airdromes and air depots of the Ninth Air Force.

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- (2) Base Section. The provisional defense plan for operation OVERLORD of the Air Defense of Great Britain, as approved by Supreme Headquarters, charged the Air Defense of Great Britain with the responsibility for antiaircraft artillery protection of shipping, operational aircraft, and troops and stores, both in preparation for OVERLORD and during the development of that operation.¹ The plan also provided for United States antiaircraft artillery units to supplement the defense, and to be operationally controlled by Air Defense of Great Britain. One brigade, two group headquarters, and four antiaircraft artillery automatic weapons battalions were attached to Southern Base Section¹ to supplement existing British deployments in the Southern Base Section. It was the duty of the commanding general of the brigade to advise the Commanding General, Southern Base Section, on matters pertaining to antiaircraft artillery defense in the base section; coordinate antiaircraft artillery defenses between attached units, antiaircraft artillery units of subordinate commands, and with British antiaircraft artillery units operationally deployed under Air Defense of Great Britain; maintain liaison with local Air Defense of Great Britain antiaircraft artillery commanders (British); properly train and tactically deploy attached units and issue necessary instructions for fire control.¹ A similar situation existed in Western Base Section, where one antiaircraft artillery group and two antiaircraft artillery battalions were attached to the base section.²

41. On the Continent the organization of antiaircraft artillery with air and service forces presented a more complex problem than in Great Britain. The final plan for antiaircraft artillery organization and air defense as devised prior to D-Day is covered in detail in paragraph eight of this study.

a. The IX Air Defense Command had been organized in the United Kingdom by the Ninth Air Force prior to D-Day to fulfill the following missions on the Continent:

- (1) To provide, with the assistance of Royal Air Force 85 Group (British), for the operation and control of night fighters in the American sector.
- (2) To follow up and relieve the IX and XIX Tactical Air Commands, supporting the First and Third United States Armies, respectively, of responsibility for daylight interception of enemy air attacks and air warning service.
- (3) To provide air warning service for, and to exercise operational control over, all antiaircraft artillery in those areas in which it has assumed responsibility.
- (4) To make air raid intelligence available to passive air defense control centers.

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2 P50 Bibliography Par 40

- (5) To supervise, coordinate and perform those movement liaison functions which were the responsibility of the Commanding General, Ninth Air Force.
- (6) To supervise and allocate all antiaircraft artillery units assigned or attached to the Ninth Air Force, and,
- (7) To supervise all airdrome defense activities within the Ninth Air Force.¹

b. The general plan was to establish as rapidly as possible behind the advancing armies an adequate and effective coordinated air defense of vital installations. Initially, the defense was to consist of ground-controlled day and night fighters and of operationally-controlled antiaircraft artillery units. The defense was to be ultimately supplemented by fighter-searchlight teams as required. Five air-defense areas were to be set up with a regional operations room located at one of the areas. The area operations rooms were to be employed in the control of day and night fighters and the operational control of antiaircraft artillery in the area, and were to serve as information centers. Antiaircraft artillery units were to be attached to IX Air Defense Command for defense of airfields in rear of the army rear boundary,

c. To fulfill the missions assigned, the 21 and 25 Sectors, Royal Air Force (British), were attached to IX Air Defense Command, and in addition, the following units were assigned or attached: as of D-plus-30, one brigade, one group, two gun battalions and two automatic weapons battalions; as of D-plus-40, two brigades, three groups, two gun battalions and five automatic weapons battalions; as of D-plus-50, two brigades, three groups, two gun battalions and seven automatic weapons battalions.

d. The fulfillment of the Air Defense plan was not realized without changes. Initially the plan was carried out, and when the army rear boundary was established, late in July 1944, the Commanding General, Communications Zone, became responsible for rear area antiaircraft artillery protection. However, the relation of antiaircraft artillery to Service Forces was short-lived. The IX Air Defense Command had become operational on 10 July 1944, assuming operational control of the 21 Sector (British), which set up on the Cherbourg peninsula, operating night fighters in defense of the American Sector. From an operational standpoint, the command consisted of two sections, antiaircraft artillery and air; but command was exercised by an air force general, inasmuch as flying units were attached. On 9 August 1944 the antiaircraft artillery mission of the IX Air Defense Command was changed. On that date all American antiaircraft artillery units assigned to other than field armies were attached to IX Air Defense Command for the antiaircraft artillery defense of vital installations in the communications zone.² This resulted in the acquisition of six brigades, 11 groups, 12 gun battalions, one searchlight battalion and one barrage balloon battalion.¹ As the campaign progressed and it was found that enemy air attacks on our rear installations had not developed in the strength anticipated, the plan of assigning day fighters to the IX Air Defense Command was changed, and the projected plan of having three areas for the control of night fighters was reduced by one, with a corresponding decrease of one fighter squadron, one fighter control squadron, and one signal air warning battalion. With respect to relation with the service forces, until the end of the war, the

1 P 50 Bibliography Par 41

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Commanding General of the Air Defense Command provided antiaircraft artillery protection for communications zone installations in accordance with priorities established by the Commanding General, Communications Zone, and the final decision as to release of antiaircraft artillery units for primary coast defense role upon request of the communications zone commander was the responsibility of the Air Defense Commander.¹ The lack of concerted enemy air effort in rear areas prevented a test being made of the adequacy of the air defense command as organized on the continent.²

e. Coordination of the rear area defenses with forward area defenses, or more specifically, delineation of exact areas of responsibility, proved to be a matter of considerable controversy, although the problem was eventually solved. Operations Memorandum Number 7, Supreme Headquarters, Allied Expeditionary Forces, dated 8 March 1944 stated, in part, that antiaircraft artillery employed in the defense of rear area installations in an army group area would be assigned to the army group; that the army group commander might, in consultation with the air force commander, establish within his area an "army group rear boundary" behind which he might delegate to the air force commander responsibility for the defense of the rear area installations, attaching antiaircraft artillery units to the air force for this purpose. The army group commander was to retain responsibility for establishing antiaircraft artillery defense priorities within his army group area, and to retain the authority to relieve antiaircraft artillery units from attachment whenever the situation required. When rear areas ceased to be a part of army group areas, Supreme Headquarters, Allied Expeditionary Forces, would issue the necessary orders assigning antiaircraft artillery units to the headquarters charged with the general defense of the areas concerned. The Commanding General, Ninth Air Force, on 15 November 1944 proposed that a policy be promulgated which would permit Ninth Air Force (IX Air Defense Command) to defend its own installations wherever they went, in army areas as well as the communications zone, and listed his reasons for such a proposal,³ among which was the statement that his air fields were not obtaining proper antiaircraft defense in areas of 12th Army Group responsibility. The Supreme Commander caused a complete study to be made in which the 12th Army Group Commander's views were considered.⁴ Air Defense Division⁵ and A-3 Division of the Air Staff⁶, Supreme Headquarters, Allied Expeditionary Forces, studied the subject, discussing everything from War Department doctrine on air defense and allocation of antiaircraft artillery at army level to the secondary mission (ground firing) of 90mm guns. The result was the publication, on 21 January 1945, of the fifth amendment to Operations Memorandum Number 7, Supreme Headquarters, Allied Expeditionary Force, with the effect as follows: For the purposes of air defense, the United States army group area was divided into two parts by an "Army Group Rear Air Boundary". That part in rear of the boundary was defined as the army group rear area; that part in front of the boundary was defined as the army group forward area. Responsibility for the defense of ground and air force installations in the army group forward area was given to the army group commander. Responsibility for the defense of ground and air force installations in the army group rear area was given to the air defense commander. The air defense command, a unit subordinate to the

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- 1 P 48 Bibliography Par 5
 - 2 P 49 Bibliography Par 20
 - 3 P 50 Bibliography Par 42
 - 4 P 51 Bibliography Par 43
 - 5 P 51 Bibliography Par 44
 - 6 P 51 Bibliography Par 45

air force which was supporting the army group, was to employ anti-aircraft artillery units assigned to communications zone but attached to the air defense command. The "Army Group Rear Air Boundary" was to be established by the army group commander in consultation with the air force commander, and its location was to be based upon the extent to which an adequate defense could be provided by army group organic anti-aircraft artillery.

SECTION 2

TACTICAL EMPLOYMENT

42. In the United Kingdom.

a. The general tactical problem resolved itself into coordination of United States anti-aircraft artillery units with the Air Defense of Great Britain the responsibility of which was to provide the air defense for the United Kingdom. Targets defended by United States anti-aircraft artillery were airfields, airdromes, air depots, supply depots, ports, and cities. Anti-aircraft artillery, both guns and automatic weapons, was employed substantially in accordance with War Department doctrine with three general exceptions:

- (1) The units available were apportioned among such a large number of objectives that the resultant scale of defense at each objective was below standard; whereas the prescribed doctrine indicated that the objectives should be arranged in order of priority and those of highest priority given adequate defense.
- (2) In an effort to extend the defense at a given objective, the distances between adjacent fire units was excessively extended, rendering such units mutually non-supporting.
- (3) In the final selection of individual firing positions, basic military considerations gave way to economic, political and local expediency; for example, agricultural, residential or economic reasons frequently precluded selection of firing sites which would normally be considered most suitable from a purely military standpoint.¹

b. In each class of exceptions noted above, it is believed that the application of military doctrine was compromised by non-military considerations. It is not the purpose of this study to pass judgment upon the decisions made. It is, however, concluded that our current doctrine is basically sound, and no major changes are recommended.

43. Anti-aircraft Artillery units on the Continent were employed to defend vital points which can be segregated into three types: airdromes, area targets, and point targets.² A discussion of the three types of objectives, and of the deployment of searchlights, automatic weapons, and heavy anti-aircraft follows:

1 P 51 Bibliography Par 46
2 P 51 Bibliography Par 47

a. The Airdromes for which the IX Air Defense Command was responsible were those of four tactical air commands, one bomber command, service command depots and transport airdromes. One brigade or group, with attached units, was assigned the mission of providing anti-aircraft artillery defense for the airdromes of each command. On the basis of anti-aircraft artillery available and enemy capabilities, normally but one battery of automatic weapons was allocated to each field. One platoon of searchlights was provided for fighter and night bomber fields, and for forward fighter fields to the extent of searchlights available. Each fire unit and searchlight had telephone communications direct to a command post so that positive control could be exercised. The command post, in turn, maintained liaison with flying control. The anti-aircraft artillery on the airdromes was governed by the rules for engagement at airfields and special rules prescribed by the airdrome commander.

b. Area Targets included, in general, ports, important cities, and large supply depots. In the case of large cities or ports, one brigade with attached units was assigned the mission of providing anti-aircraft artillery defense. Normally, guns provided the overall defense of the area, and automatic weapons, with searchlights occasionally furnishing illumination, provided defense for the smaller targets within the area. The area was usually set up as an inner artillery zone or gun defended area and the anti-aircraft artillery was governed by the rules for engagement of that type restricted area. An anti-aircraft operations room was installed, and communications established to each fire unit so that control could be exercised over each fire unit. In addition, intelligence lines from the gun radar sites to the anti-aircraft operations room were installed to provide anti-aircraft artillery intelligence service. From the anti-aircraft operations room, communications were maintained to the nearest area operations center. It was the responsibility of the anti-aircraft artillery unit charged with the defense of the area to furnish anti-aircraft artillery personnel to the area operations center. These persons acted as assistant controllers, anti-aircraft artillery. Operational control of anti-aircraft artillery units defending vital areas which were in communication with operation rooms was vested in the chief controller, an air force officer, at the area operations center. It was his responsibility to decide which means of defense, anti-aircraft artillery or night fighters, could most successfully meet the attack. If he decided to intercept the raids with fighters, the fighters were allowed freedom of action, even in restricted anti-aircraft artillery zones. Under such circumstances the controller, through the assistant controller, anti-aircraft artillery, advised the anti-aircraft artillery units concerned that friendly fighters were in the area and that anti-aircraft artillery fire was restricted.

c. Point Targets were, in general, small vital installations such as highway or railroad bridges. Usually one or more batteries of automatic weapons with searchlights were allocated for their defense, depending on their importance, vulnerability, and the anti-aircraft artillery available. These fire units usually operated under the rules for an unrestricted area,

d. Searchlights. For a tabulation and analysis of the use of searchlights, reference is made to paragraph 33, chapter 2, of this study.

e. A study of anti-aircraft artillery questionnaires answered by automatic weapons battalion commanders who operated with the air force reveals the following:

- (1) Usual deployment placed 40mm guns on an outer ring around the objective.
- (2) 4.51's (multiple mounts) were considered as separate units and were placed on an inner ring, providing defense in depth.
- (3) Only in isolated cases were 40mm guns more than 1200 yards apart, most often being sited 700 to 800 yards apart.
- (4) Dead areas in many cases of airdrome protection were all directed toward the objective.
- (5) All-around coverage was provided without exception other than occasional incidents where unfavorable terrain prevented.

The major criticism of the siting of automatic weapons on the Continent lies in the apparent tendency to place guns farther apart than is normally considered best. No major changes are indicated in current published War Department doctrine as a result of this study.

f. Heavy Antiaircraft Gun Employment, as discussed in War Department publications, calls for all-around defense of the objective, a normal use of at least one battalion in the defense of a single objective, and mutually supporting batteries; actual deployment or siting of batteries is dependent upon the type of air attack expected, including altitude and speed of the aircraft and the expected length of hostile bombing runs. A study of the questionnaire answered by battalion commanders of gun units attached to the IX Air Defense Command reveals that departure from the general doctrine was not a common occurrence. No changes in published doctrine are indicated.

g. Barrage Balloons were used very little on the Continent, especially with the air force. Only one battalion was present on the Continent, and after its initial use on the beaches, one battery was employed in a modified ring defense of Cherbourg for a period during a small part of which the defenses of Cherbourg were a responsibility of the IX Air Defense Command. Lack of enemy air activity, the short period of time, and the small number of balloons involved precludes the possibility of reaching any conclusions as to barrage balloon employment, particularly as might effect the making of recommendations for changes in, or additions to, War Department doctrine on their employment.

h. Special Ramifications of tactical employment of antiaircraft units were developed and used during the campaign as a result of attacks by German pilotless aircraft weapons on Antwerp and Liege. A complete discussion of the antiaircraft artillery defense against pilotless aircraft, including the deployment of weapons, is included in Chapter 6 of this study.

ANTIAIRCRAFT ARTILLERY INTELLIGENCE SERVICE

SECTION 1

BACKGROUND, SCOPE AND PURPOSE

44. Widespread Dissatisfaction With Air Warning in the European Theater has led to this examination of the plans used and their adequacy, with a view to proposing a doctrine which will assure an efficient system for use in future operations. Antiaircraft Artillery Intelligence Service and Air Warning Service are so inter-locking and mutually dependent that it is considered impracticable to discuss them separately. Lately, this has become particularly true because of the development of radar and because of the increased ranges and speeds of aircraft. This study, therefore, will consider the problem under the more inclusive heading of air warning systems.

SECTION 2

GENERAL PLANS OF AIR WARNING SYSTEMS USED

IN THE EUROPEAN THEATER

45. The General Plan in Division Units.¹ The antiaircraft artillery intelligence service nets established by divisional units conformed generally to doctrine. In static situations they were tied into antiaircraft operations rooms at corps level. In moving situations, the service frequently lost contact with the operations rooms of corps, and degenerated into a vehicle-to-vehicle warning in the case of self-propelled battalions, and into no warning at all in the case of mobile automatic weapons battalions. The status of warning generally remained at this low level until movement slowed down or stopped, at which time units experienced considerable delay in contacting a corps operations room.

46. The General Plan in Corps Units.² The antiaircraft artillery officer in corps (the commanding officer of the group normally assigned or attached to the corps) was responsible for the antiaircraft artillery intelligence service in the corps. He coordinated the nets of the divisional units with those of the corps units and controlled these nets through an operations room operated by his own or a designated lower headquarters (the operations room of a gun battalion, if available). The operations room was connected either directly to an Air Force source of early warning or to an antiaircraft operations room at army level from which early warning was received by a relay from the latter. This system broke down into separate battalion systems when movement of the corps operations room took place. Openings in the net occurred when the battalions moved.

1 P 49 Bibliography Par 20

2 P 49 and P 51 Bibliography Par 20 and 54

47. The General Plan in Army Units.¹ The warning system in the army areas corresponded to that in corps, with the responsibility for anti-aircraft artillery intelligence service delegated to group commanders. The service in this area, except in cases of very rapid and extensive movements, remained more stable because of proximity to the anti-aircraft operations rooms, which were either in close liaison with the aircraft warning service of the tactical air commands or integrated with tactical control centers.

48. The General Plan in Units of the Communications Zone.¹ On the continent the air defense of the communications zone was the responsibility of the Commanding General, IX Air Defense Command. Anti-aircraft Artillery Intelligence Service was the responsibility of subordinate area defense commanders. In large or important defenses, early warning was effected through anti-aircraft operations detachments operating in close liaison with the air force Air Warning Service. In such instances early warning was reasonably effective. However, in the case of many small units operating in isolated areas, this service was entirely lacking. During movement part or all of the Air Warning Service for a particular unit failed because of inability to maintain communications.

SECTION 3

DEVIATIONS FROM WAR DEPARTMENT DOCTRINE

49. War Department Doctrine Requiring Modification. War Department doctrine with respect to air warning provides, in general, for an Air Warning Service under control of air force commanders, and an Anti-aircraft Artillery Intelligence Service under control of anti-aircraft artillery commanders. It further provides for liaison but forbids integration of the two services in the combat zone.² Policy, as evidenced in the tables of equipment, did not contemplate the necessity for early warning for isolated units or the general inadequacy of early warning from air force sources for anti-aircraft artillery purposes. Moreover, it does not specifically acknowledge the need for early warning for all anti-aircraft artillery units in the combat zone.

50. Major Deviations from the Doctrine.

a. During the initial phase of the operation on the Continent, First Army combined the warning service (air force)³ center and anti-aircraft artillery operation detachment in one room. In an effort to cut down the time lag, Third Army placed its anti-aircraft operations detachment in the tactical control center of the XIX Tactical Air Command.⁴

b. Early warning radars (AN/TPS-2 and comparable sets) were used at battalion level for purely early warning search purposes.⁵

1 P 49 and p 51 Bibliography Par 20 and 54

2 P 51 Bibliography Par 52

3 P 49 Bibliography Par 20

4 P 51 Bibliography Par 51

5 P 49 and P 51 Bibliography Par 20 and 49

SECTION 4

ADEQUACY OF AIR WARNING SYSTEMS

IN THE EUROPEAN THEATER

51. General. A survey¹ of the opinions of commanders of all echelons of antiaircraft artillery in the European Theater regarding the adequacy of air warning systems was made and conclusions drawn therefrom. Despite success of the system implemented according to War Department doctrine in certain areas², the general conclusion is that it was inadequate in this operation, and certainly will be inadequate in any future operations involving an enemy equipped with greater and swifter air power. In particular, air warning was not sufficiently early to permit readying the equipment for the use of directors by automatic weapons units.

52. Reasons for Inadequacy of Present Air Warning Systems. According to the consolidated opinions obtained from the survey and the opinions of Antiaircraft Artillery Committee of The General Board, the major reasons for the inadequacy of air warning, including antiaircraft artillery intelligence service, are as follows:³

a. Communications were not adequate. Frequencies were not available in sufficient numbers; the range of radios was too short; wire communications were too slow; too little equipment was available.

b. No reliable means of identifying aircraft was generally available. Direct identification was lacking and information of friendly flights was too slow, or altogether lacking.

c. The allotment of antiaircraft operations detachments was inadequate. The drain on units to improvise and augment detachments was severe.

d. Early warning supplied from air force sources was inadequate. Some antiaircraft artillery units were issued non-table-of-equipment radars to obtain their own warning, but in insufficient numbers and of types unsuited for the purpose. ✓

e. Generally, systems of warning disintegrated during movement.

SECTION 5

CONCLUSIONS AND RECOMMENDATIONS

53. Conclusions:

a. Early air warning beyond the present capabilities of antiaircraft artillery units to provide such warning was necessary in the European Theater² and will be even more necessary in any future

1 Appendix No. 2.

2 P 49 Bibliography Par 20

3 P 49 and 51 Bibliography Par 20, 48, 49 and 51

operations.¹

- (1) Distant visual observers will be ineffective against targets of the future.
- (2) The placing of surveillance radars at appropriate distances from any proposed parent firing organization would result in duplication.
- (3) Spreading of purely surveillance radars over appropriate distances automatically results in an early warning net far more extensive in area than that of any contemplated firing organization.
- (4) The required net of surveillance radars is of such extent and of such value to several arms as to warrant control by commanders of combined arms at a high level. Surveillance with filtering facilities must be capable of detecting and tracking very-high-speed targets including missiles of certain types.

b. Transmission of information as practiced was inadequate in the European Theater and must be redesigned for any future operation.²

- (1) Communications for an air warning system, including facilities for automatic transmission, must be more positive and more rapid.
- (2) Uniformity of equipment must be universal, to include combat units served.
- (3) Positive means of identification must be incorporated.

c. Antiaircraft Artillery Intelligence Service, as such, must be confined to that obtained solely through the surveillance capabilities of the organic radar equipment and reports from gun-sites. Any other system will overlap the general air warning service and will, therefore, be uneconomical.

d. The personnel to operate an air warning system must be provided, or mechanical and electrical means substituted therefor.

54. Recommendations: It is recommended that:

a. A theater-wide Air Warning Service be developed as a function of the Signal Corps, under control of the theater commander, with echelons thereof attached to appropriate commands down to and including corps and comparable levels.

b. Antiaircraft Artillery Intelligence Service be limited to gathering and disseminating information obtained from organic radar equipment and reports from gun sites through operations detachments allotted on the basis of area defenses of corps and comparable areas.

1 P 51 Bibliography Par 50

2 P 51 Bibliography Par 49

c. Antiaircraft artillery operations rooms and similar rooms of other interested agencies operate at, and in conjunction with, the air warning center at the appropriate level.

d. Suitable positive means of two-way transmission of filtered intelligence be developed, to include gun-site and comparable levels, and that these means provide for identification between air and ground.

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R E S T R I C T E D

COORDINATION IN MAJOR OPERATIONS

SECTION 1

COORDINATION IN THE COMBAT ZONE ✓

55. Coordination in General.¹ A major difficulty in the coordination of antiaircraft artillery units in the combat zone in the European Theater arose from the organization of separate battalions, and the frequent changes in attachments of these battalions to higher headquarters. Attachments of a semi-permanent nature were generally as follows:

- a. One automatic weapons battalion (mobile or self-propelled) to an infantry division.
- b. One automatic weapons battalion (self-propelled) to an armored division.
- c. One group² and two automatic weapons battalions (mobile) to a corps.

In each army a brigade, with two or more attached groups, formed the semi-permanent framework of the antiaircraft defense of the army area. The remaining units formed a pool of battalions which were shifted back and forth between the army and its corps, and between groups in the brigade to supply such coverage of objectives in the whole combat zone as was deemed necessary.

56. Coordination in the Army.

a. Although the brigade commander was in command of all antiaircraft troops in the army area, and responsible for the defense of installations located therein, the coordination of the defense was in the hands of the antiaircraft officer at army headquarters, at least so far as the disposition and movement of troops were concerned. By virtue of his position on the army staff, the antiaircraft officer not only had complete knowledge of the current disposition of antiaircraft troops, but he also knew the future commitments planned and the availability of roads for movements, which information was not readily available to the brigade commander, especially in moving situations. Thus, generally there were two coordinators of the defense: the antiaircraft officer for movement and disposition, and the brigade commander for other operations. As the situation changed, the number and type of battalions under the brigade and its attached groups changed, some being detached for attachment to corps and vice versa. When a pursuit operation was in progress, the brigade had a rapidly-changing assortment of battalions passing through its control. Constant liaison between the brigade commander and the army antiaircraft officer was maintained for planning future defenses so far as they could be anticipated.

1 Exceptions to the rules outlined herein occurred, of course, but were not such as to disturb the main trend herein set forth.

2 In this chapter the words "brigade" and "group" are used to denote headquarters and headquarters batteries and are not meant to include any subordinate units.

b. Coordination with the tactical air command for early warning was a function of the brigade commander through his antiaircraft operations detachment. This early warning was furnished to all units, including divisional and corps units through operations rooms in the corps and in the brigade groups. Thus, the brigade commander became a coordinator whose functions extended beyond his own area.

c. Coordination between army and corps was effected through the antiaircraft officer on the army staff and the group commander in corps. The latter made his request for battalion attachments (usually gun battalions); the former worked out a solution in conjunction with the brigade commander and the corps was furnished what was available.

d. Coordination across corps and army boundaries was a function of the army antiaircraft officer with a minimum of consultation with army group.

57. Coordination in the Corps. The defense of corps units and installations, including the protection of such important objectives in division areas as could not be protected by division battalions, was a function of the group commander in the corps. He procured the necessary units through the army antiaircraft officer, and coordinated the defenses and attendant activities in conference with the commanders of his attached battalions and, when necessary, with the commanders of divisional battalions. Lacking command of the battalions attached to divisions, he coordinated defenses across division boundaries by mutual agreements with the battalion commanders concerned.¹ Such of his troops as occupied positions in division areas customarily effected coordination of movement and positions themselves by liaison with division staffs, and with a minimum of assistance from the group. Coordination for fire direction was effected through an operations room in direct communication with an antiaircraft operations detachment at the army brigade.²

58. Coordination in the Division. The commander of the antiaircraft battalion attached to the division was responsible for the protection of the division units and installations. In some divisions, he worked through division artillery, and in others directly under the division commander. Coordination was effected internally by personal visit and agreement or through liaison and, often, by attachment of batteries to combat commands and task forces. Coordination across division boundaries was effected through mutual agreement or by consultation with the group commander at corps. The systems were not uniform and depended upon personalities. Early warning, when obtained, came through the corps operations room. In moving situations there was, as a rule, no coordination from above and no early warning.

SECTION 2

COORDINATION IN REAR AREAS

59. Coordination in Rear of the Army Group Rear Air Boundary. The air defense of the communications zone and of an area extending forward to a line known as the Army Group Rear Air Boundary, was a responsibility of the Commanding General, IX Air Defense Command. The zone was divided into major areas containing important installations, and the antiaircraft

1 P 49 Bibliography Par 16.

2 P 49 Bibliography Par 20.

artillery defense of each was assigned to an antiaircraft brigade. When operating in conjunction with a command of the air force, the antiaircraft operations detachments were placed under control of the air force control centers. Coordination in the zone of the IX Air Defense Command was achieved by unified command through a deputy chief of staff for plans, and a deputy commander for operations, who moved with a forward echelon.¹

60. Coordination Across the Army Group Rear Air Boundary. As an army moved forward, the defense of installations in its rear area was assumed by antiaircraft artillery units of the IX Air Defense Command. Since the need for antiaircraft artillery units in the advance, and the movement of the army rear boundary could not be expected to coincide, there was established an Army Group Rear Air Boundary¹ which formed the dividing line of responsibility for air defense between the armies and the IX Air Defense Command. Arrangements for moving this line were effected by agreement between the army groups and the IX Air Defense Command.

SECTION 3

COORDINATION IN TASK FORCES

61. Operation NEPTUNE. This operation illustrates the principle of unity in coordination in a task force.² The Commanding General, 49th Antiaircraft Artillery Brigade, coordinated the defense of a certain portion of the invaded territory upon arrival, and of the entire American sector as soon as contact between the United States elements had been effected.³ He coordinated the antiaircraft defense with the air force commander present.

SECTION 4

CONCLUSIONS AND RECOMMENDATIONS

62. Conclusions. Coordination could have been more economically effected if the senior antiaircraft officer commanding troops in a major command had also been the antiaircraft officer on the staff of the command.

63. Recommendation. It is recommended the commanding officer of the major antiaircraft artillery unit within a command be also designated as the antiaircraft artillery staff officer of that command.⁴

1 P 51 Bibliography Par 49.

2 P 50 Bibliography Par 24.

3 P 49, 50, 51 Bibliography Par 23, 24 and 53.

4 This subject is completely covered in the Theater General Board Study on Command, Staff and Administration of Antiaircraft Artillery Units.

PILOTLESS AIRCRAFTSECTION 1INTRODUCTION64. Background.

a. Pilotless Aircraft, a relatively small, automatically controlled, jet-propelled monoplane, carrying nearly a ton of high-explosive, made its first appearance as a weapon of war on 12 June 1944, when four exploded in the suburbs of south London. This attack marked a new phase in warfare--a carrying plane being sacrificed in bringing its bomb-load to the objective. Until near the end of World War II, pilotless aircraft constituted a formidable element in the Germans' long-range counter-offensive and practically replaced their use of strategic bombers.

b. Name and Designation.

- (1) German derivation. Pilotless aircraft was the forerunner of a long series of secret weapons which the Germans had threatened to use against England. Its code designations were FZG76 and E-103. However, it was introduced to the world through broadcasts by the German Ministry of Propaganda as Vengeance Weapon Number One--later simply V-1.
- (2) Allied version. The Allies have variously (officially and unofficially) called this weapon V-1, Flying Bomb (or FB), Diver, Buzz Bomb, Doodle Bug, and Pilotless Aircraft (or PAC). To avoid confusion with "vengeance" weapons of the rocket type (included in General Board Study: V-2 Rockets), and for the sake of brevity, subject weapon will hereinafter be called FAC.

SECTION 2CHARACTERISTICS65. Physical and General Flight Characteristics.

a. Physical. In general outward appearance the FAC is similar to a small conventional type monoplane, the main difference being a tube-like, super-imposed jet-motor, instead of the familiar engine and propeller. Its principal physical characteristics are

- (1) Wings -- mono-mid-wing type, total span 17.5 feet.
- (2) Overall length -- 23 feet (from front of fuselage to rear of jet).

- (3) Warhead -- 2,240 pounds.
- (4) Explosive -- 1,660 pounds (included in weight of Warhead).
- (5) Fuel -- 150 gallons (any low grade combustible, approximately 30 octane).
- (6) Propulsion Unit -- Argus-type jet-motor (mounted on top of, and protruding beyond, the fuselage).
- (7) Tail assembly -- Single fin and rudder type.
- (8) Construction -- All metal. (Later models incorporated plywood in wings and fuselage).
- (9) Total Weight -- 4,758 pounds.

b. Control in flight is accomplished by means of a magnetic compass and gyros. The master-control-gyro acts as a compass and is electrically connected with the magnetic compass. The two compensate each other and thus keep a continual check on accuracy of course. Altitude is also controlled by the master-control-gyro in conjunction with an altimeter. Controls for pitch and yaw are damped by a pair of gyros within the automatic pilot.

c. Air range is controlled by a distance measuring device operated by a propeller mounted on the nose of the warhead. When the PAC has reached a predetermined air range this device starts a sequence of actions which first shuts off the fuel supply to the jet-motor, then depresses the stabilizer control surfaces, causing the PAC to dive to the ground. The maximum range of the PAC is 250 miles.

66. Detailed Flight Characteristics.

a. Maneuverability. The individual PAC is set to fly at a constant speed and altitude. In direction, it is almost invariably flown in a straight course, but it can be set to make one turn up to 45 degrees at any time during its flight.

b. The Rate of Travel is constant during flight and there is no provision for adjusting this rate. The average speed of 5,000 PAC's in the Antwerp attack was 350 miles per hour. Actually, only some half dozen came in at less than 300 miles per hour and about the same number at more than 400 miles per hour.

c. Altitude is predetermined and, when reached by the PAC after take-off, is constant. Altitudes can be selected and pre-set from 600 to 10,000 feet. Altitudes between 4,000 and 5,000 feet were generally used against London, while 3,000 feet was normal on the Continent. In the Antwerp attack, the average fixed altitude was 3,000 feet and was seldom exceeded. Some came in at less than 3,000 feet, especially those from the north. These were still rising since, because of the nearness to launching sites, they had not yet attained their operational altitude.

d. Vulnerability. The PAC proved to be a difficult target to destroy.¹ It was small in size and rugged in construction. Its

1 The eminent English scientist, Mr. Duncan Sandys, Chairman of the V-1 Committee for the defense of London, reported to Parliament that the PAC is eight times harder to destroy than an ordinary plane flying the same course.

normal operating altitude usually placed it beyond the most effective range of automatic weapons. Even when hits were obtained by automatic weapons, they seldom succeeded in destroying a FAC or in permanently deflecting it from its pre-determined course. In most cases the explosive charge of the 40mm projectile was insufficient to secure the desired destruction, and the robot pilot was eminently successful in maintaining directional stability. On the other hand, the destructive effect of the 50mm shell was ample, but the FAC's customary altitude was unfavorable to 90mm gun batteries (or British 3.7's). The gunnery and tactical problems were solved with increasing success, beginning with the defense of London and reaching a climax in the defense of Antwerp. These defenses will be discussed in paragraphs 69 and 70 of this study.

e. Accuracy. The accuracy achieved by PAC launched from different areas is tabulated below. Rounds falling more than 20 miles from the mean point of impact are excluded.

<u>Target Attacked</u>	<u>Range (Miles)</u>	<u>Deviations in Miles</u>	
		<u>Range</u>	<u>Lateral</u>
ANTWERP, from North	50	5.8	4.7
LIEGE, from South-East	75	5.8	5.1
ANTWERP, from North-East	110	5.9	6.1
ANTWERP, from South-East	135	6.1	6.5

These figures show that range accuracy was nearly independent of the distance of the target from the launching area but that lateral accuracy decreased slowly as the range increased.

SECTION 3

EFFECT AS A MILITARY WEAPON

67. Strategic and Psychological Effectiveness of PAC

a. PAC caused little damage to Allied military materiel and relatively few casualties. Civilians, however, were not so fortunate. The PAC bombardments of London and Antwerp destroyed an incalculable amount of property and killed or wounded thousands of people. The principal strategic effect of PAC on the allied war effort was that it required the employment of large amounts of antiaircraft artillery to combat its attack. The Antwerp defense, for example, consisted of approximately 18,000 troops, 208 50mm guns, 128 3.7 inch guns (British), 188 40mm guns, and 72 searchlights (British). Some idea of the amount of supplies consumed by the defenders of Antwerp during the five months campaign may be gained from these figures: 3,255,000 sandbags, 532,000 rounds of heavy ammunition, and over 1,000,000 gallons of gasoline. Against this defense the Germans employed not over 2,500 men. From approximately 42 sites they launched an average of 25 PAC daily, with a peak of 160 launched during the 24-hour period 15-16 February 1945.

b. Psychologically, PAC had a considerable effect. Thousands of Allied troops over whom they flew - and quite frequently landed amongst - were kept in a continuous state of nervous tension. Whether by design or by malfunctioning, many PAC fell and exploded along their paths to the objectives. Individuals could take few protective measures against PAC, for, although PAC were easily recognizable by sight or

sound, there always was uncertainty as to where or when they might fall. Even one several miles to a flank might side-slip in and strike from the rear if the jet motor cut off or was damaged by gun fire. They were launched in fog, rain or snow. Sometimes as many as eight appeared, seconds apart, from one direction, although for the most part they came sporadically throughout the day, so that no relaxation was possible. The characteristic roar of the motor in flight, the stream of flame flying to the rear, the cutoff, silent dive, and violent detonation caused soldier and civilian alike to wonder with nervous anxiety whether or not each approaching PAC would cut off and dive into his immediate area. Amongst soldiers in the PAC area, PAC was the subject of more conversation than any other weapon.

SECTION 4

MEASURES FOR DEFENSE

68. General. PAC defenses were set up at various times for the defense of the cities of London, Antwerp, Liege, Brussels and Meestricht (VK5552). Brief descriptions of the defenses of the first three cities are given below. The latter two are not covered, one having been entirely a British defense and the other never having been subjected to attack. The total PAC launched on London during the period in which American units participated was 7,539, of which 1,651 were destroyed by antiaircraft with 281 being credited to American units. Destruction by all air defense methods, including use of aircraft, totaled 3,787. There were, however, a total of 2,341 incidents in Greater London. Of the 9,000 PAC launched against Continental targets, over 5,000 were directed against Antwerp. Many were wide of the target or for various reasons failed to arrive. Of the 2,394 which were plotted by radar on a course which would have hit the city, the antiaircraft defenses destroyed 2,183. Between 2,000 and 3,000 PAC were launched against Liege with about 1,000 incidents occurring within the city. The PAC attack on Liege lasted from early in October 1944 until 16 December 1944, but the city was defended by antiaircraft only from 23 November 1944 to 11 December 1944. There was a total of 392 PAC engaged, of which 79 were claimed destroyed.

69. Defense of London.

a. Intelligence. Through various sources of intelligence, the British, as early as April 1943, were in possession of considerable information on the subject of German plans to employ long-range bombardment weapons. This information included accurate estimates of the characteristics of PAC and of the planned method of attack. Soon other information was added which included the location of the main experimental station and factory at Heonemunde, Germany, (RF9532) and a number of launching sites under construction along the French coast. Further information indicated that PAC attacks against London could be expected not earlier than February 1944.

b. Plans. The British reacted vigorously and promptly by bombing the experimental station, factory, and launching sites. In addition, the British Antiaircraft Artillery Command made extensive plans for an antiaircraft defense. Results of their study indicated that the American equipment (the SCR-584, radar, M-9 director and remote-controlled guns) would be far more effective than existing British equipment. Supreme Headquarters decided that American units would participate in the defense of London. This defense project was given the code word CROSSBOW. Plans were completed in December 1943, and it was

expected to put them into effect by 15 January 1944. As time passed and the F4C attacks did not materialize, it was concluded that they would come concurrently with, or shortly after our attack on the Continent. It was therefore necessary to consider carefully the allocation of antiaircraft artillery strength between CROSSBOW and OVERLORD.

c. The F4C Attack finally began on 12 June 1944. On 13 June 1944, the 415th and 601st American Antiaircraft Gun Battalions under the 2d Antiaircraft Artillery Group, already on the Folkstone-Dover coast in an antiaircraft role, were ordered to assume the Diver mission as planned. On 15 June 1944 the attack started in force, and within 24 hours 192 British heavy antiaircraft guns and a like number of automatic weapons were in position in a belt defense just south of London.¹ A balloon barrage of 480 balloons was deployed on 22 June 1944. This was later built up to 1400 balloons. On 14 July 1944 a decision was made to shift the defense to the coast for more effective fire control. The attack continued all during this period. The attack reached a peak of 215 bombs launched in the 24-hour period 3-4 August 1944.² The American units in the defense were built up during this period to one group and five antiaircraft artillery Gun Battalions. The attacks diminished until 9 September when all American Antiaircraft Artillery units were relieved.

d. A number of old principles were proved and a few new lessons were learned during the London F4C defense, some of which were later used to advantage on the Continent.

- (1) The importance of careful preparation for firing and the exercise of diligence and skill in operating techniques during action were particularly emphasized. The constant altitude and rectilinear characteristics of the F4C's flight made errors in technique glaringly apparent. Conversely, the number of hits increased in direct ratio to the skill and diligence with which the principles of sound gunnery were applied.
- (2) A defense in depth, secured by placing successive belts of guns along the path of the F4C, was found to be most effective.
- (3) The use of proximity fuzes increased the percentage of hits.
- (4) The efficiency of the defense increased when the gun belt was moved to the coast. This permitted the use of proximity fuzes and also took advantage of the greater efficiency of radar when used over water rather than over land.

70. Defense of Antwerp.

e. When the capture of Antwerp was imminent, it was realized that this city was a suitable target for CROSSBOW weapons and a defense should be planned. Therefore, on 1 October 1944, 21 Army Group (British) requested Supreme Headquarters to make available certain American gun battalions for a defense. This was approved and on 2 October 1944 an intelligence appreciation was issued indicating that a

1. See Appendix IV.

2. See Appendix III.

German attack by P4C was being planned. About ten days later the attack on Antwerp began. On 15 October 1944, orders were issued to IX Air Defense Command to deploy three gun battalions. It was realized, however, that this scale of antiaircraft artillery was inadequate and additional units were requested and gradually arrived.¹

b. By 10 November 1944, the defense consisted of two anti-aircraft artillery brigades, four antiaircraft artillery groups, seven gun battalions, two automatic weapons battalions and a British searchlight regiment.² This searchlight regiment was deployed to mark the irregularly-shaped inner-artillery zone,³ the unusual pattern of which was caused by the presence of operational airfields in the vicinity of Antwerp. The attacks continually grew in number and began coming from various directions. Initially, they came only from the southeast, but on 16 December 1944, concurrently with the beginning of the German offensive in the Ardennes, new attacks began from the northeast. Therefore, the defenses had to be redeployed,⁴ and continual redeployment thereafter became necessary to meet attacks from new directions. By mid-December five gun battalions and one automatic weapons battalion had been added to the defenses.

c. The P4C attack continued and also the Ardennes offensive gained ground rapidly. The field armies called for reinforcing antiaircraft artillery units. Five gun and three automatic weapons battalions were ordered from the Antwerp defense for this job. The remaining American units were supplemented by two British heavy anti-aircraft regiments.⁵

d. There was not much further change in the defense until about 11 January 1945, when the Ardennes offensive had been crushed and some of the units had returned to Antwerp. Inasmuch as the southeast attacks had lessened, and the northeast attacks had increased, most of the returning units were deployed in the northeast.⁶

e. By this time the number and percentage of P4C's destroyed were increasing daily.⁷ One factor contributing to favorable results was increased proficiency in gunnery by personnel. The major factor was the use of proximity fuzes (T 152), made especially for this defense and now available for the first time. The new fuze provided for earlier self-destruction, thus permitting its safe use at lower angles of elevation than were formerly possible. The immediate effect of this feature was to increase the number of targets destroyed in the air from 19 plus to 31 plus percent. This improved performance resulted in fewer destructive explosions on the ground. (Certain disadvantages had to be overcome. At no time was the supply of the new T 152 type fuze sufficient to permit its use except in the lower brackets of elevation. As a result, typical courses were fired with three types of ammunition. The guns went into action at elevations as low as 106 mils using the M4345 mechanical fuze. At 200 mils (later reduced to 165 mils) they shifted to the short proximity fuze T152, and at 400 mils (later reduced to 330 mils) changed to the T74E6. The use of these three types

1 See Appendix V.

2 See Appendix VI.

3 Inner Artillery Zones are areas defended by AA Artillery in which aircraft are prohibited from flying.

4 See Appendix VII, VIII.

5 See Appendix IX.

6 See Appendix X.

7 See Appendix XII.

of fuzes complicated not only the service of the piece but also the ammunition supply problem. However, the procedure followed was necessary under the conditions imposed, and the results attained amply justified the effort and care taken in solving the problem.

f. Toward the end of January 1945 the third and last major change of direction of attack began. This attack came from the north, and the launching sites were so close that it is estimated that 90 percent of the PaC's launched would have been hits on Antwerp had that city's defenses not been effective.¹ This attack became quite serious, and the defense was complicated by three factors: first, one of the largest airfields on the continent lay in the zone of attack, necessitating special rules of fire and eliminating 70 percent of the possible gun positions in this area; second, because of the proximity of the enemy lines on the Waal River, the time of warning was very small; and third, the PaC's flew at a very low altitude. Due to the short range from the launching sites in the Rotterdam area, many targets passed over the front belt of guns as low as 600 feet and rose rapidly.

g. Air warning in the other zones of approach had been exceptionally good. Approximately eight minutes of warning was consistently received on PaC's launched from the southeast and northeast, but when they started coming in from the north, the warning time dropped to an average of three to four minutes. About the same time multiple flights of as many as eight PaC's were used in an attempt to confuse the defenders in target selection. These difficulties were overcome by assigning extremely narrow normal sectors to each battery and making it standing procedure that a battery fire in sectors other than normal only when no targets were approaching in its assigned sector. The attacks continued from the north and northeast but fell off from the southeast. In February 1945 the attacks reached their highest peak and came almost entirely from the north and northeast. A defense in great depth was established, using units from the southeast to bolster the north and northeast belts of defense.² The belt method of defense in depth was by far the most effective. During the period February-March 1945, the antiaircraft artillery defense reached its peak of efficiency. Within a six day period, 87 out of 91 PaC's, or 96 percent, were destroyed.³ During the entire period of this defense many air-launched PaC's were directed at Antwerp. This made it difficult to adhere to the decision to keep the guns strictly belted along the paths from the true launching sites to the objective. German airplanes were equipped with carrying racks for PaC which could be launched from these planes at some pre-designated location, thus giving extreme mobility to the launching location. This was particularly disconcerting, because if the enemy had sufficient air strength he would be able to launch PaC attacks from all directions against a target, thus making our zone defenses impotent in those areas not covered. It was continually necessary to gamble on where the true launching sites were located, as no G-2 information on the subject was ever available. With this threat always in mind, the planning staff kept special deployment plans up to date, so that should attacks from all directions start, immediate steps could be taken to counter them. This applied particularly to the location, through actual physical tests, of a vast number of radar sites in order that units could be shifted without delay as the attack changed.

h. Items of General Interest. Of the 5,000 PaC's launched

1 See Appendix XI

2 See Appendix XIII

3 See Appendix XII

against Antwerp, only 211 exploded within the city, and of those 55 were not engaged by the defending guns, because of restrictions against firing in non-restricted areas. Targets not within designated areas were fired on only if recognized visually. The ammunition supply was extremely critical. On each of two particular nights, under very heavy attack, approximately 15,000 rounds were fired, thereby reducing the available stock of ammunition on hand in the theater to a dangerously low level. In order to conserve ammunition, the guns were permitted to engage only those targets directed toward the vital area. Every gun-battery operations room plotted targets with radar and made the decision whether or not to engage.

i. Lessons learned in the Antwerp defense against P&C were, in general, a continuation and development of those principles brought out in the London defense. The following additional comments are pertinent:

- (1) The siting and turning of radars for use over land is more critical than for use over water, because of the necessity for screening.
- (2) The belted defense was further developed, providing where possible 10,000 to 12,000 yards between belts, and between the inner belt and the defended area. This arrangement, used where possible, afforded more area for damaged P&C's to fall in non-congested areas and prevented shell-clutter of one belt from blinding or confusing the radar operators in the next belt.
- (3) Automatic weapons were found to be of little or no value against P&C.
- (4) An efficient early warning system is of extreme importance to insure the necessary degree of alertness and to minimize the strain on men and equipment.
- (5) The tables of organization do not contemplate continuous operation for extended periods.
- (6) Special rules of fire must be improvised to meet special situations, with emphasis on allowing the greatest possible freedom of action to the fire units.
- (7) The habitual use of "Salvo Fire" resulted in decided improvement in firing results. It permitted precise fuze-cutting, a uniform and accurate "dead-time" and held the rate of fire to desirable limits.
- (8) The efficiency of the guns increased when the use of proximity fuze over land areas was authorized. This feature was further emphasized when the proper fuze was obtained with the short-time-self-destruction feature thus enabling its use at lower angles of elevation.

71. Liege.

a. Defense of Liege against P&C was established for several reasons, only one of which was a consideration of the city itself. Liege was on the path of P&C attacks against Antwerp from the southeast.

The fall of shorts from these attacks was doing considerable damage in the First Army area. Although the attack on Antwerp and Liege started in October 1944, the defense of Liege was not established until 23 November 1944. This delay was caused by the 12th Army Group order that PAC's could not be engaged over congested friendly troop areas or installations; also, First Army anti-aircraft units were not made available until that date. After some study, it was decided that an attempt would be made to fire on PAC's before they crossed the enemy lines. Therefore the defense was to be set up as close as possible to the front. This sector was considered very quiet, and it was felt that the risk of having anti-aircraft battalions so near the front was justified by the ability to fire on the PAC's over the enemy lines.

b. The first units moved into the belt on 23 November 1944. Additional units later joined the defense, and on 10 December 1944 the total troops employed were two groups, four gun and three automatic weapons battalions (less one battery). The defense was just becoming proficient when the Ardennes breakthrough on 16 December 1944 began. All units were redeployed in anti-tank roles covering the northern and southern flanks of the German advance. Thus ended the Liege defense against PAC on 16 December 1944. After the breakthrough was crushed, the First Army anti-aircraft units were needed in an anti-aircraft role; consequently, the Liege defense was never reestablished.

c. No lessons involving the defense against PAC were brought out at Liege that have not already been covered in the London and Antwerp discussions.

SECTION 5

CONCLUSIONS AND RECOMMENDATIONS

72. Conclusions:

- a. Defense of industrial sites, harbor facilities, cities, or large areas against PAC is best accomplished by a multiple-belt defense of heavy anti-aircraft guns.
- b. Distances between belts, and between the inner belt and the defended area, should be from 10,000 to 12,000 yards.
- c. Careful preparation for firing and the exercise of diligence and skill in operating techniques are essential to a PAC defense.
- d. Automatic weapons are not effective against PAC.
- e. Proximity fused ammunition, capable of being fired at minimum elevation, is more effective than time fused ammunition.
- f. Guided missiles with homing device should be developed to replace anti-aircraft guns in the defense against PAC.
- g. The lessons learned in World War II concerning defense against PAC are not yet included in War Department doctrine.

73. Recommendations:

- a. Guided missiles with homing device and proximity fuze be developed to replace anti-aircraft guns in the defense against PAC.
- b. Current doctrine (paragraph 62, Field Manual 44-4) be expanded to include detailed tactics and technique for anti-aircraft defense against pilotless aircraft.

CONCLUSIONS AND RECOMMENDATIONS

74. Conclusions:

a. Sufficient antiaircraft artillery was allocated to the European Theater; however, there exists no convenient and adequate yardstick by which suitable scales of antiaircraft artillery can be readily determined.

b. The use of searchlights by antiaircraft artillery is no longer necessary.

c. The use (in ship-to-shore assault) of provisional machine gun battalions, employing light, man-portable mounts, is sound.

d. The use (in ship-to-shore assault) of man-portable barrage balloons which can be walked ashore is sound.

e. Air warning, including Antiaircraft Artillery Intelligence Service, was generally inadequate.

f. Current doctrine on the subject of defense against pilotless aircraft is inadequate.

75. Recommendations: It is recommended that:

a. A joint staff study be made to determine the suitable scale of antiaircraft artillery for a theater of operations, based on the number of divisions employed.

b. Searchlight organizations and equipment be deleted from appropriate antiaircraft artillery tables of organization and equipment. As a corollary: The Corps of Engineers develop the use of searchlights in battlefield illumination, illumination for construction, et cetera, and the Air Forces include in their own units the searchlights essential for their needs, such as fighter-searchlight teams, homing beacons, landing strip illumination, et cetera.

c. Present tactics be expanded to include the landing of man-portable barrage balloons and antiaircraft machine guns with assault waves in amphibious operations.

d. Present policies and doctrines on air warning, including both the present Air Warning Service and Antiaircraft Artillery Intelligence Service, be completely revised and expanded to include an integrated, theater-wide service of air warning and identification.

e. Current doctrine (paragraph 62, Field Manual 44-4) be expanded to include detailed tactics and technique for antiaircraft defense against pilotless aircraft.

THE GENERAL BOARD
UNITED STATES FORCES, EUROPEAN THEATER

TACTICAL EMPLOYMENT OF ANTI-AIRCRAFT ARTILLERY UNITS,
INCLUDING DEFENSE AGAINST PILOTLESS AIRCRAFT (V-1)

PART THREE

BIBLIOGRAPHY

Unless otherwise indicated, all documents listed herein are located in the files of the AAA Section, Headquarters Fifteenth U.S. Army, APO 408.

1. Letter, Subject: "Tactical Command, Administration and Supply of Antiaircraft Units Arriving in ETCUSA", AA Section, ETOUSA, 1 July 1943, and 1st Indorsement thereto.
2. Letter, Subject: "Effect of Provisions of Field Manual 100-20 on Antiaircraft Organization and Operation in the ETC", AA Section, ETOUSA, 6 August 1943.
3. Letter, Subject: "Directive for AA Plan OVERLORD", AA Section, ETCUSA, 14 March 1944.
4. Operations Memorandum Number 7, SHAEF, 9 March 1944. Filed in 12th Army Group, AG Records File Number 370.21 of Headquarters Fifteenth US Army, APO 408.
5. Amendment Number 4, Operations Memorandum Number 7, SHAEF, 3 August 1944. Filed in 12th Army Group, AG Records File Number 370.21 of Headquarters Fifteenth US Army, APO 408.
6. Joint Memorandum: Assessment of Antiaircraft Requirements for Overseas in 1943 in connection with Operation "ROUNDUP", 18 May 1942. Filed in Combined Commanders File Number HF/00/531/G (Plans), Headquarters USFET, APO 887.
7. Study of Antiaircraft Requirements, ETC, 2 July 1942.
8. Study of Antiaircraft Requirements, ETO, 10 June 1943.
9. Letter, Subject: "Antiaircraft Troop Requirements", AA Section, ETCUSA, 23 October 1943.
10. Study, "Proposed Use of Antiaircraft Troops Across Channel," attached to inter-office Memorandum, G-3, ETOUSA, to Chief, AAA Section, ETCUSA, dated 30 October 1943.
11. Notes of Conference, Air Defense Division, SHAEF, 10 September 1944.
12. Letter, Subject: "Antiaircraft Defense of Ninth Air Force Installations" (Consideration of Non-Concurrences), SHAEF, Air Defense Division, 29 November 1944.
13. Cables, ETCUSA to Fifteenth US Army, 30 October 1945 and 1 November 1945, AG Cable IR-1008, Filed in AG Records, Headquarters Fifteenth US Army, APO 408.

14. OVERLORD APPRECIATION, Filed in 12th Army Group AG Records File of Headquarters Fifteenth US Army, AFO 408.

15. Annex 15 to First US Army Operations Plan NEPTUNE, 25 February 1944.

16. SHAEF Air Defense Reviews.

17. Cable, War Department 79874 to USFET, 30 October 1945. Filed in AG Records, Headquarters Fifteenth US Army, AFO 408.

18. Appendix I, Assignment and Attachment of Units.

19. After /After Action Reports of the following units:

Antiaircraft Artillery, Automatic Weapons, (SP),

398th	465th	489th
441st	467th	571st
443d	474th	777th

Antiaircraft Artillery, Automatic Weapons, Mobile,

106th	440th	552nd
376th	456th	556th
438th	535th	634th

Antiaircraft Artillery, Gun, Mobile,

109th	119th	141st
110th	135th	184th
116th		

Antiaircraft Artillery, Groups,

11th	109th
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Infantry Divisions,

1st	3d	75th	78th
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Note: The foregoing documents are filed in the Historical Section, ETOUSA, St. Germain, France.

20. Unit Factual Data (AAA Questionnaire) prepared by the Third, Seventh, Ninth and Fifteenth Armies, 397th AAA AW Bn (M), 225th, 226th, 231st, 353d and 357th AAA Slt Bns, IX Air Defense Command, and the 34th, 35th, 49th and 50th AAA Brigades.

21. Part I and II antiaircraft Artillery in Landing Operations in France, 6 to 27 June 1944. Submitted by Colonel Walter R. Goodrich, CAC, War Department Observers Board, ETOUSA, 17 July 1944.

22. Field Order No. 1, Headquarters 49th AAA Brigade, dated 20 May 1944 for the assault on the continent of Europe.

23. Field Order No. 1, Headquarters 18th Antiaircraft Artillery Group, dated 18 April 1944 for operation "Neptune".

24. Antiaircraft Artillery Plan Neptune (Utah) Through D-plus-3, published by Headquarters 11th Antiaircraft Artillery Group, dated 28 March 1944.
25. Field Order No. 1, Headquarters First US Army, dated 26 June 1944.
26. Field Order No. 1, Headquarters 11th Antiaircraft Artillery Group, dated 16 May 1944 for assault on the Cotentin Peninsula.
27. Field Order No. 2, Headquarters 16th Antiaircraft Artillery Group, dated 21 May 1944 for the area defense of Omaha Beach.
28. Narrative Report, Employment of Antiaircraft Artillery in Rhine River Crossing, dated 22 April 1945, published by Headquarters 18th Antiaircraft Artillery Group.
29. Field Order No. 1, Headquarters 29th Infantry Division, dated 21 April 1944, for the landing on Beach "Omaha".
30. Graphic History, 82d Airborne Division, Filed in G-3 Section, Headquarters Fifteenth US Army, APO 408.
31. Ground Operations Employing Radar Observation, by Lt. Col. E. L. Mickelson, GAC.
32. Antiaircraft Artillery Notes published by ETCUSA, No. 1-10, and 24-30 inclusive.
33. Report No. 160-AAO Submitted to the Commanding General, Army Ground Forces, Army War College, Washington, D. C. (Att. AC of S, G-2), dated 19 August 1944, by Col. G. E. Atkinson, in reply to questionnaire by AAA Command.
34. Doctrine for the employment of Antiaircraft Artillery in Amphibious Operations by Hq First US Army, Office of the AAA Officer. See par 5c.
35. Tentative War Department Training Circular on Employment of AAA Automatic Weapons in a Ground Support Role.
36. Letter, File No. 452.3 Hq 320th Bln Bn (VLA) 9 October 1944, Report on Initial Landing on D-Day, with attached memorandums.
37. Letter, Headquarters ETOUSA, AAAC, Subject: "Effect of Provisions of FM 100-20 on AAA Organization and Operations in the ETO", dated 6 August 1943.
38. Letter, Headquarters, ETCUSA, AAAC, Subject: "Quarterly Report, Antiaircraft Operations", dated 22 May 1944.
39. Letter, Headquarters, ETOUSA, AAAO, Subject: "Responsibilities for AAA Protection, SBS," dated 24 April 1944.
40. Letter, Headquarters, ETOUSA, AAAO, Subject: "Responsibilities for AAA Protection, WBS", dated 24 April 1944.
41. Letter, Headquarters, ETOUSA, (War Department Observers Board), Subject: "AGF Report No. 322, IX Air Defense Command", dated 20 October 1944.
42. Letter, Headquarters, Ninth Air Force, Subject: "Antiaircraft Defense, Ninth Air Force Installations", dated 15 November 1944.

43. Letter, Headquarters 12th Army Group, Subject: "Antiaircraft Defense of Ninth Air Force Installations", dated 26 November 1944.

44. Letter, SHAEF (Air Defense Division), Subject: "Antiaircraft Defense of Ninth Air Force Installations", dated 29 November 1944.

45. Letter, SHAEF (Air Staff, A-3), Subject: "Study by ADD; SHAEF, AAA Defense, Ninth Air Force Installations", dated 2 December 1944.

46. Extract, letter, Hq ETOUSA (War Department Observers Board), 2 May 1944, Subject: "Report Number 64- Tactical Deployment of United States Antiaircraft Artillery in Operational Roles in the United Kingdom."

47. Letter, Headquarters, ETOUSA (War Department Observers Board), Subject: "AGF Report No. 321 - Air Defense in the Communications Zone", dated 20 October 1944.

48. Appendix II - Resume of Opinions and Factual Statements on Early Warning and AAAS.

49. Extract, Functional Organization and SOP of the Hq, IX Air Defense Command.

50. Extract of Report of the Army Air Force Board, Orlando, Florida, Project Number 4364 G 373.1, dated 16 June 1945, "Defense of Airdromes Against Attack by Jet Aircraft."

51. Letter, Hq ETOUSA, Subject: "Antiaircraft Artillery Operations Report", 16 May 1945.

52. FM 11 - 25, 3 August 1942 and FM 44 - 8, 10 August 1945.

53. Operation NEPTUNE, First US Army.

54. Charts of flights of PAC and V-2 Rockets prepared by ETOUSA, 17 February 1945.

55. Pamphlet, Subject: "The Story of Antwerp X", published by 50th AAA Brigade.

56. ETOUSA file, Subject: "Defense of London Against Flying Bombs", 30 November 1944.

57. Report, Subject: "AA in CROSSBOW", ETOUSA, 25 October 1944.

58. Report, Subject: "Defense of Liege and Maastricht Against PAC."

59. Booklet, Subject: "An Account of the Continental Crossbow Operation, 1944 - 1945", SHAEF.

60. Technical Intelligence Report Number N-31, Subject: "Pilotless Aircraft", Hq USSAF in Europe, 29 June 1945.

61. Report, Subject: "Initial Report on Antwerp Defense", 50th AAA Brigade, 14 December 1944.

62. Report, Subject: "Final Report on Antwerp X Defense", 50th AAA Brigade, 10 April 1945.

63. AGF Report #665, Subject: "Intelligence Summary on PAC", Hq IX Air Defense Command, 19 February 1945.

64. AGF Report #464, Subject: "Overlays of AAA Deployment in PAC Defense in Belgium", 50th AAA Brigade, 18 December 1944.
65. AGF Report #165, Subject: "AA Defense Against PAC in United Kingdom by 21st Army Group", 17 August 1945.
66. Appendix III - Graph of London PAC Assault.
67. Appendix IV - AA Deployment in London Defense Against PAC.
68. Appendix V - AA Deployment for Defense of Antwerp, 28 October 1944.
69. Appendix VI - Sketch of AA Deployment for Defense of Antwerp, 10 November 1944.
70. Appendix VII - Sketch of AA Deployment for Defense of Antwerp, 6 December 1944.
71. Appendix VIII - Sketch of AA Deployment for Defense of Antwerp, 18 December 1944.
72. Appendix IX - Sketch of AA Deployment for Defense of Antwerp, 20 December 1944.
73. Appendix X - Sketch of AA Deployment for Defense of Antwerp, 11 January 1945.
74. Appendix XI - Sketch of AA Deployment for Defense of Antwerp, 31 January 1945.
75. Appendix XII - Graph PAC Attack on Antwerp.
76. Appendix XIII - Sketch of AA Deployment for Defense of Antwerp, 28 February 1945.
77. Appendix XIV - Sketch of Liege PAC Belt.

LIST OF PERSONS INTERVIEWED

1. Lt. Col. George E. Lawrence, CAC, CO, 839th AAA AW Bn (M).
2. Lt. Col. R. E. Dunnington, CAC, CO, 486th AAA AW Bn (SP).
3. Lt. Col. Benjamin M. Warfield, CAC, CO, 552d AAA AW Bn (M).
4. Lt. Col. Lawrence W. Linderer, CAC, CO, 554th AAA AW Bn (M).
5. Lt. Col. W. S. McArthur, CAC, CO, 574th AAA AW Bn (SP).
6. Lt. Col. James A. May, CAC, CO, 530th AAA AW Bn (M).
7. Lt. Col. Philip I. Baker, CAC, CO, 574th AAA AW Bn (SP).
8. Lt. Col. Edgar H. Thompson, Jr., CO, 433d AAA AW Bn (M).
9. Major Dewey S. Harwood, CO, 778th AAA AW Bn (SP).
10. Major O. A. Moonaw, CAC, CO, 839th AAA AW Bn (M).
11. Brig. Gen. Claude M. Thiele, ETOUSA and 12th Army Group.

12. Brig. Gen. Leslie Kieth Lockhardt (Br), Cuxhaven, 20 October 1945.
13. Dr. H. P. Robertson, SHAEF, Hochst, 14 October 1945.
14. Col. W. S. J. Carter (Br), SHAEF, Cuxhaven, 20 October 1945.
15. Col. W. H. Brucker, SHAEF, Frankfurt, 10 September 1945.
16. Col. H. P. Newton, 11th AAA Group, Heidelberg, 10 October 1945.

Note: The first ten individuals listed were all interviewed at Headquarters Fifteenth US Army, Bad Nauheim, on 24 October 1945.

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R E S T R I C T E D

APPENDIX IASSIGNMENTS OR ATTACHMENTS OF UNITS AS OF 15 October 1944¹

Type Unit	First Army	Third Army	Ninth Army	6th Army Group	12th Army Group	IX ADC	Total Field Forces	Theater Total
Brigade, Hq and Hq Btry	1	1	1			7	3	10
Group, Hq and Hq Btry	7	5	4	1	1	11	18	29
Gun Battalions (Mobile)	5	5	7	1	1	7	19	26
Gun Bns (Semi-Mobile)	1/2					12	1/2	12 1/2
AW Bns (Mobile)	17	13	11	2	2	3	45	48
AW Bns (Semi-Mobile)						17	0	17
Searchlight Battalions						3	0	3
AW Bns (Self-Propelled)	6	6	3	1	2		18	18

1. These tabulations are based on unit cards filed in USFET AG Records. While some errors in these files were discovered, they are, in general, considered reasonably accurate.

ASSIGNMENTS AND ATTACHMENTS OF UNITS AS OF 1 MAY 1945¹

Type Unit	First Army	Third Army	Seventh Army	Ninth Army	Fifteenth Army	6th Army Group	12th Army Group	IX DC	Com Zone	Total Field Forces	Total Theater
Brigade, Hq and Hq Btry	1	1	2 ²	1	1	1 ³		7		7	14
Group, Hq and Hq Btry	5	6	5	6	2			15		24	39
Gun Battalions (Mobile)	6	7	7	5			1	6	1 ⁴	26	33
Gun Bns (Semi-Mobile)				1/2				7	7 ⁴	1/2	14 1/2
AW Bns (Mobile)	13	16	13	20	3	2	2	6		69	75
AW Bns (Semi-Mobile)								17	3 ⁴	0	20
Searchlight Battalions				1/3			1	2 2/3		2 1/3	5
AW Bns (Self-Propelled)	5	7	5	5	1	1	1			25	25

1. These tabulations are based on unit cards filed in USFET AG Records. While some errors in these files were discovered, they are, in general, considered reasonably accurate.
2. One brigade operational with French Forces.
3. On ground security mission.
4. On Military Police duty.

APPENDIX II

RESUME OF OPINIONS AND FACTUAL STATEMENTS

ON EARLY WARNING AND AAAS

Source: Paragraph 33, Section III---Unit Factual Data, Replies to Inclosure (Questionnaire) to Letter (AG 472 OpAA), Headquarters ETOUSA, Subject: Antiaircraft Artillery Questionnaire, dated 11 June 1945.

1. The following is a resume of replies to the above-cited ETOUSA Questionnaire received to nine questions from Army Antiaircraft Officers, Brigade Commanders, IX Air Defense Commander, and Group Commanders, who operated in the ETO.

Question 1: "Have the systems of Early Warning and AAAS provided adequate early warning under all conditions?"

<u>Replies:</u>	<u>No</u>	<u>Yes</u>
IX ADC	1	
Hq Armies	3	1
AAA Brigades	3	9
AAA Groups	11	22
Totals:	18	32

Question 2: "Has Early Warning from Air Force sources been satisfactory under all conditions?"

<u>Replies:</u>	<u>No</u>	<u>Yes</u>
IX ADC	1	
Hq Armies	4	
AAA Brigades	7	3
AAA Groups	20	7
Totals:	32	10

Question 3: "Was notification of the movement of friendly aircraft satisfactory under all conditions?"

<u>Replies:</u>	<u>No</u>	<u>Yes</u>
IX ADC	1	
Hq Armies	4	
AAA Brigades	10	1
AAA Groups	24	3
Totals:	39	4

Question 4: "Are the types and numbers of radio sets authorized by present T/E adequate for AAAS and Early Warning (in addition to their tactical and administrative use)?"

<u>Replies:</u>	<u>No</u>	<u>Yes</u>
Hq Armies	4	
AAA Brigades	10	1
AAA Groups	26	6
Totals:	40	7

Question 5: "Was the range of radios too short?"

<u>Replies:</u>	<u>No</u>	<u>Yes</u>
Hq Armies		3
AAA Brigades		5
AAA Groups		20
Totals:		<hr/> 28

Question 6: "Were the frequencies and numbers thereof of radios used for warning satisfactory?"

<u>Replies:</u>	<u>No</u>	<u>Yes</u>
Hq Armies	2	
AAA Brigades	6	
AAA Groups	11	
Totals:	<hr/> 19	

Question 7: "Were non T/E radios used?"

<u>Replies:</u>	<u>No</u>	<u>Yes</u>
IX ADC		1
Hq Armies		4
AAA Brigades	2	10
AAA Groups	3	26
Totals:	<hr/> 5	41

Question 8: "Has the present allotment of AA operations detachments been adequate?"

<u>Replies:</u>	<u>No</u>	<u>Yes</u>
IX ADC	1	
Hq Armies	4	
AAA Brigades	6	2
AAA Groups	19	8
Totals:	<hr/> 30	10

Question 9: "Have the recently authorized OP teams with AW battalions proved satisfactory?"

<u>Replies:</u>	<u>No</u>	<u>Yes</u>
IX ADC	1	
Hq Armies	2	1
AAA brigades	2	7
AAA Groups	9	15
Totals:	<hr/> 14	23

2. Comments on the Resume.

a. Questions 1, 2, 3, 4, 7, 8, and 9 were taken directly from the Questionnaire. Questions 5 and 6 arose in connection with the adequacy of radios and were interposed to cover the comments of some of the officers who saw fit to make them.

b. Direct answers to the specific questions occasionally were not made; they had to be inferred from remarks made. Several of the positive answers (yes) made in connection with Questions 1, 2, 3, and 4 were made with reservations. For example, "Yes, the system of warning was satisfactory except in a moving situation." Such answers have been recorded as "Yes".

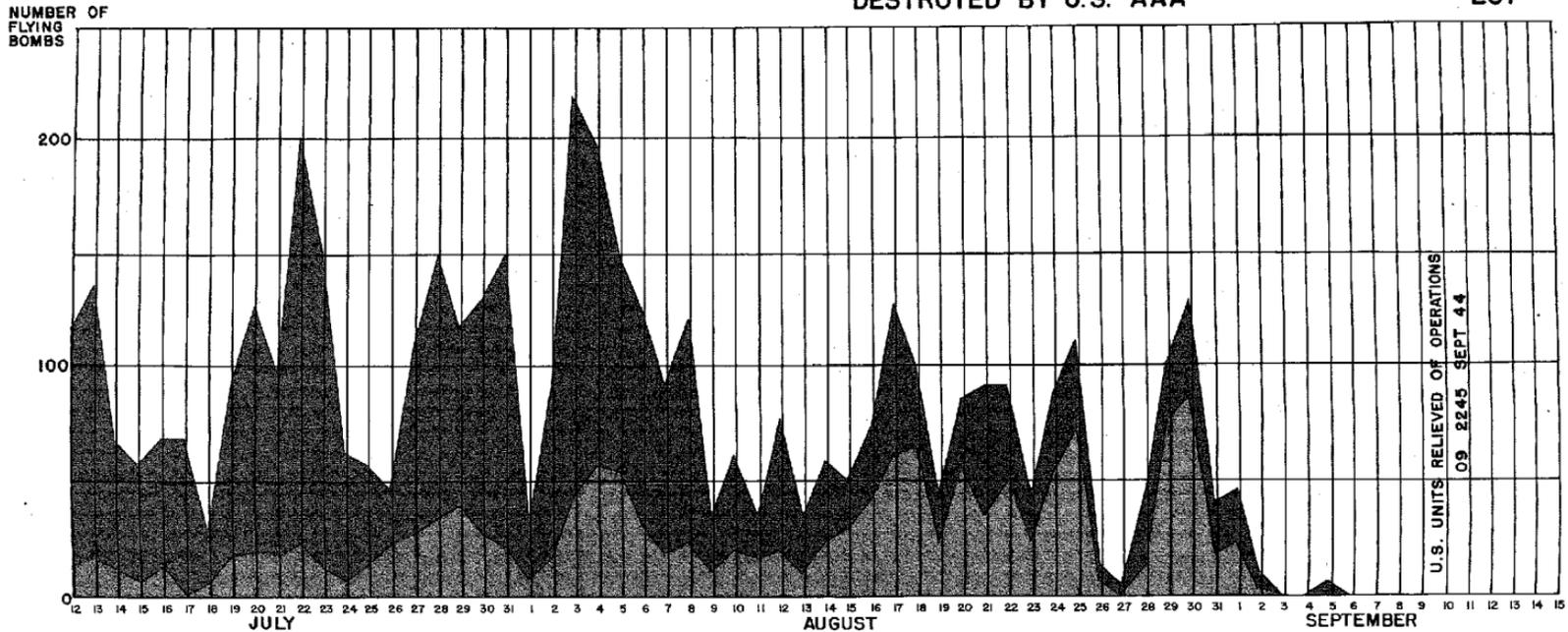
c. The answers given by battalions (which to conserve time are not given herein) corroborate the trend established in paragraph 1, above, except that the contradiction between the answers to Questions 1 and 2 are not so pronounced.

LONDON PAC ASSAULT GRAPH OF ACCEPTED CLAIMS

TOTALS DURING ENTIRE PAC ASSAULT

BOMBS LAUNCHED
 BOMBS DESTROYED BY AAA

LAUNCHED DURING U.S. PARTICIPATION	7539
DESTROYED BY ANTI-AIRCRAFT	1651
DESTROYED BY ALL MEANS	3852
DESTROYED BY BRITISH AAA	1370
DESTROYED BY U.S. AAA	281



NOTE HOW EFFECTIVENESS OF ANTI-AIRCRAFT IMPROVED

ORIGINAL DEPLOYMENT
AREA

FINAL DEPLOYMENT
AREA

GUNS(EAA) A belt, as indicated, consisting of 4 rows of 8 gun sites, Each row 3000 yds apart and a lateral spacing of 6000 yds, between sites

All guns and 40 mm, as well as 20 mm and rocket firing equipment, moved to compact belt as indicated (i.e. on the coast from Beachy Head to Dover to a depth of 5000 yds inland. Lanes, to enable fighters to proceed to patrolling area over Channel were inserted into the belt as required.

AWS(LAA) Initially: One 40 mm on each gun site and one 40 mm on each S/L site in area concerned. Later: All 40 mm move to a belt running just south of the southern edge of the gun belt.

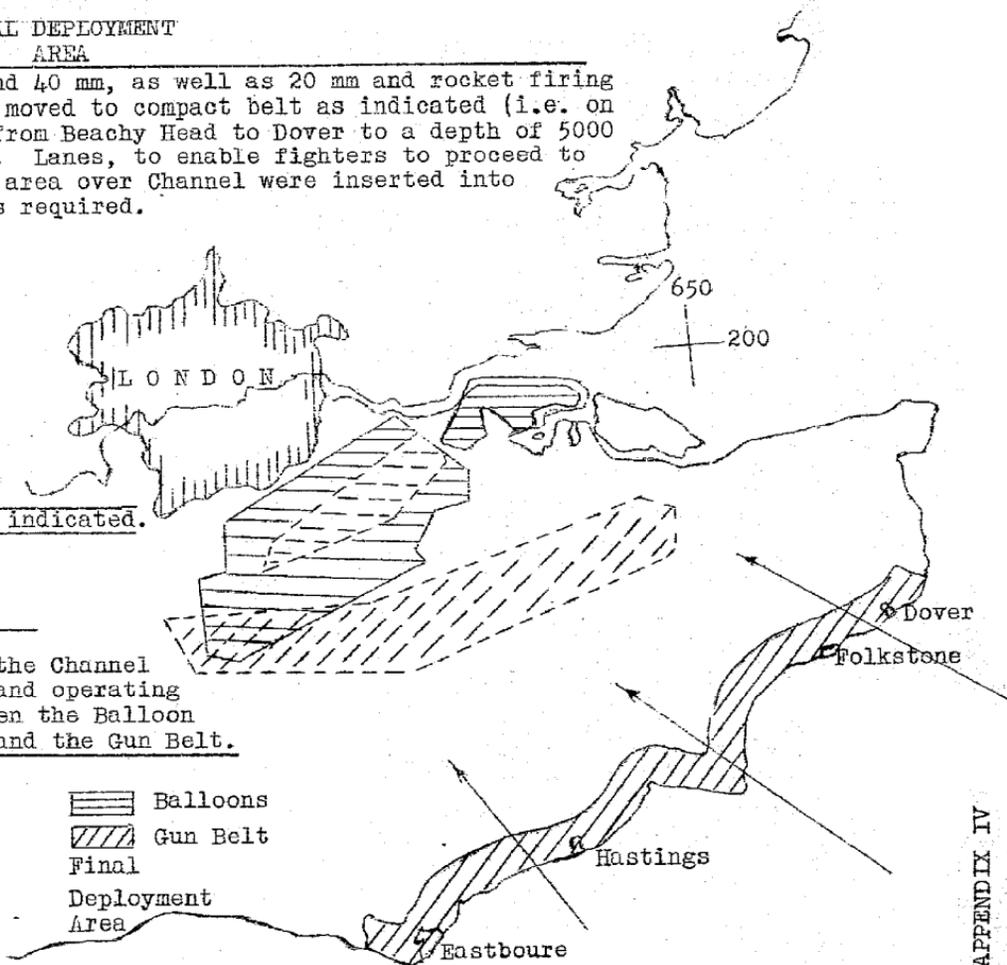
BALLOONS As indicated. Enlarge as indicated.

S/L's Thickening of normal deployment to 3000 yds in area concerned. No change.

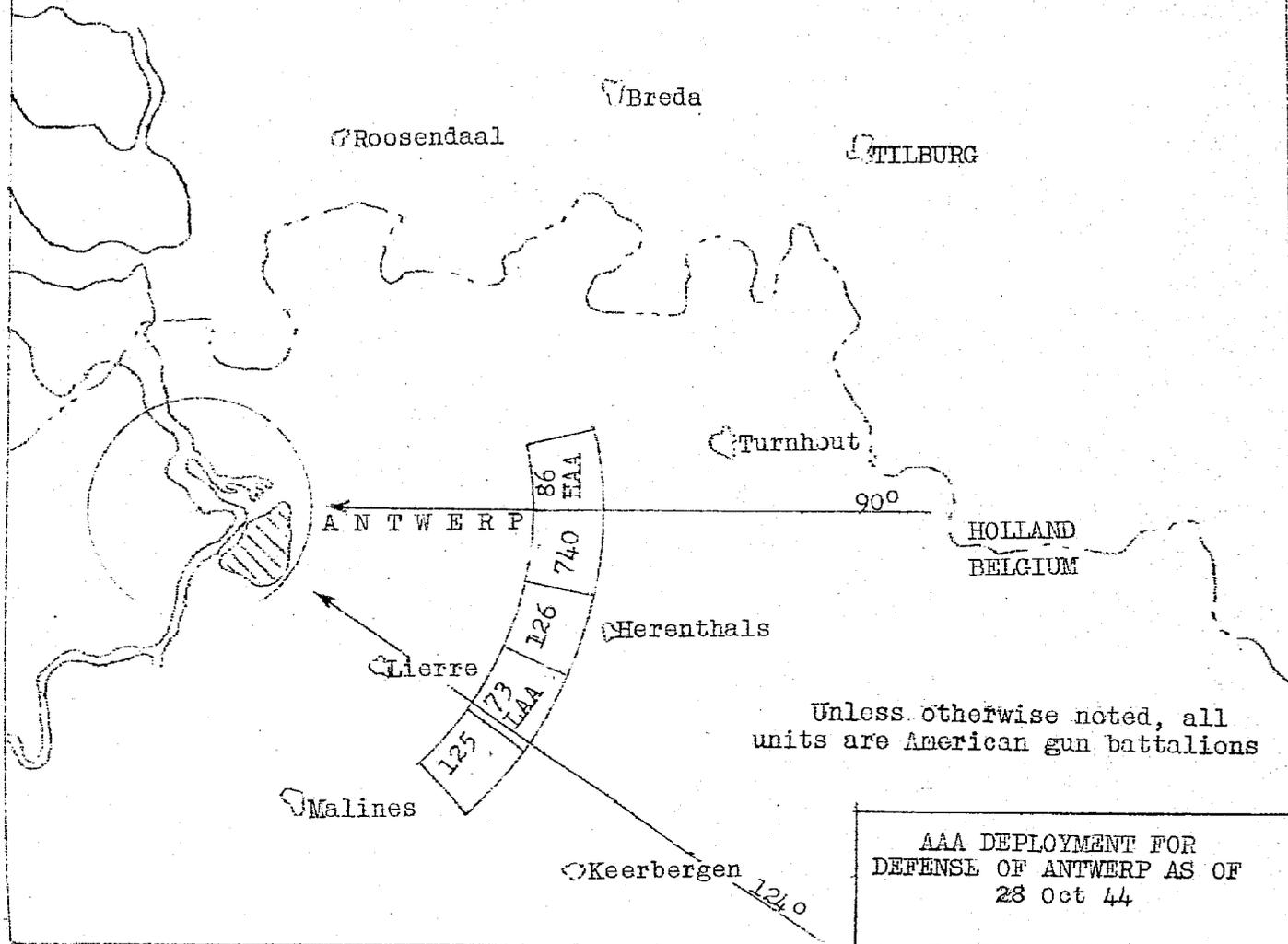
FIGHTERS 3 PATROLS: 2 PATROLS:
 (1) Over the Channel (1) Over the Channel
 (2) Over the coast from Newhaven to Dover. (2) Overland operating between the Balloon Belt and the Gun Belt.
 (3) Along southern edge of gun belt Hayward Heath to Dover.

LEGEND

		Balloons
		Gun Belt
Original Deployment Area	Final Deployment Area	

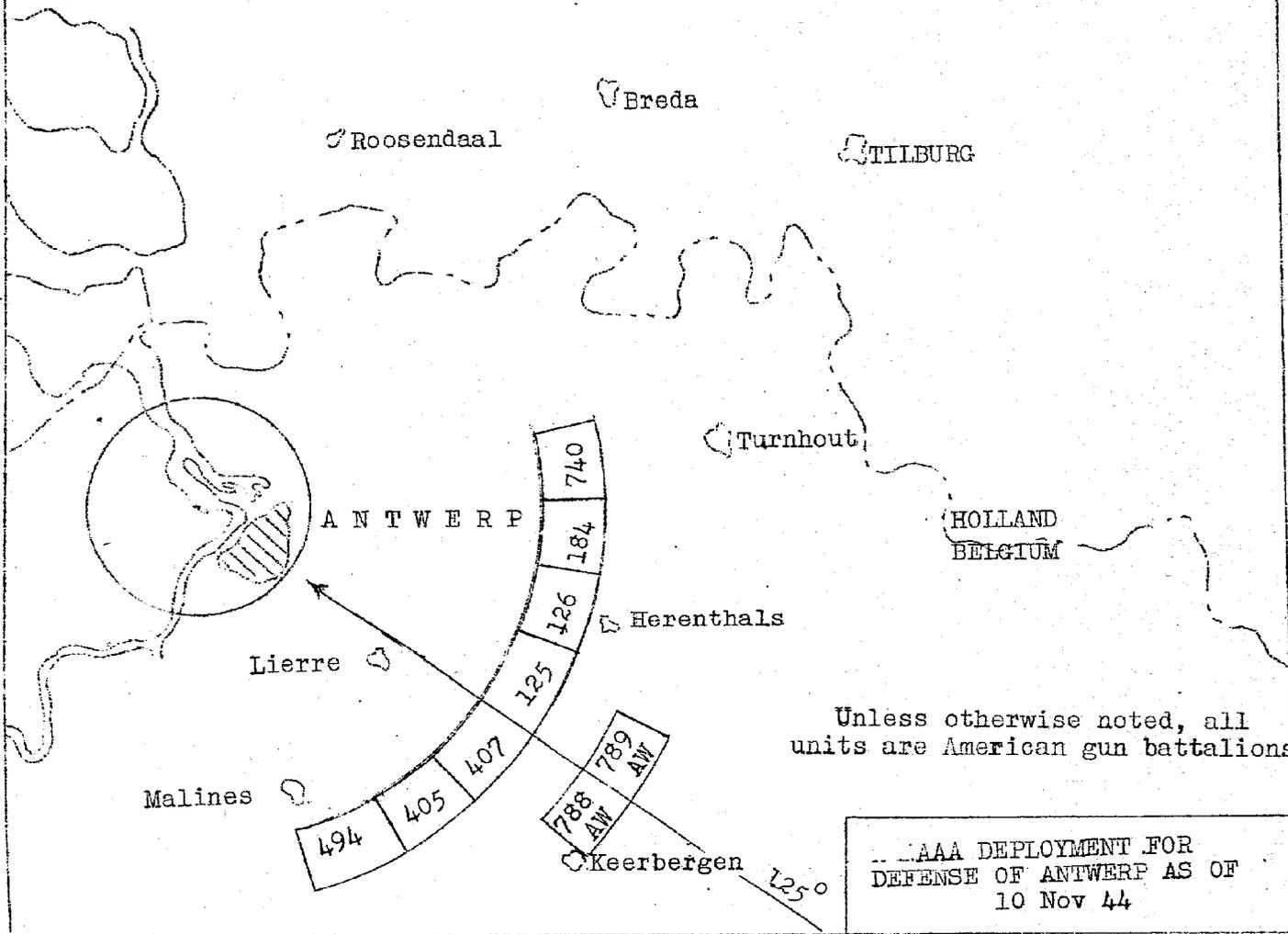


Observation Posts extend North to the Waal River and East to the Front Lines



AAA DEPLOYMENT FOR
DEFENSE OF ANTWERP AS OF
28 Oct 44

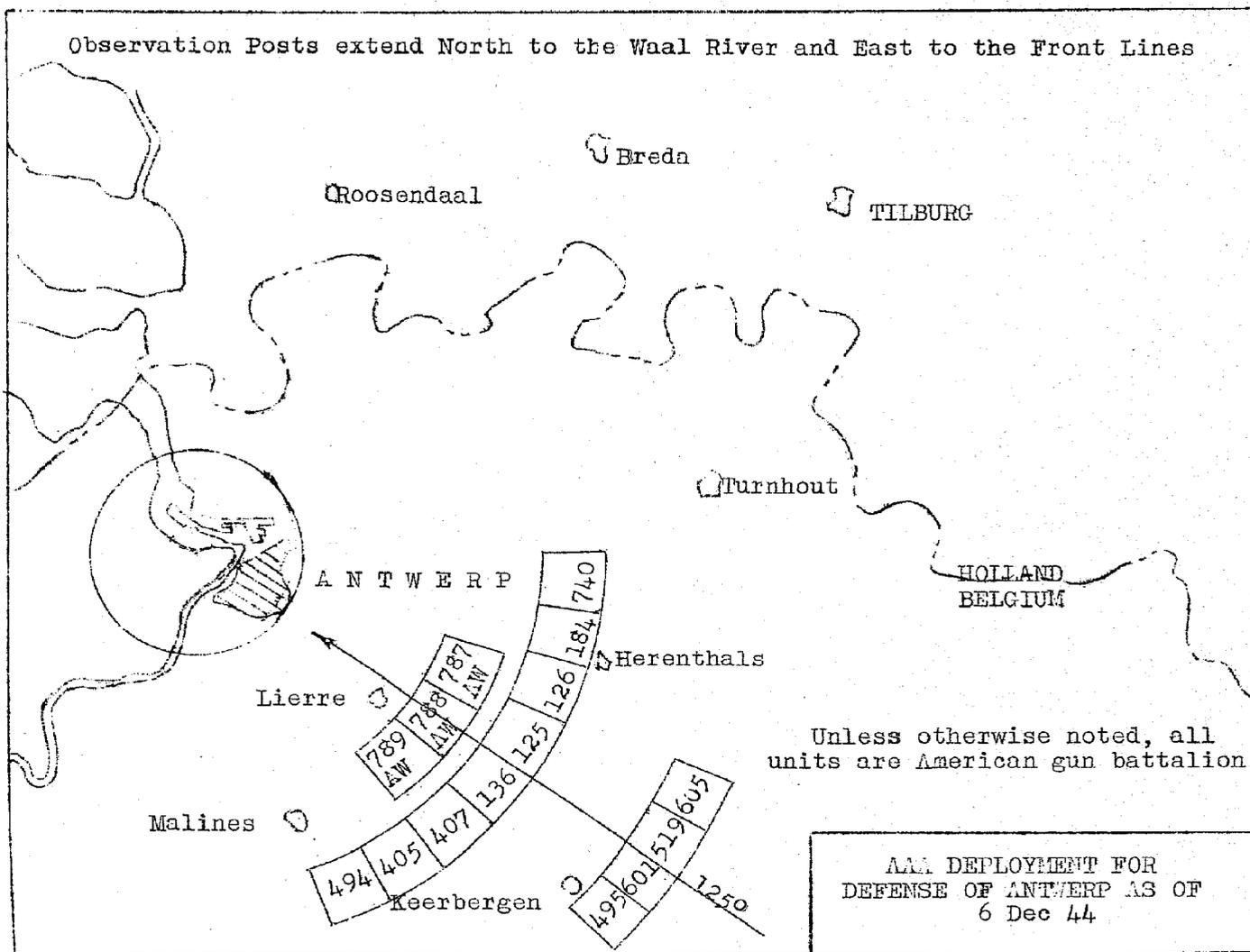
Observation Posts extend North to the Waal River and East to the Front Lines



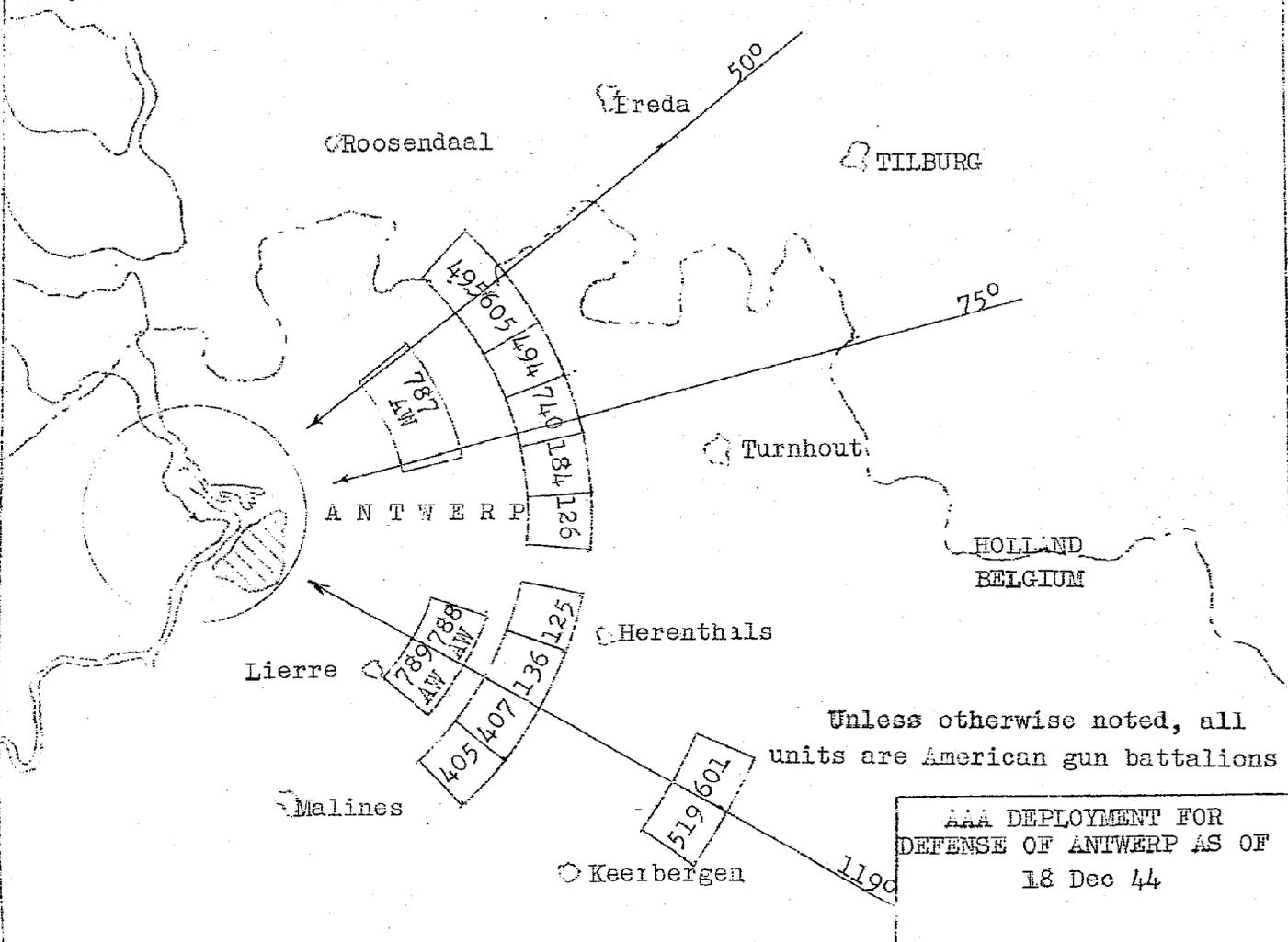
Unless otherwise noted, all units are American gun battalions

AAA DEPLOYMENT FOR DEFENSE OF ANTWERP AS OF 10 Nov 44

Observation Posts extend North to the Waal River and East to the Front Lines



Observation Posts extend North to the Waal River and East to the Front Lines



Roosendaal

Ereda

TILBURG

75°

Turnhout

ANTWERP

HOLLAND
BELGIUM

Herenthals

Lierre

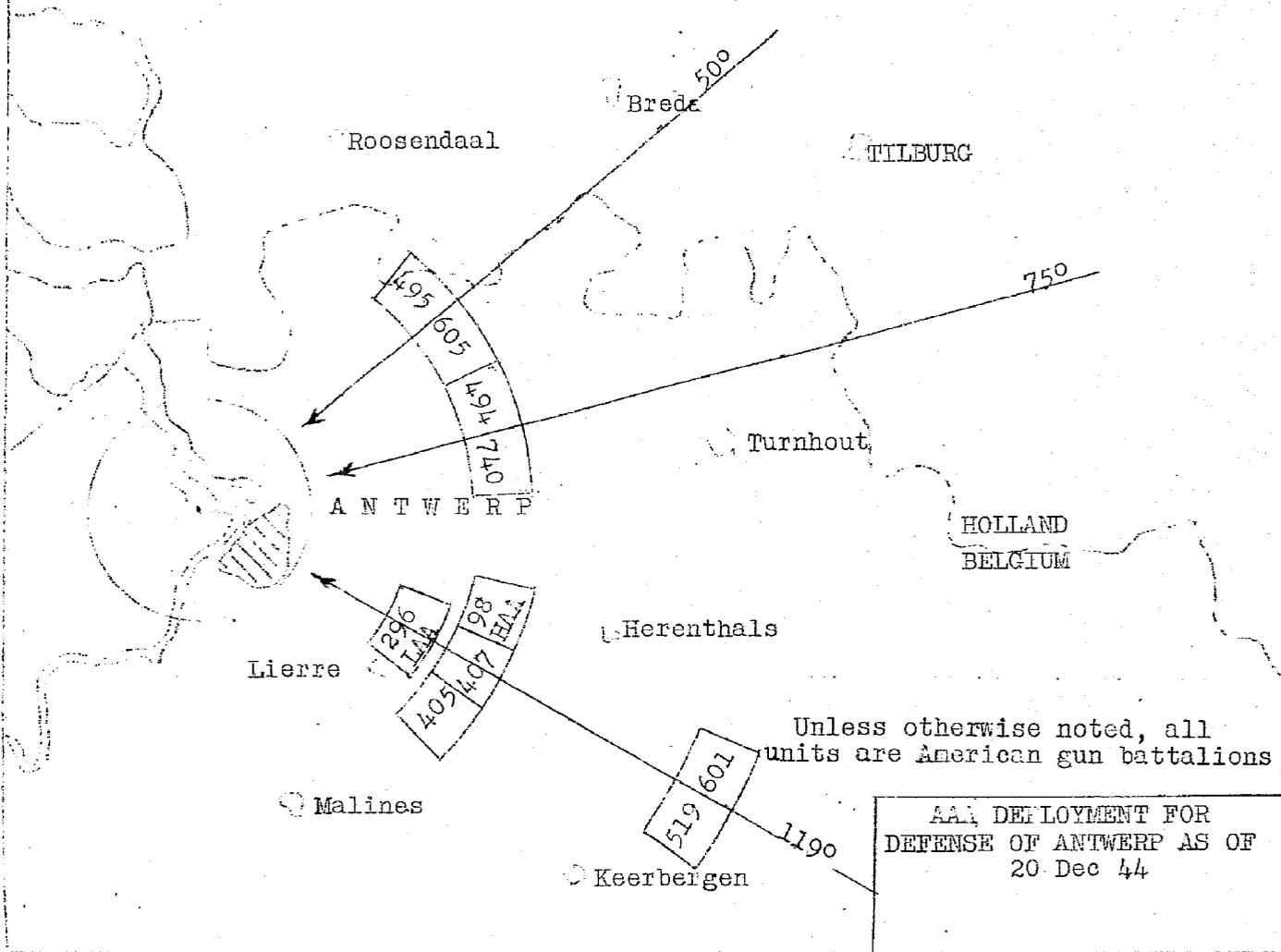
Malines

Keerbergen

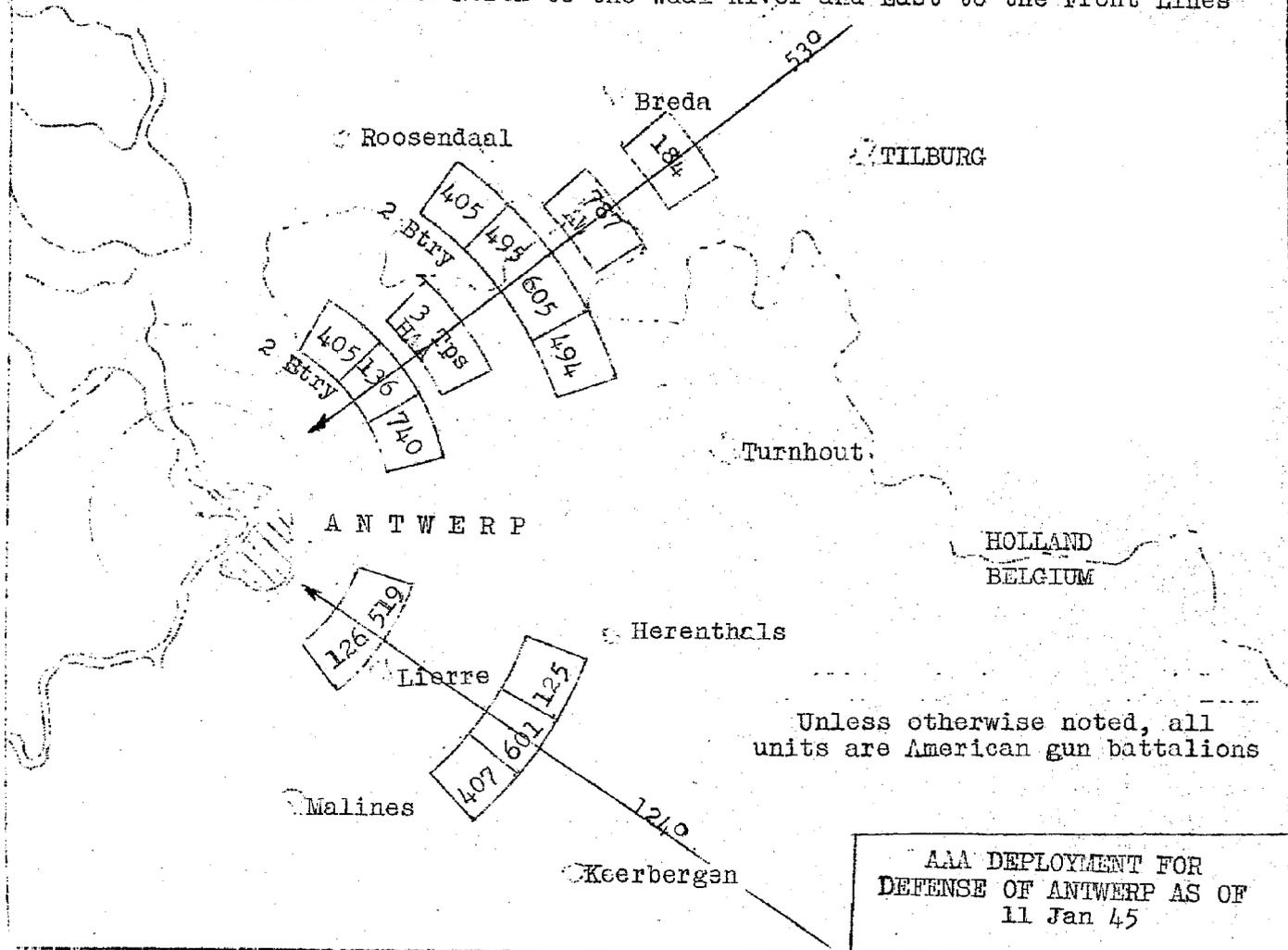
Unless otherwise noted, all units are American gun battalions

AAA DEPLOYMENT FOR
DEFENSE OF ANTWERP AS OF
18 Dec 44

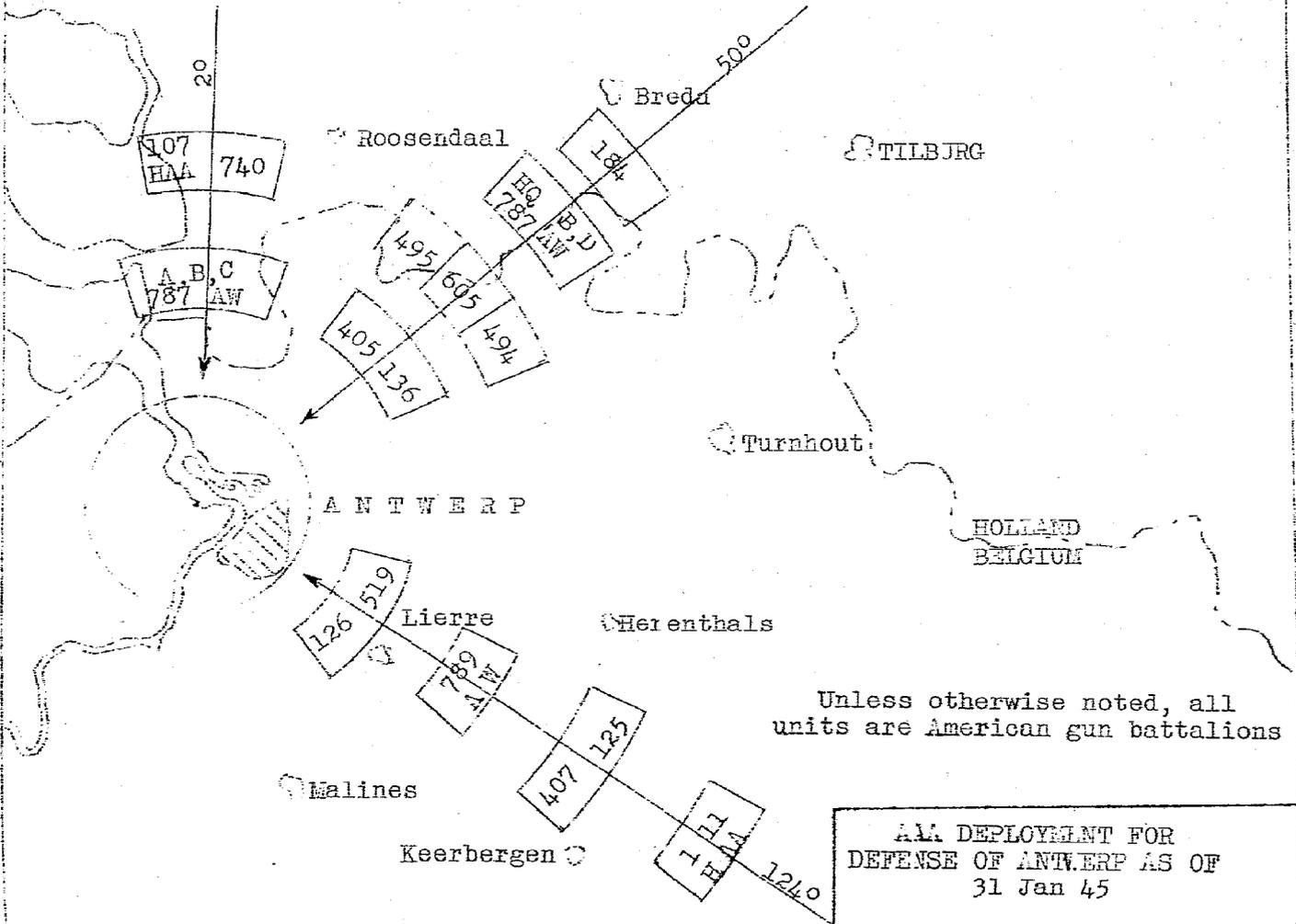
Observation Posts extend North to the Waal River and East to the Front Lines



Observation Posts extend North to the Waal River and East to the Front Lines

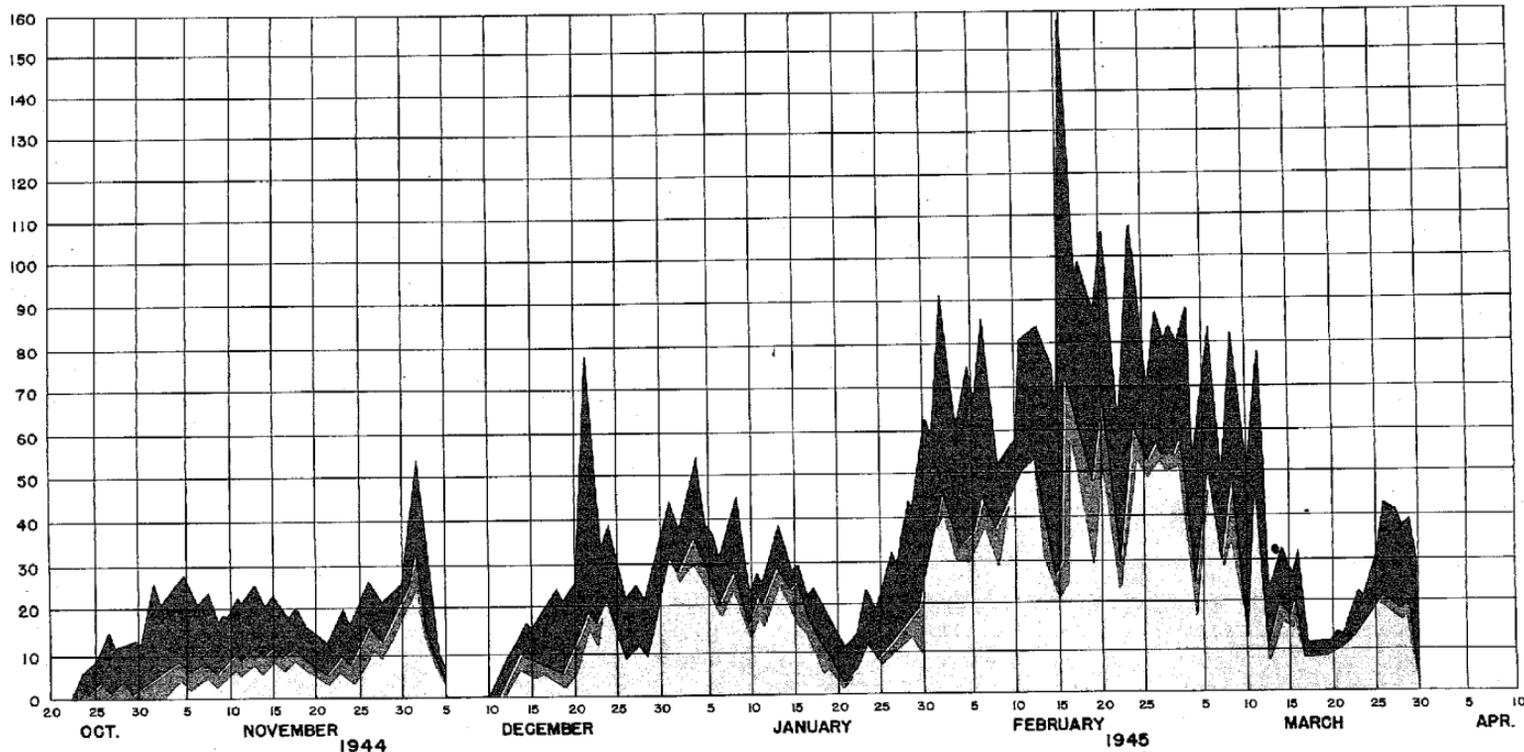


Observation Posts extend North to the Waal River and East to the Front Lines



PAC ATTACK ON ANTWERP

NUMBER OF
PAC



INTENSITY OF ATTACK



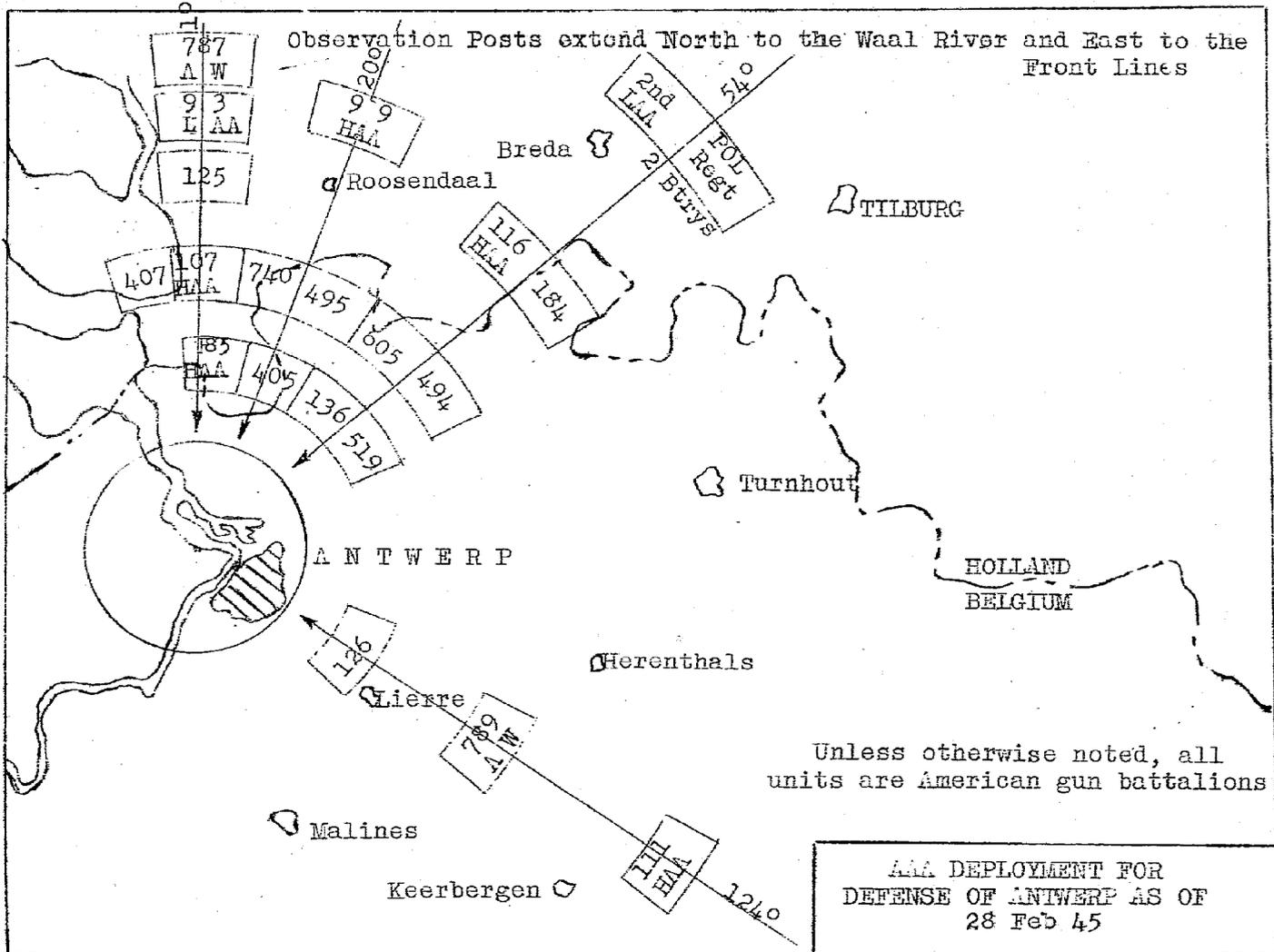
V. A. THREATS



PAC DESTROYED

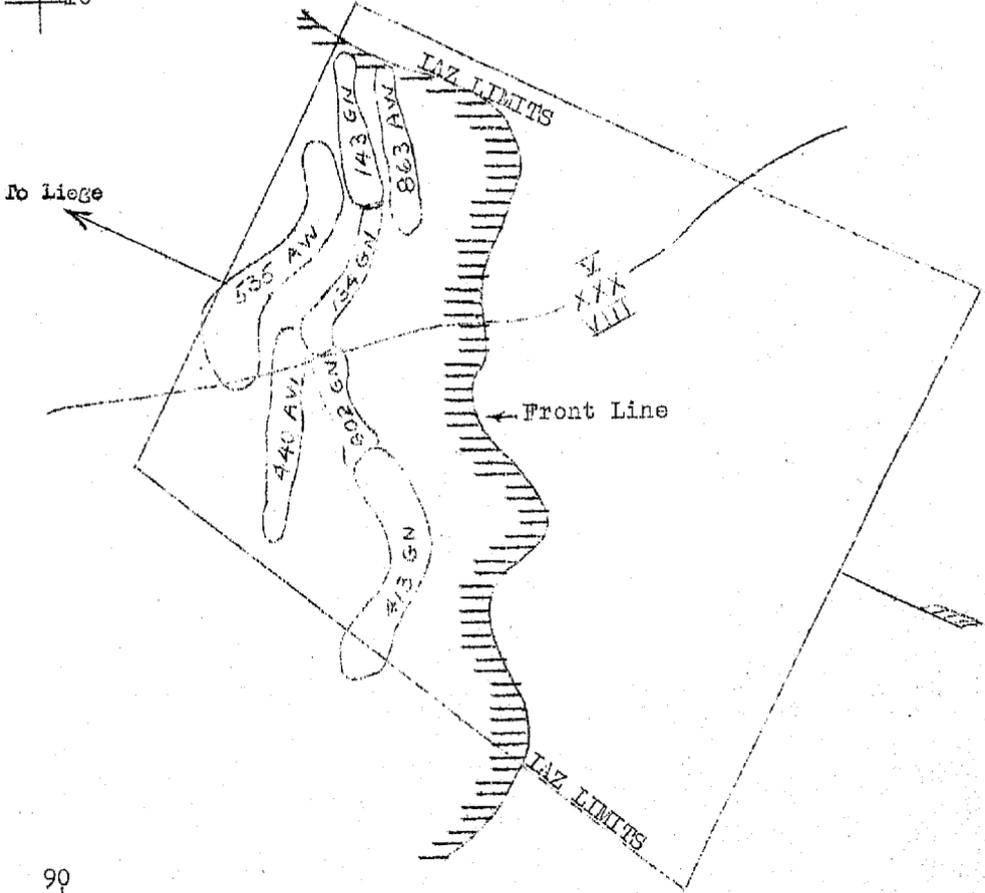


Observation Posts extend North to the Waal River and East to the Front Lines



10
+
20

90
+
10



90
+
80

LIEGE DIVER BELT
AAA DISPOSITIONS
SCALE: 1/100,000