Eighth Air Force

TACTICAL DEVELOPMENT

August 1942 - May 1945

Prepared by

Eighth Air Force

and

Army Air Forces Evaluation Board
(European Theatre of Operations)

FOREWORD

In a directive dated 26 November 1944 Lieutenant General James H. Doolittle, then Commanding General, Eighth Air Force, requested a report of the development of the Eighth Air Force for the Commanding General, Army Air Forces, and to be used as a background for tactical study by the Air Force Tactical School.

This report, Eighth Air Force - Tactical Development - August 1942 - May 1945 was prepared under the direction of Major General Orvil A. Anderson, former deputy for operations, Eighth Air Force.

It is believed that the report is sound in its statements and conclusions, and that it offers valuable information to anyone reviewing the combat activities of the Eighth Air Force during the air war against Germany.

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THE PROBLEM

The original objective of formation flying by bombers was to concentrate sufficient fire power to permit the formation to fly anywhere in spite of enemy fighter attacks. The vital difference in viewpoint of the American bomber force from that of other nations was its emphasis on security of the force. To continue pressure on the enemy, our bomber force must be able to fly today, tomorrow, and the next day. Without ample defense, we would take losses which might force out bombers to fly at night for security, thus losing all the advantages which would accrue from daylight bombing attacks.

Although security of force was the dominant factor in these formations, other vital factors were involved in flying any formation: bomb pattern, visibility, flexibility, ease of flying, and ability to be commanded in the air. Every new formation had to be analyzed for its adequacy in all these respects.

By the fall of 1943, it became obvious that no new formation could develop sufficient defense to enable the force to venture unescorted deep into Germany where our choice targets lay. Enemy tactics had improved; new German armament outranged our .50 caliber machine guns. The rocket mortar mounted on twin-engine fighters was lethal beyond the range of our guns. Much needed fighter escort of long range was soon to make its appearance.

With the advent of these long range fighters, the development of bomber formations proceeded toward quite different objectives. Now the need was the develop a formation which:

1) could be escorted readily,
2) would break down easily into units giving a better bomb pattern, and
3) would permit the passage of a number of units so rapidly over an area of heavy flak defense that the anti-aircraft guns could fire on only a few of the units.

SEPARATE SQUADRONS OF SIX A/C EACH (AUGUST 1942)

On 17 August 1942 the Eighth Air Force dispatched its first formation against Fortress Europe - one of two formations (each of six aircraft) flying a couple of miles apart. This separation range did not permit mutual fire support. Spitfires furnished top cover over the round trip to Rouen and return.

Succeeding operations saw up to four such squadrons, flying wide apart. These were covered by Spitfires except on the missions down to St. Nazaire and Lorient, in which bombers outranged their RAF escort.

This initial formation had the advantage of flexibility, but could only bring a small number of guns to bear on each attacking enemy aircraft.

18 A/C GROUP (SEPTEMBER 1942)

At a time when Germany's U-boat campaign was inflicting mounting losses on Allied shipping, the Eighth Air Force increased its penetration and ventured beyond escort range to attack submarine bases in France, Holland Belgium.

Growing aggressiveness of the Luftwaffe dictated compression of the previous loose formation of four squadrons in order to make possible mutual support and more concentrated fire power. Air commanders experimented with two basic formations, the 18 aircraft group and the 36 aircraft group.

The 18 aircraft group consisting of two boxes of 9 aircraft each was designed to permit better control of more aircraft. Each squadron was a "V" of three elements, and each element a "V" of three aircraft. The nine aircraft in each squadron flew at the same altitude, with the wing elements in trail of the lead element. The second squadron of nine aircraft flew 500 feet above the first, slightly in trail and echeloned away from the sun.

Although this formation was more compact than the original "Rouen" formation, it had less flexibility. On turns, wing aircraft lost sight of those toward the center of the formation during completion of the maneuver. Because unstacked elements blocked out each other's field of fire, vulnerability to German Air Force attacks at certain times was increased.

36 A/C GROUP (SEPTEMBER 1942)

This alternate formation was a further step in the direction of unified control. It had three units of 12 aircraft each, with each unit broken down into four elements of three aircraft each. Inner aircraft were protected but the formation did not solve the problem of flexibility, nor did it increase fire power. Also, it was difficult to fly. The two trailing elements were required to be abreast of each other with all six aircraft at an elevation of eight feet below the lead elements. These elements were echeloned toward the sun from the lead elements.

The formation did, however, solve in overall fashion the problem of staggering. In such a 36 aircraft group, three units of 12 aircraft each flew in a staggered formation, a lead unit, followed by a wing unit to the side and 500 feet above the lead; then the other wing unit still further behind at the opposite side and 1,000 feet above the lead.

Although this type of formation kept as tightly closed as possible, the lead aircraft flew out of the line of vision of many units, and this made a cohesive formation virtually impossible.

JAVELIN OF GROUPS OF 18 A/C EACH (DECEMBER 1942)

Numerical growth of the eighth Air Force began to increase the capability of attaching more targets, and penetrations went as deep as Romilly and Wilhelmshaven. But this extended time of expssure to enemy fighter attacks. It should be remembered that at this time bomber formations still relied primarily on their own fire power for defense against the GAF. Therefore, the development of a formation affording an absolute maximum of mutual fire power was vital.

The first standardized javelin formation appeared in December 1942. It consisted of three squadrons - lead, high and low. Squadrons comprised two elements in echelon, each element stacked toward the sun, with elements and squadrons similarly stacked. This change increased flexibility over the previous 36 aircraft formations, and brought greater fire power to bear within each group, but it did not significantly help forward fire power. The Luftwaffe exploited the vulnerability of the lightly defended nose of our aircraft, causing losses of 10 percent and 12 percent by midwinter. Attempting to deny the enemy his best line of attack, groups were flown in trail, stacked above and behind the range of mutual fire support, but at least column effect provided some denial to the enemy's freedom of attack.

The chief disadvantage was difficulty of flying this formation. Stacking in trail at increasing altitudes caused troublesome speed differentials between high and low groups with resultant stringing out. Abortives mounted as individual bombers were unable to remain in formation, and mutual support became increasingly difficulty. The addition of a fifth group to the 8AF made it necessary to discard this javelin formation.

WEDGE OF FIVE GROUPS (FEBRUARY 1943)

The wedge formation replaced the javelin in an attempt to stop "stringing out" in the column. The lead group was placed in the center of this formation with two groups stacked above in echelon and two groups stacked below in opposite echelon. Aircraft, squadrons and groups were all stacked in the same direction.

This formation considerably shortened the column but did not entirely overcome a tendency to "string out" caused by a difference in altitude between high and lpw groups. What it did do was to reduce the speed differential between lead and trailing groups, by placing the leader at mid altitude.

Also, by increasing forward fire power it reduced somewhat the vulnerability to nose attacks and thus favored mutual support. However, analysis of losses revealed that still more compression was necessary to counter the devastating nose attacks, and experiments were begun in order to increase forward fire power.

THE EARLY 54 A/C COMBAT WING (MARCH, APRIL 1943)

"S" ringing out" became so bothersome that, in March 1943, a unit was developed consisting of the combat wing of three groups of 18 aircraft each (total varied from 54 to 60 aircraft). During the next few weeks variations were tried:

1) a lead group with one high wing group, and one low wing group, echeloned to the sides;

2) a lead group with high and low grpups above and below and slightly in trail.

The latter arrangement resulted in greatly increased forward fire power and mutual support, but was difficult to fly, especially on turns. The high group had trouble keeping the lead group in view.

Even with the wingmen echeloned to the sides, this 54 aircraft formation proved unwieldly, and squadrons at the outside positions, high and low, where too few guns could be brought to bear, were exposed.

The doctrine of mutual support which prompted this larger formation was largely negated by the technical difficulties encountered, Consequently, it was replaced shortly thereafter.

MORE COMPACT COMBAT WING OF 54 A/C (APRIL-DECEMBER 1943)

In June 1943, p-47s of the 8FC began escorting our bombers. As the force gained in both experience and equipment these fighters gradually increased their range from about 175 miles away from fighter bases in the United Kingdom to approximately 250 miles. In October 1943, p-38s joined them. But bomber penetrations deepened even further beyond escort range, increasing greatly the hazard from enemy fighter attacks. Consequently, mutual fire power support continued to be the most important factor in bomber defense, as the Luftwaffe waited for the fighter escort to return home before attacking the bombers.

In this deadly struggle, the need for increased fire power and minimum exposure heightened. Hence, two important variations in the 54 aircraft combat wing formation were put into effect:

1) Aircraft in each element were stacked in one direction, while both the elements and squadrons were stacked in the opposite dirsction;

2) the previously exposed highest and lowest squadrons were "tucked in" behind by reversing the echelon of the elements in each wing squadron of each group.

The "tucked in" 54 aircraft formation afforded greater lateral compression, and considerably increased the number of guns uncovered, but it did little to solve the mounting problem of

stragglers (responsible on some missions for over 50 percent of the aircraft lost). Twin-engine aircraft could lob rockets into a large bomber formation to disrupt it, after which the enemy, with coordinated single-engine attacks, would pick off the stragglers.

Deep and costly penetratio ns, such as those to Schweinfurt in August and October, finally caused discard of the inflexible 54 aircraft combat wing.

THE 36 A/C GROUP (JANUARY 1944)

Between mid-October 1943 and mid-January 1944, the 8AF experimented with a revised 36 aircraft group, and after this period the 36 aircraft formation entirely replaced the unwiedly 54 aircraft combat wing.

Two factors, more than any others, influenced the adoption of the 36 aircraft group as Standard Operating Procedure:

1) the introduction and extended use of oversast bombing;

2) the increasing range of fighter escort.

Seventy-five percent of the 8AF attacks in January and February of 1944 involved German targets, and over half of these were bombed through the overcast. Because of the sortage of PFF (Pathfinder Force) equipment, it was necessary that the squadrons be compressed as tightly as possible. This was accomplished by fashioning a 12 aircraft squadron with four elements of three aircraft each. All aircraft in an element flew at the same elevation. The four elements were a lead, a high-wing, a low, and a low-low trailing. This uncovered more guns and increased cohesion of the individual unit, although the formation was still difficult to fly.

Escort problems affected the group formation as much as overcast bombing influenced the squadron. For all this time, the escort range and number of our fighters was increasing and more attention was being paid to flying bomber groups in a way best calculated to aid fighter escort. Savings of width and height were effected in the three squadrons which flew as a group consisting of lead, high-wing and low-wing squadrons.

The effectiveness of this tigher formation and its fighter escort was established in the February debacle of the GAF, which was rendered temporarily impotent by a series of knockout blows during the Spring of 1944.

THE 27 or 36 A/C GROUP - B-17 FORMATION (FEBRUARY-APRIL 1945)

By 1945 the GAF was no longer a major threat. Lack of fuel and experienced pilots had reduced it to a mere shadow of its once-powerful self. Our bomber hours and sorties mounted; bomber combats decreased. Our expanded escort could now control the sky over all the target routes. Fighter cover had supplanted bomber fire power as the first line of air defense.

Being able to rely less and less on their crippled Luftwaffe, the Nazis tightened and intensified their flak. What was needed then was a formation which could be easily escorted en route, and still bomb targets as effectively but in less time and with less exposure to flak. Thus evolved the normal 27 aircraft group of three nine-aircraft suqadrons, increasing to 36 aircraft when a fourth or low-low squadron was added.

The new nine aircraft squadron, compressed in air space, was superior to the 12 aircraft squadron in that it increased cohesion of the individual unit and afforded more flexibility. The smaller formation was easier to control and easier to fly. With less confusion it was now possible to obtain better results in the bomb pattern and reduce per-plane exposure to flak.

So satisfactory was the new formation that B-17s flew it until operations ended.

OVERCAST BOMBING

Weather in this theatre was the most important limiting factor in operations when the 8AF began to fly from England. To begin with, we were grounded four out of every five days because visual bombing conditions were lacking. There was great need to fine some means to utilize non-visual days.

Much thought had already been spent on this problem in the U. S. Some procedures had been devised, The British had experimented with radar to locate targets through cloud with limited sucess. Their device was called H$_2$S and, with it bodies of water could be distinguished from land, and cities could be found. But pinpoint targets were impossible to locate.

The 8AF experimented with British H2S. It was a distinct aid to navigation over cloud but was nearly selective enough for accurate bombing. As a result of experimentation, an American device was produced, called H2X. This was an improvement over H2S, but still was incapable of distinguishing small targets. But H2X soon increased our capabilities to a marked degree.

There were some targets of an industrial nature, each of which was situated at the side of a large city. The city could be located on the H2X scope. By approaching the city from the appropriate

direction, the target could be bombed by aid of its known distance and direction from the center of the city. Sometimes a huge industrial plant would make a "blip" of its own on the scope which could be distinguished from the main "blip" made by the city.

Other targets might be located on a shore line. If the shore were irregular in shape so that a landmark would appear in the scope, the landmark would aid in locating the target.

In general, H2X could not locate the average pinpoint target, but it could locate enough area targets through the overcast to increase our capability of bombing to a marked degree. In addition, it was of great value in locating targets on visual days by aiding in finding of check points and correcting navigation over cloud on the way to the target.

A great advantage of H2X is the fact that it is self-contained on the aircraft. This only limits the range of its utility to the range of the aircraft. Many other navigational and bombing devices are "tied" to ground transmitting stations which send out the radar pulses which actuate the scope in the aircraft. Since radar rays travel in a "line of sight", they gain in altitude over the ground as the distance from the station results in more and more curvature of the earth. Hence, radar ground stations can only reach aircraft at greater altitudes with greater distances from the transmitting stations.

Adaptation of another British navigational instrument resulted in the American navigation device called Gee-H. Its scope was actuated by two ground transmitting stations. With this device the aircraft could know its own location over the ground with more or less accuracy, depending on the distance from the transmitting stations. Techniques were developed to use this navigation device for bombing. Marked success resulted, even in bombing small targets.

Another instrument, called Micro-H, was devised along similar lines but was more accurate than Gee-H. It was limited in range to around 170 miles from the transmitting stations when the aircraft was at 20,000 feet, 200 miles when at 25,000 feet. With proper techniques, this device was found to have several advantages over Gee-H.

The accuracy of bombing by Gee-H and Micro-H continued to improve as crews became better trained and more experienced. The small supply of equipment was a limiting factor in their use/..

During the war with Germany, Gee-H and Micro-H never achieved the accuracy of visual bombing. But their use greatly improved our operating capabilities within their range. ...

By use of all three devices we were able to operate on a high percentage of days instead of the few which would permit visual bombing, and targets suitable for each tupe of device could be hit with a profitable percentage of bombs...

An important additional advantage of overcast bombing was the factor of loss. The cost to our force in aircraft loss, both to

enemy fighters and to flak, was constantly much lower on overcast days than it was in clear weather.

...

Back in June 1943, 12 handmade H2X sets were installed in B-17s as navigational aids. The first actual bombing mission was flown the following October...

By April 1944 serious thought was given to improving H2X bombing accuracy through the use of the Norden bomb sight and the automatic pilot, in conjunction with the H2X set...

...

In the combat missions that followed it was found that one out of every four H2X sightings proved to be ineffective because of H2X equipment failures. Moreover, there was a striking correlation between the degree of cloud cover on the bombing run and bombing errors. Even a small break in the clouds enabled the bombardier to synchronize his bombsight with considerable accuracy, and thus improve the bombing pattern.

STRATEGIC OPERATIONS - Phase I
17 August 1942 - 11 December 1942

Bombing attacks by small formations of 8AF B-17s to the coastal area of the Continent typified this period. Top cover was supplied by very large numbers of RAF Spitfires, but on some shallow penetrations beyond the coast into Occupied France and the Low Countries, the bombers ventured beyond range of this escort. Surprise was gained in certain cases through the use of radio countermeasures, fighter sweeps, and medium bomber attacks to "fix" or pin down the enemy defenses.

Enemy disposition extended along the coast line from Brest to Heligoland Bight with the bulk of the defenses in the Pas de Calais area and in front of Paris.

Enemy interceptions largely were local in nature. No reinforcement of the area under attack was attempted by the Luftwaffe until the last mission of the period.

The enemy seemed uncertain as to the best tactics to use against the 8AF formations, but he was moderately aggressive.

Penetrations in this first phase generally did not exceed 50 miles into enemy territory. Eighty-four per cent of the attacks might be termed shallow with only 16 per cent penetrating in depth into enemy defenses. Virtually all the attacks went directly to the target, and withdrawals in general were reciprocal. Approximately two-thirds of the attacks were made with a single bomber force attacking one target. Bomber losses in this phase were small.

Our attacking force averaged about 50 bombers flown in various formations shown in Chapter I under the appropriate dates. Escort was provided by between 400 and 500 RAF Spitfires, which gave high top cover to a point either just beyond the enemy coast, or short of it. Range of the Spitfires depended upon the length of the sea route and the accuracy of timing for the rendezvous with the bombers.

There were two areas of enemy attack: one between the Seine River and Amsterdam extending into the heart of enemy defenses, and the other from Brest to La Pallice.

The bombers employed certain measures to aid them in surprise and evasion. The two most important were "Moonshine," and medium bomber attacks accompanied by fighter sweeps. "Moonshine" was a radio countermeasure used by a small force of RAF Defiants to make the force appear to German controllers as a large heavy bomber formation. The Defiants flew out over the North Sea or the Channel but returned to England without reaching the enemy coast to prevent the enemy from realizing exactly what it was he mistook for heavy bombers.

Medium bomber raids were timed to engage enemy fighters sufficiently to "fix" them and thereby prevent or delay attacks by these fighters on heavy bombers. Fighter sweeps either with or without medium bomber attacks, were successful at first in at-

tracting the attention of a considerable number of enemy fighters.

Three other measures of evasion were used to a less extent. Feints by the heavy bombers were flown on 27 per cent of the missions; "fixing" attacks by heavy bombers 18 percent, and routes indicating alternative objectives for the actual target were flown five percent of the time.

Because of "Moonshine" and other "fixing" operations during this early period, the enemy's interception was almost entirely local. That is, aircraft attacking the bomber force, were based within approximately 70 miles of penetration and withdrawal routes. Individual enemy units would continue the attack for 80 to 110 miles along the route.

Enemy attacks were made on the average along approximately two-thirds of the total penetration and withdrawal across enemy territory.

As there was no fighter reinforcement by the enemy of the area under attack, no secondary defenses were involved. This was the case both because of shallow bomber penetration, and becuase of the lack of deeper enemy disposition.

The enemy reacted strongly to evasion methods, particularly during the early part of the period. Reaction to "Moonshine," fighter sweeps, and medium bomber attacks were strong. "Moonshine" worked well until November 1942. Thereafter it decreased somewhat in spite of the fac that the enemy never did understand what caused the effects of "Moonshine." Toward the latter part of the period the enemy attempted to concentrate on the heavy bombers which he now was beginning to identify.

Feints througbout this period by the heavy bombers continued to draw strong reaction. Due to weakness of the enemy's warning system, he resorted to air alerts. The reason for this was that only shallow penetrations were being made and German warning services were unable to estimate types or numbers of aircraft with any accuracy.

A strong reaction usually resulted whenever heavy bomber "fixing" attacks were employed. Small forces of heavy bombers under escort pinned down disproportionately large numbers of enemy interceptors.

STRATEGIC OPERATIONS - Phase II
12 December 1942- 24 July 1943

This period opened with the first 8AF attack on the Romilly airfield and storage depot on 12 December 1942 and ended when an attack on Rostock on 25 July 1943 began a new phase. It represented an extension of the 8AF's demonstrated depth of penetration to approximately 160 miles of enemy territory as compared to approximately 50 miles in the first period. This addition was the result of the increased size of the bomber force and of the formations flown which gave some improvement in defensive fire. There was no increase in escort range, armament or any other defensive factor, Enemy disposition had changed little by the beginning of the period, but by the period's end in July 1943, there had been a considerable build-up, chiefly in Holland and Northwest Germany of enemy defensive fighters. Some secondary defense was added in the vicinity of Stuttgart.

The bomber formations flown continued the trend towards compressing many bombers into smaller and smaller air space. When the phase began, the 8AF was flying ajavelin of four groups of 18 A/¢ each. The groups had a tendency to string out because of the increasing altitude of each successive group. When a fifth group finally was added, this tendency was seriously amplified. A new formation was needed.

By February 1943, the lead group has been placed at mid-altitude, echelonning up to one side an down to the other. This reduced the speed differential between the lead group and the one at the end. This group wedge was flown only a few times before it was discovered that, under fighter attack, the other groups tended to close in on the lead as much as possible. Five groups, tightly closed, made an unwieldly mass of aircraft. So it was decided to capitalize on this defensive maneuver and fly only three groups close together for defensive fire protection. This was called a Combat Wing.

The 54 aircraft Combat Wing was too wide. By the end of April a similar formation had been devised, with each squadron compressed by overlapping the element: the Group compressed by overlapping the Squadrons; and the Combat Wing was compressed by overlapping the Groups. The width of the Combat Wing was cut to about half its original dimensions.

By May 1943, U. S. p-47s began to join the RAF in providing escort. These fighters began by flying a tight top cover - the RAF umbrella. But before long, P-47 pilots began to drop down and engage the enemy fighters. Their range of escort was similar to the Spitfire, about 170 miles from bases, or only a short way into enemy territory. This was the period of trying out the equipment and gaining experience.

In June 1943 the P-47s began a process which was to continue throughout the Air War. They began to open up somewhat, up to 100 yards between each aircraft, to add flexibility and thereby increase the number of guns which could be brought to bear on the enemy.

Throughout the war, as 8AF formations became more compact, theescort flew more and more widely until it became a huge net to envelope the enemy.

During this period enemy targets mainly in three areas were attacked. One area was the heart of the enemy's defenses in France; the second the area of German U-boat bases along the Atlantic coast, and the third the area of U-boat facilities in Northwest Germany around Heligoland Bight.

By this time the enemy had become much more aggressive. He was reinforcing the areas under attack, and his fighters were following 8AF bombers far out to sea on withdrawal. Penetration depth of the 8AF was insufficient to permit the enemy to inflict serious losses when the bombers were without escort.

The depth of penetration into the enemy fighter defenses still was shallow on 42 percent of the missions in this period, and of medium depth 58 percent of the time. Fifty-nine percent of the penetrations went directly to the targets and 77 percent of the withdrawals were reciprocal or direct. By now the 8AF was attacking more than one target 70 percent of the time and by indirect route penetrations was attempting to confuse the enemy as to the objective 41 percent of the time.

Tactics of surprise and evasion were used. On 32 percent of the missions routes were chosen with the primary objective of confusing the enemy concerning which important target was to be attacked. On 30 percent of the missions the heavy bombers made feints intended to use up flying time of the enemy fighters or distract them from the real targets.

Fourteen percent of our missions resorted to medium bombers and fighter sweeps. "Fixing" attacks also were employed on 14 percent of the missions.

Enemy fighter dispositions at the start of the period were much as they had been in August 1942. It still consisted of a shallow coastal defense from Brest to Heligoland Bight, weighted heavilybin the Pas de Calais area. German Air Order of Battle in the coastal area dropped from 270 s/e fighters in August to 215 in January.

During the second phase, 8AF attacks resulted in an increase to 515 enemy fighters in the coastal area, with a secondary defense of 60 s/e enemy fighters in the Munich-Stuttgart area. Enemy disposition was spread fairly evenly along the coast, with some weakening in the southwest toward the Brest Peninsula.

Reaction differed in the three large areas of attack. For instance, in Northwest Germany, bomber penetration of enemy territory was not great, alhtough the bombers flew a long route over the North Sea. In that area enemy fighters sometimes came distances of 110 to 130 miles to the attack.

To defend targets in the Brest Peninsula and along the Atlantic coast of France, German fighter aircraft would fly 90 to 110 miles to attack during the 8AF's first 100 miles of penetration, and from as far as 190 miles to attack during the second 100 miles.

Penetrations towards the center of the enemy defenses would attract enemy fighters as far away as 120 miles from the bomber route on occasions when the 8AF penetrated more than 100 miles.

Center attacks and penetrations around Brest Peninsula would attract enemy fighters from distances of 160 to 170 miles during withdrawal.

But in all areas the enemy attack was "piecemeal," Each enemy unit attacked when and where it could. On withdrawal the bombers sometimes were under attack all the way across the North Sea to the coast of England.

Individual attacks by enemy units in all three areas usually would persist for distances of 170 to 190 miles along a route. The entire route in enemy territory was under attack by one or more enemy units during penetrations into northwest Germany or the center of the French defenses. The enemy's interception during this period was very aggressive; he attacked fighers as well as bombers.

The enemy still lack secondary dispositions until the end of this phase. He got somehwat the same result by providing temporary reinforcement for the loca fighters in an area of attack. Reinforcement units would land and refuel after coming into the Brest Peninsula from distances as great as 250 miles; into Northwest Germany from 210 miles; and into the center of the enemy disposition around Paris and the Pas de Calais from a distanee of 170 miles.

Enemy reaction to measures of evasion also varied. In the central area there was strong reaction to most "fixing" attacks, fighter sweeps and medium bomber attacks. Feints began to lose the ability to draw enemy fighters, as bomber penetrations deepened and the enemy began to realize the futility of air alerts. However, he still reacted strongly to about one-half the feints.

In the Brest Peninsula area he continued to react to two-thirds of the "fixing" attacks, but reacted only to one-third of the feints, medium bomber attacks or fighter sweeps.

In Northwest Germany, because 8AF targets were at distances then too great for fighter escort to reach, measures of evasion were difficult. Feints by unescorted bombers began to receive too vigorous attacks and had to be discontinued.

STRATEGIC OPERATIONS - Phase III
25 July 1943 - 19 February 1944

On 25 July 1943 an attack was made by 8AF heavy bombers on a target at Rostock in North Germany, thus initiating a new phase in the depth of penetrations to which the Eighth was prepared to extend operations. This phase ended when the attacks of 20 February 1944, on targets near Leipzig, began the fourth phase.

The limits of the penetrations for this third phase were demonstrated on 17 August 1943 when one force, equipped with Tokyo tanks, thrust deep into Germany to attack the Messerschmitt plant at Regensburg, and withdrew southward over the Alps to North Africa. A few hours later a second force of B-17s with standard tanks flew to Schweinfurt to attack the ball bearing plants there and then withdraw westward to England. The first force demonstrated a capability of attacking anything in Southwest Germany, all of France, and most of Italy, by withdrawing to North Africa.

The bomber formation flown for most of this period was the more compact 54 a/c Combat Wing. A Task Force consisted of such Combat Wings in trail.

In January 1944 a new formation came into use. The 54 a/c Combat Wing had too little flexibility. Its three groups of 18 each had been tied closely together, and the handling of so many aircraft as a unit was difficult.

Now, the individual group was doubled in strength to 36 aircraft. It was still composed of three squadrons, with the wing squadrons echelonned either side of the line of flight. But the individual squadron now was composed of four flat elements of three aircraft, stacked as lead, high, low and low-low.

Combat Wings now lost much of their identity as units. In such a formation there was a four-mile interval between the lead and number one group, and another four-mile interval between the one and two groups. The two groups following after the lead were staggered slightly to opposite sides of the line of flight.

The Combat Wing following left an interval of four miles. The lead group of the next Combat Wing flew in trail of the lead group of the previous Combat Wing.

The Group formation presented a compact defensive fire for the defense of its 36 aircraft. Limiting this unit to 36 aircraft instead of 54 added considerably to flexibility.

The processes of opening out the fighter formation continued throughout this period. Late in July 1943 the first belly tanks became available for P-47s, and made possible some tactical

surprises. The enemy had been in the habit of formingup just beyond range of escort with his twin-engined fighters. On several occasions following the sudden addition to range, 8AF fighters were able to fly straight into an enemy formation, score many victories and tereby disrupt the attack on our bombers.

By September 1943 the 8AF fighters began to get useful aid from the British "Y" service. Trained radio operators translated intercepted messages from German controllers and passed on this information for immediate operational use. This enabled our fighters to attack enemy assembly areas, throw enemy concentrations off balance, and disrupt the enemy's plan of bomber interception.

When both EAF and 8AF fighters were within range of British Type 16 control, this control directed the 8AF fighters to a position of advantage. It was a radar device similar to Micro Early Warning but of shorter range, which allowed a fighter controller to observe on a screen the relative positions of firnedly and enemy fighters.

In January 1944 the basic concept of the use of fighter escort changed. The earlier order, "protect the bombers" was expanded by adding "and pursue and destroy the enemy." Now, some of the escort remained in constant defense of the bombers while others intercepted enemy attacks on bomber formations and then pursued enemy fighters wherever they fled. Fighters leaving escort were permitted to "sweep the deck." This added a powerful new force to the attack on German troops, transport, and communications.

Toward the end of the period the 8AF fighter escort groups spread out to 25 or 30 miles in width, ao that it was difficult either for the enemy in the air or his warning services on the ground to detect them. One squadron would sweep well ahead of the bombers while the other two squadrons of the group swept at the sides of the bomber formation.

From August 1943 through February 1944 there was little change in the number of single-engine enemy day fighters disposed against the 8AF. The increase which did take place built up a single-engine night fighter force to a strength of about 25 percent of the day fighters.

A very serious enemy threat came from a new day fighter which grew to considerable proportions during this period--the twin-engine rocket-firing fighter. During this phase, such fighters became roughly one-third as numerous as single-engine day fighters. Because of its long range, the twin was a constant menace. It appeared from distant airfields in opposition regardless of which route the bombers took.

GAF fighter disposition changed during the period from essentially a coastal defense to a defense behind the Rhine. Small forces were left for defense of probably invasion areas. But the bulk of the GAF was disposed just west of the great industrial areas in Germany, with secondary defenses as far as Berlin.

This change was a result largely of the destructive effect which 8AF long range fighters began to have on German interceptors, particularly toward the end of the period. The provision of fighter defense in the area of the Eight's early penetration of enemy territory became too costly for the GAF, and a disposition of fighters on the ground exposed to our fighter escort "sweeping the deck" on the route home proved too vulnerable.

The attack at Schweinfurt involved a direct penetration into enemy territory of 320 miles and withdrawal to England, This depth of penetration was not be exceeded until February 1944. It employed about the full range capability of the B-17 with standard tanks for a direct penetration. Requirements for effecting formation and gaining initial altitude before reaching the coastline with the limiting factors.

During this third phase there were three major areas of attack and two minor. The major areas were Northwest Germany, Western Bermany, Northern France, and the Low Countries. A few attacks were made against targets on the Atlantic Coast around Bourdeaux, and a few more were made in North Germany.

During most of this period, fighter escort of the 8AF was capable of penetrating beyond the enemy coast to distances up to 160 miles. The penetration of the bombers, however, went beyond this. To reduce the time of exposure beyond the range of escort, attacks usually went straight to the targets and back. Yhese deep bomber penetrations beyond fighter escort represented a bold attempt by the 8AF to establish that heavily-armed bombers could fly deep into enemy territory with only the protection of their own defensive fire power. The losses on some of these missions tended to prove the opposite, if the bombers were opposed by an alert and desperate enemy.

The enemy at this time was exceedingly aggressive and quick to grasp the plan of 8AF operations. He developed methods of concentration, new armament and improved tactics which made deep daylight bombing penetrations beyond escort too costly to be continued.

During phase III 81 per cent of 8AF penetrations were direct and 86 percent of withdrawals were direct or reciprocal. By this time the bomber force was large enough so that 81 percent of the time more than one target was attacked per mission. Depth of penetration was sufficient for routes to be chosen suggesting alternative objectives 22 percent of the time.

Penetrations were very deep seven percent of the time, deep 18 percent, medium deep 52 percent, and shallow 23 percent.

The bulk of our enemy bombing missions penetrated to the center of enemy defenses. On penetration, enemy fighters intercepted from distances as great as 160 miles from the route on penetration and as great as 220 miles on withdrawal. Attacks by dindividual units of enemy fighters extended as far as 180 miles along the route. Bomber forces were under attack 60 to 100 percent of the whole route on these center penetrations.

Many withdrawals, out over the North Sea or the Channel, were attacked. In one instance enemy fighters followed the bombers back over Kent.

On these central attacks reinforcement areas of enemy defenses extended as far as 200 miles from the bomber route. Both single-engine and twin-engine fighters were disposed in secondary defense. The "twins" rapidly learned to avoid areas where bombers were under escort.

Routes from Northwest Germany were intercepted from distances as great as 130 miles, both on penetration and withdrawal. As penetrations in this area did not go so deep into enemy territory, and because of the long North Sea route, attacks by individual enemy units never exceeded 110 miles of the route. But the entire route in this area was under attack while over enemy territory, and frequently withdrawals over the North Sea were under attack almost to the shores of England.

STRATEGIC OPERATIONS - Phase IV
20 February 1944 - 20 June 1944

The new phase began with a highly important mission by the 8AF to Leipzig, beyond the old demonstrated range. The full limits of the new range capability were not demonstrated, however, until an attack was made on targets at Munich 19 March. This indicated to the enemy a capability of penetrating his territory to a distance of approximately 450 miles made possible by the addition of large numbers of long-range escort fighters. This depth of penetration was not to be exceeded until 21 June.

Throughout this pahse, the same formation was flown as at the end of the third phase: the 36 aircraft Group, and the Combat Wing of three groups at four-mile intervals in trail with the Wing Groups stepped one to each side of the line of flight.

A new factor of the utmost importance now had entered the air war, the long range escort fighter began to appear in increasing numbers. Instead of evading the enemy, the aim now was to provole attack and to force enemy fighters into combat which the 8AF could stand, but which the GAF could not.

The escorting fighter groups spread out 25 to 30 miles in width and frequently a squadron or a group was sent to sweep the route directly ahead of the bomber formation.

Increasing use was made of groups on a "free sweep." They would fly deep into enemy territory toward an area of expected enemy assembly, there break into flights and "throw out a net" to enmesh the enemy fighters. 8AF fighter pilots were becoming increasingly aggressive. Frequently a flight of four would charge into an assembly of 50 to 100 of the enemy, break up this formation and destroy a considerable number for little or no loss.

Sometimes the enemy would not come up to fight. Then our sweeping fighters would go down on the deck, strafe airfields, flak towers, railroad tr ains, and oher suitable military targets.

At the beginning of this period, attacks were made simultaneously on many targets with decisive effect. The mission of 20 February, during which enemy controllers and fighter pilots became thoroughly confused, brought the enemy a realization of the true capabilities of a great bomber-fighter force.

For the first part of the period, indirect penetrations were used to a great extent, but as the 8AF's new long range fighters increased and its pilots became increasingly aggressive, routes became more and more direct. Over the whole period 62 percent of penetrations were direct and 72 percent of withdrawals were reciprocal or direct. Almost every mission involved multiple targets.

The area attack was including all of Germany. A few missions included formations destined for Poland. With such deep penetrations the opportunity of flying routes affording alternative objectives was greatly increased, with a result that 52 percent of missions were flown in this manner.

Fighter sweeps were no longer evaisive in purpose. On 51 percent of the missions in this period, fighter sweeps were made deep into enemy territory to search out the enemy, break up his assembly, and force him into combat.

A violent change in enemy disposition took place near the end of this period. The enemy had thrown a cordon across the routes to his industrial haart area. He had moved 68 percent of his single-engine fighters to the Western Front to stop daylight heavy bombing attacks. Only 32 percent were disposed on the Eastern and Mediterranean Fronts and in Scandinavia.

But further trouble was in store for him. With the invasion of Normandy he was forced to neglect for the moment his desperate defense of Germany industry in order to attempt to thwart the Allied landing.

But further trouble was in store for him. With the invasion of Normandy he was forced to neglect for the monet his desper-

So the end of this phase in the air war found most of the German Air Force of the west, disposed in the genral vicinity of Normandy beachhead.

But a secondary defense was left to intercept deep bombing attacks. Single-engine night fighters used more and more in the daytime, eventually became a straight dayfighting force, and with remnants of the enemy's twin-engine day fighters, constituted most of this deep defense.

Enemy reaction took the form of increasingly large concentra-

tions of enemy fighters. These assembled in formations to attack heavy bomber task forces only after they had penetrated well into enemy territory. The enemy now attempted to make massive attacks with single-engine fighters. In such attacks succeeding waves of fighters flying line-abreast were exceedingly lethal to any bomber unit which had become too widely separated from its fighter escort.

The enemy was still very aggressive. He attempted to assemble all aircraft possible to make interception, bringing fighters from distances as great as 300 miles to reinforce the area under attack. But by now he had found that twi-engine fighters could not live in the same sky with long range Mustangs and Lightnings.

Two new tactical developments ofthe enemy are of interest.

He made increasing use of scouting or "shadow" aircraft to give his controllers information about weather and the disposition of our bomber and fighter forces. He also made use of "fugitive sorties." Pilots of his twin engine aircraft no longer wished to stay, even on the ground, in the area over which the 8AF flew. The result was that in the area which the enemy assumed was under attack, twin-engine aircraft would make off early for points as far north as Denmark.

At the same time, 8AF fighters demonstrated greater offensive capabilities. First the fighters were permitted to "sweep the deck" on returning homeward after being relieved of escort duties. Then fighter sweeps were inaugurated to the areas where enemy fighters assemblies might be expected while the bombers were making their early penetrations.

After considerable success in these efforts, fighter pilots became more and more offensive minded. They felt that if they were permitted to attack the enemy unhampered by the necessity of escorting bombers, dividends in crippling the enemy would result.

The pressure to carry out the bombing program within a limited period was too great to permit such experiments when weather was suitable for bombing, and at this time, virtually all weather permitted some sort of bombing attack. But eventually the fi hters had two opportunities to go on mission alone. Both days had weather conditions too poor to offer any success for a bomber attack, but just above the minimum for a fighter sweep. On 5 April weather was so bad at bases and on the continent that the bomber force was "stood down." Ten groups of fighters were assigned to strafing operations at a large number of airfields over occupied territory and Germany. Weather was so bad over France, Holland, Belgium and Western Germany that groups with targets in these areas were able to do relatively little. Two P-51 groups, however, had been assigned targets deep in Germany, one in the vicinity of Berlin and the other near Munich. They found visibility such that, although few assigned targets could be found, a large number of enemy aircraft could be destroyed, chiefly on the ground.

The group attacking in the Berlin area crossed 10/10ths clouds until east of Brunswick where some breaks were visible. The group dropped from 23,000 feet through the cloud when in the vicinity of Berlin and attacked five airfields through flak that ranged from moderate to intense for claims of 45 enemy aircraft destroyed, three probables and 39 damaged. Only two aircraft were claimed in the air. Three P-51s were lost to flak and one in the Channel, the pilot being rescued.

The Munich attackers found similar weather conditions en route and in the target area. One assigned airfield and five airfield targets of opportunity were attacked for claims of 51-1-81, of which 8-1-2 were in air fights. Losses of the 8AF were three, one to flak, one to enemy aircraft, and one unknown.

Most of the enemy aircraft dest oyed were twin-engined. The airfields attacked were only moderately defended by flak at this time and flak fire was generally of moderate intensity and fairly inaccurate.

In addition, there were a large number of miscellaneous targets attacked, such as locomotives, flak towers, gun installations, barracks, hangars, barges, and personnel.

On 21 May, weather prevented large scale bomber operations, and again the fighters wre assigned to strafing attacks, this time against enemy transportation. Fighters from the 8AF, 9AF and RAF were assigned areas for group attacks in Holland, France, Belgium and Germany. The areas assigned to the 8AF extended from the western Border of Germany, eastward just past Berlin, and from the North Sea to Dresden. This was more than 60,000 square miles.

Thirteen out of 14 8AF fighter groups completed their assignment in spite of very bad weather. Enemy aircraft were 122-0-78, of which 20-0-2 were in the air. The list of transportation and other targets destroyed and damaged follows:

Rail Transportation Targets	Destroyed	Damaged
Locomotives	91	134
Locomotive tender	1	
Goods wagons	6	7
Boxcars	3	3
Tankcars	11	
Entire trains		29 (16 on fire)
Railroad Station		1
Roundhouse		1
Switch Tower		1
Signal House	1	6

Other Transportation Targets	Destroyed	Damaged
Motor Trucks	4	13
Barges	6	18
Tug	1	
Canal Locks		1
Miscellaneous Targets		
Small oil refinery	1	
Oil tank		1
Staff car	1	
High tension towers	15	2
Power station		1
Radar stations		2
radar towers		7
radio station		1
Radio tower		1
Flak towers and installations		5

In addition, there is a long list of damaged targets, inO cluding searchlights, gun posts, ammunition depots, hanggrs, water towers, factories, warehouses, barracks, an ore smelter, and other buildings.

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STRATEGIC OPERATIONS - Phase V
21 June 1944 - 8 May 1945

The new phase in range capabilities was shown June 21 as the AF spilt up to attack many targets in a wide area, chiefly in the vicinity of Leipzig-Dresden. One force of B-17s with Mustang escort, "hidden" by its route in relation to other forces, bombed the synthetic oil plant at Ruhland, north of Dresden. Then, completely unnoticed by the enemy fighters heavily engaged elsewhere, the Ruhland force continued eastward to land at Poltava in Russia.

This fofce demonstrated clearly to the enemy that, thereafter, there was no spot in "Fortress Europe" safe from bombing. No longer was there any belt of safety to which the enemy could remove his battered industries, military headquarters, or government offices.

Bombers of the 8AF still were flying $he 36 aircraft Group. Jwst prior to D-Day a Micro Early Warning Station started operating, giving "radar eyes" to our fighter controllers and pilots. In November 1944 this station moved to Luxembourg, thereby advancing its 200 mile range far into enemy territory.

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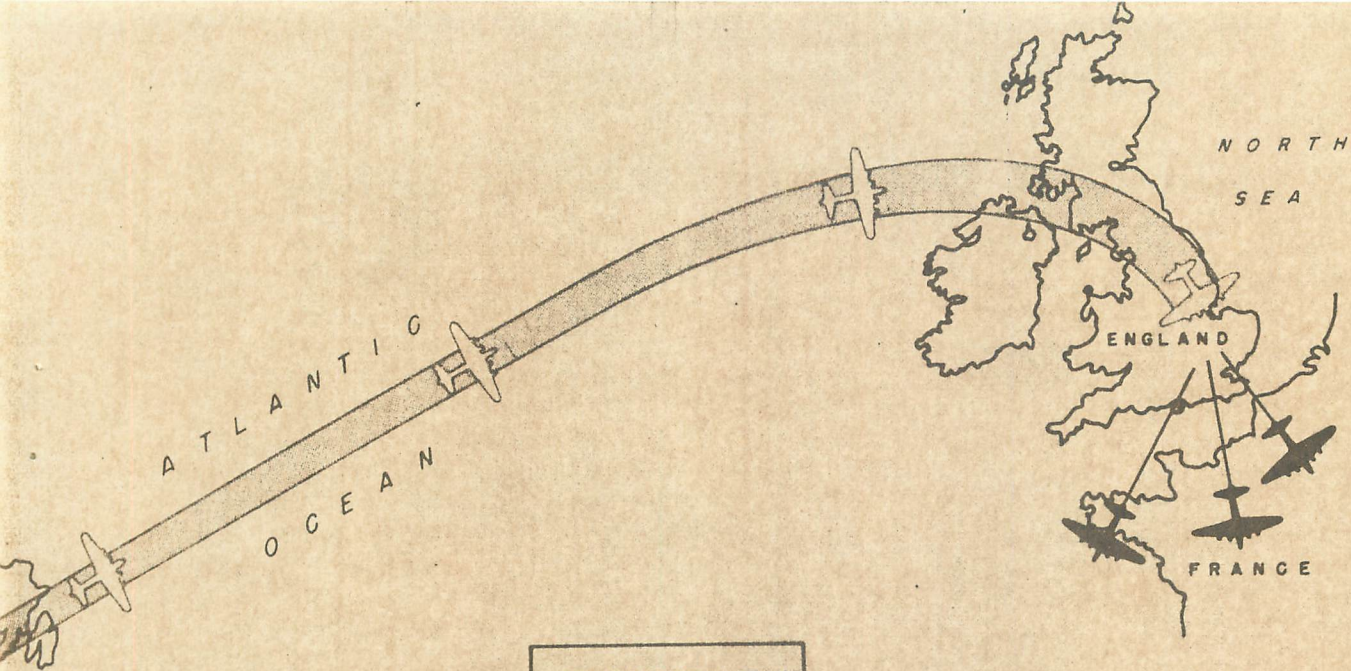
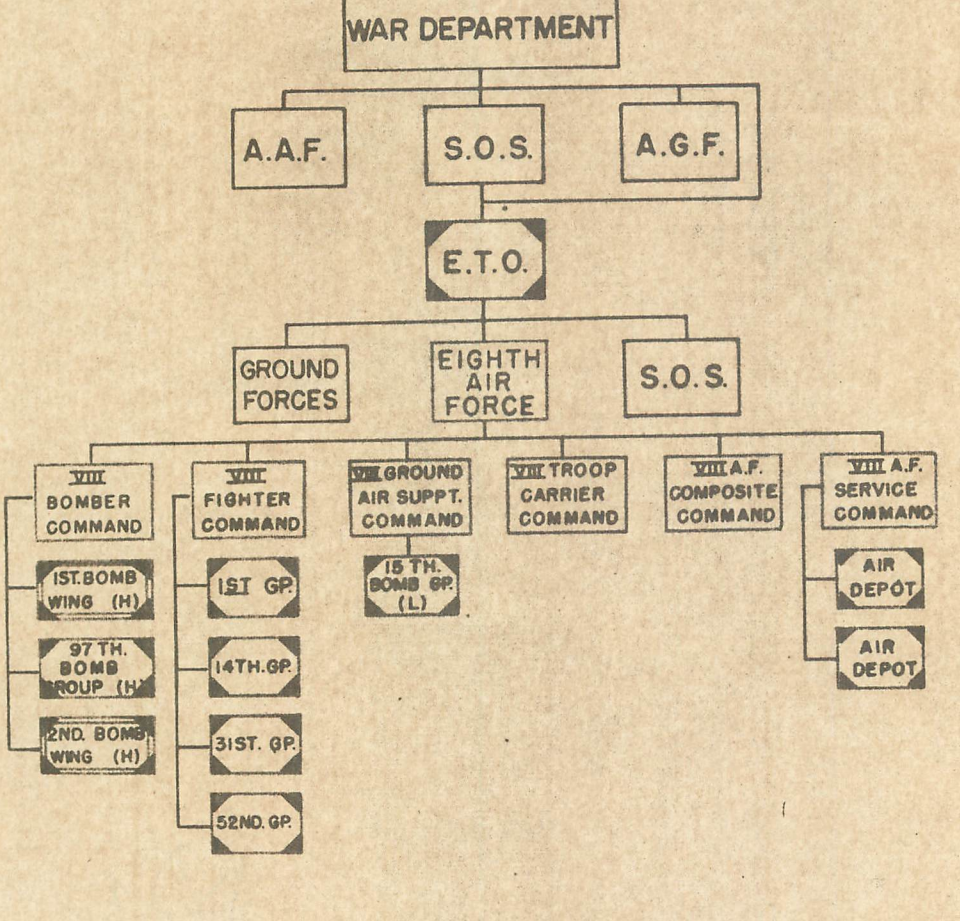
The area of bombing was no all of industrial Germany and the military supply lines to the west. Bomber routes varied more

than at any time previously. Two-thirds of the routes left the enemy in doubt as to which of several targets were to be attacked. Considerable use was made of "hidden forces", which allowed relatively small units to turn off to attack isolated targets, or in some cases innumerable small targets, without fear of heavy loss from fighters.

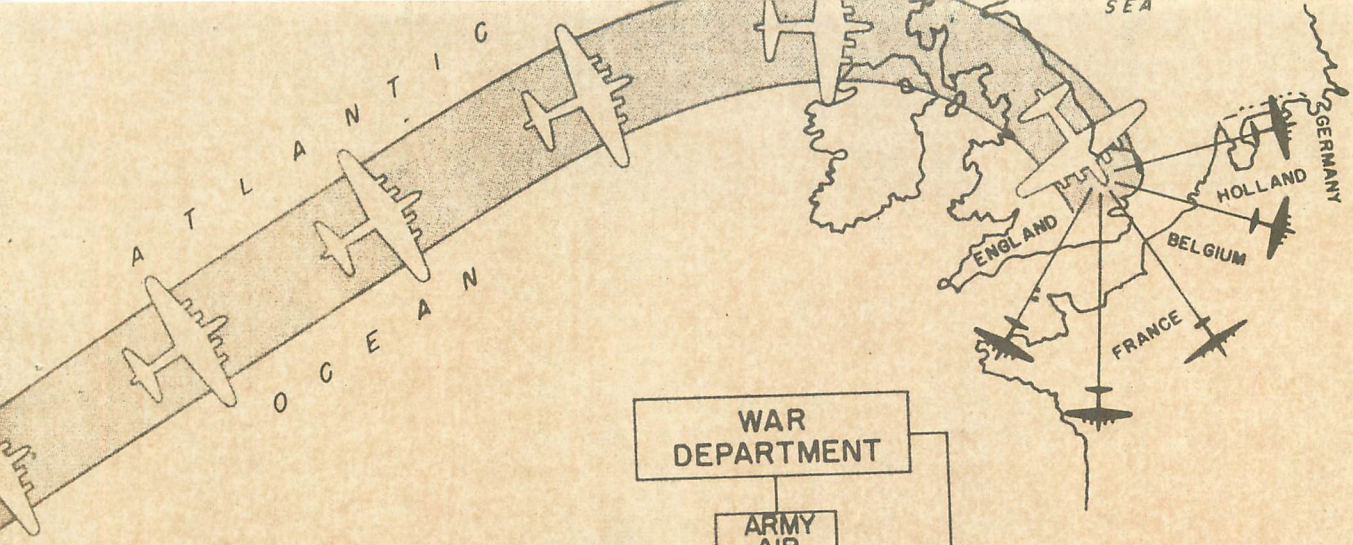
A new type of "fixing" attack came into frequent use. A bomber column could fly deep into enemy territory aiming directly at an objective vital to the enemy. With a concetration of enemy fighters piling up defense of a sensitive target, the one bomber force, heavily escorted, would ttack this target and engage the enemy, while the rest of the bomber column turned and bombed a multitude of targets to the rear along the route. Unhampered by enemy fighter attacks, these formations were able to focus all attention on acourate bombing.

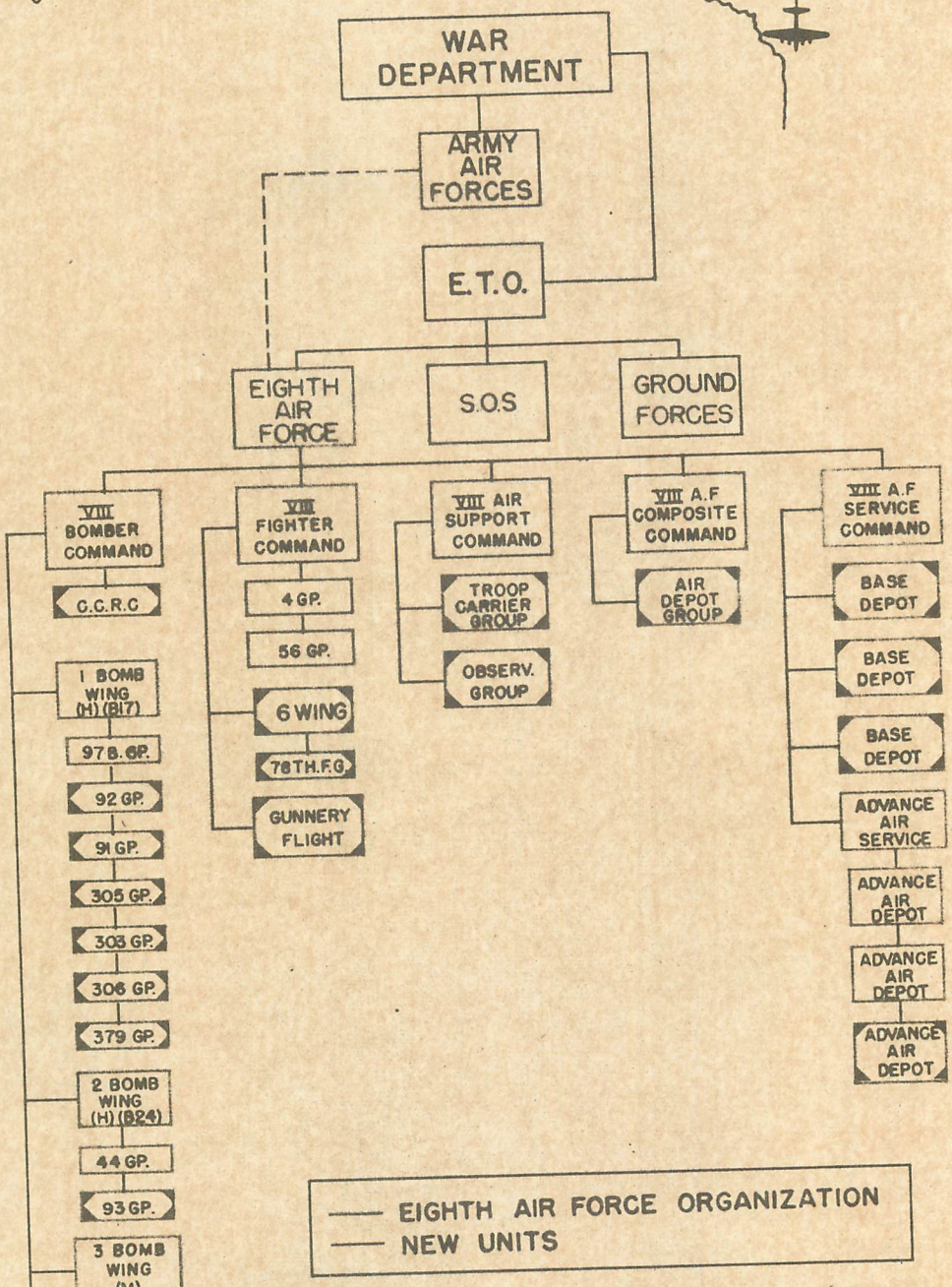
With his fighter force split between defense of strategic targets and army cooperation, the enemy was truly in difficulty.





ORGANIZATION OF THE 8AF ON DATE OF FIRST INDEPENDENT COMBAT MISSION





10 May 1943
ORGANIZATION OF THE 8AF DURING THE FIRST MONTH IN WHICH A TOTAL OF 1000 BOMBERS WERE DISPATCHED AGAINST GERMAN OCCUPIED EUROPE

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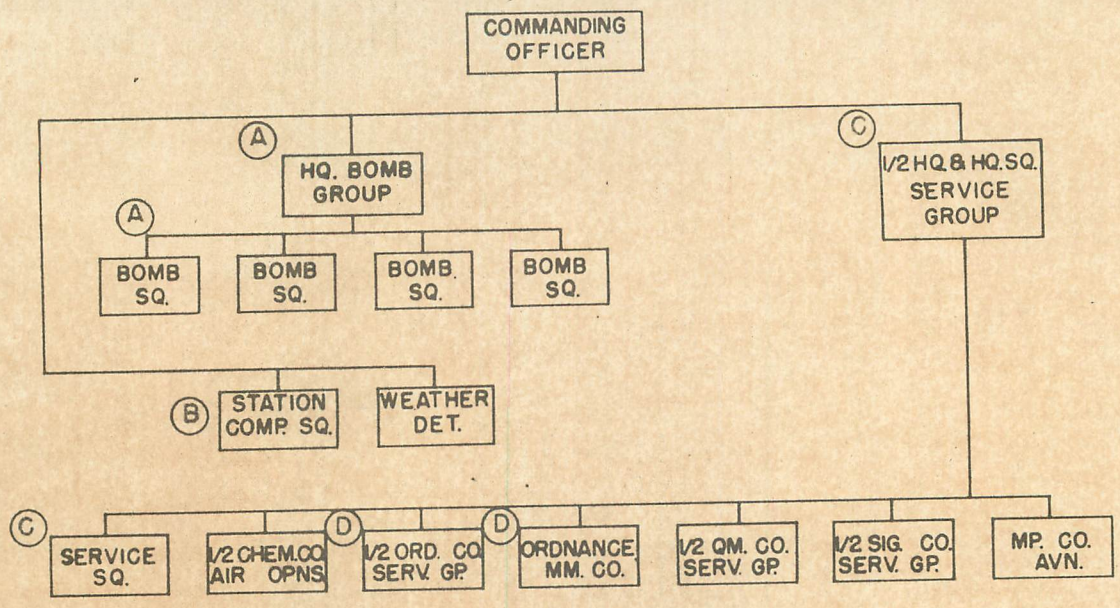
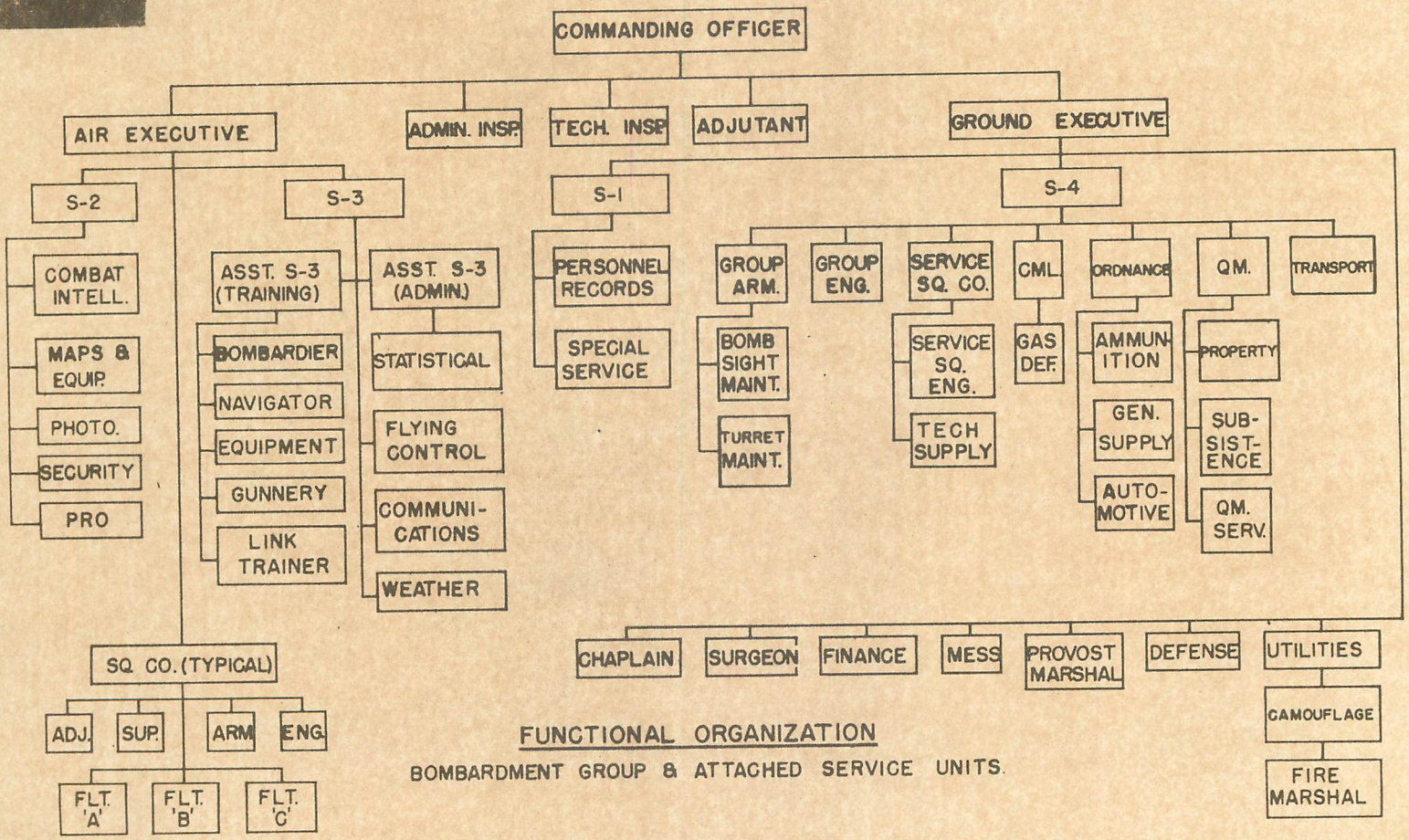


(A) OR FIGHTER
(B) PROJECTED ONLY - NOT ASSIGNED UNTIL AUGUST, 1943.
(C) LATER REPLACED ON BOMBER STATIONS ONLY BY SUB-DEPOT
(D) LATER COMBINED TO FORM ORDNANCE S & M COMPANIES OF WHICH ONE WAS ASSIGNED TO EACH TACTICAL STATION AS AVAILABLE



FUNCTIONAL ORGANIZATION

BOMBARDMENT GROUP & ATTACHED SERVICE UNITS.

STATION ORGANIZATION - Showing command and line organization in the Spring of 1943

A.A.F.

E.T.O.

GROUND FORCES

EIGHTH AIR FORCE

S.O.S.

479 ANTI-SUB GP.

RCN. GP.

VIII BOMBER COMMAND
- C.C.R.C.
- 1ST BOMB WING
  - 92 GP.
  - 91 GP.
  - 305 GP.
  - 306 GP.
  - 379 GP.
  - 303 GP.
  - 351 GP.
  - 381 GP.
  - 384 GP.
- 2 ND BOMB WING
  - 93 GP.
  - 44 GP.
  - 389 GP.
  - 392 GP.
- 4 TH BOMB WING
  - 96 GP.
  - 390 GP.
  - 385 GP.
  - 95 GP.
  - 388 GP.
  - 94 GP.
  - 100 GP.

VIII FIGHTER COMMAND
- GUNNERY SCHOOL
- 66 TH FIGHTER WING
  - 78 GP.
  - 352 GP.
  - 353 GP.
- 65 TH FIGHTER WING
  - 4 GP.
  - 336 GP.
  - 56 GP.
  - 355 GP.
- 67 TH FIGHTER WING

VIII A.F. SERVICE COMMAND
- BASE AIR DEPOT AREA
- 401 AIR DEPOT
- 402 AIR DEPOT
- 403 AIR DEPOT
- STRATEGIC AIR DEPOT AREA
- 1 ST S.A.D.
- 2 ND S.A.D.
- 3 RD S.A.D.

VIII AIR SUPPORT COMMAND
- 3 RD BOMB WING
  - 322 GP.
  - 386 GP.
  - 387 GP.
  - 323 GP.
- 315 TROOP CARRIER GROUP
- 67 RCN. GP.

VIII A.F. COMPOSITE COMMAND
- COMBAT CREW REPLACEMENT CENTER

EIGHTH AIR FORCE ORGANIZATION
NEW UNITS

5 September 1943
ORGANIZATION OF THE 8AF AT TIME OF THE INVASION OF ITALY

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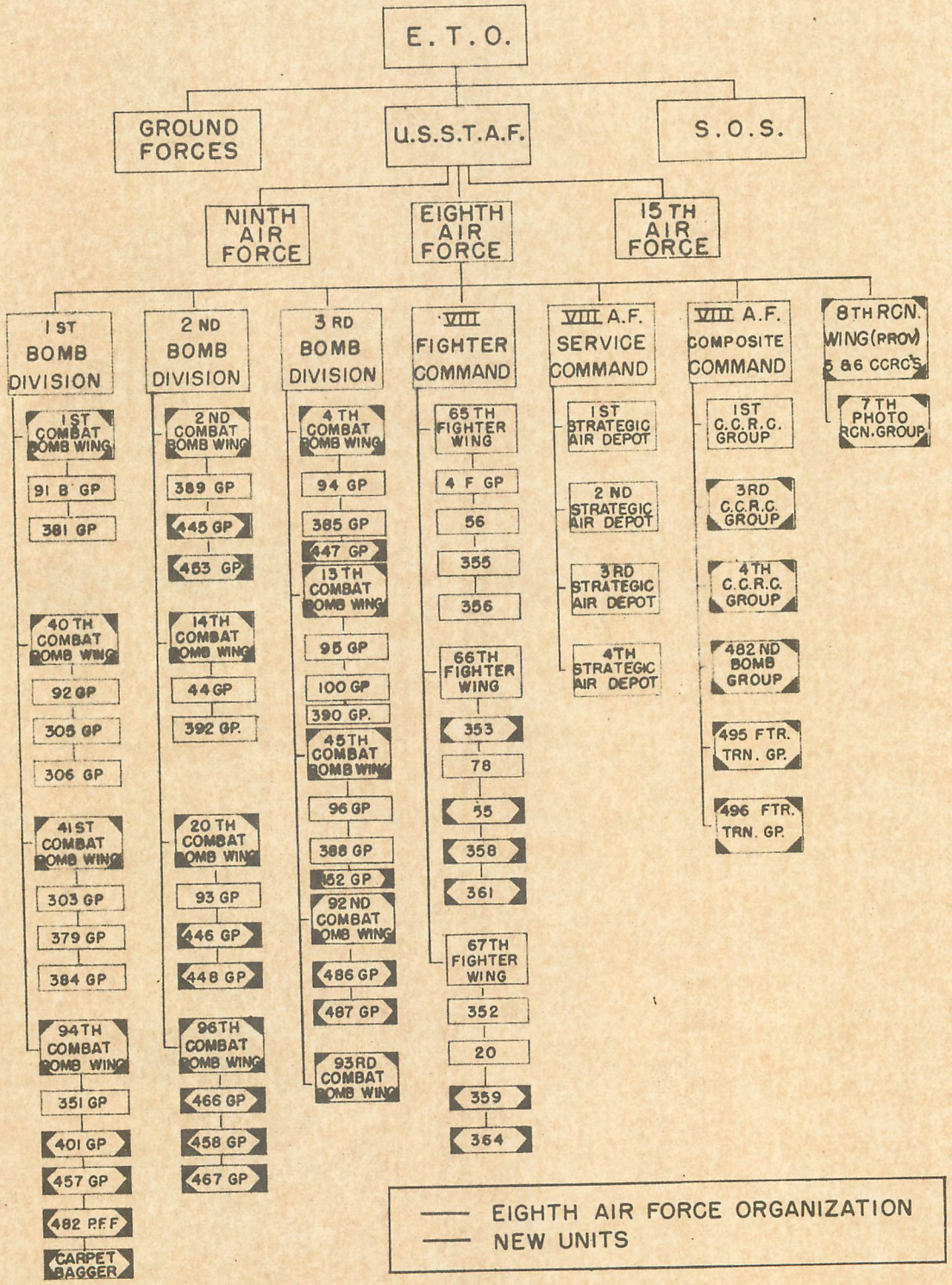
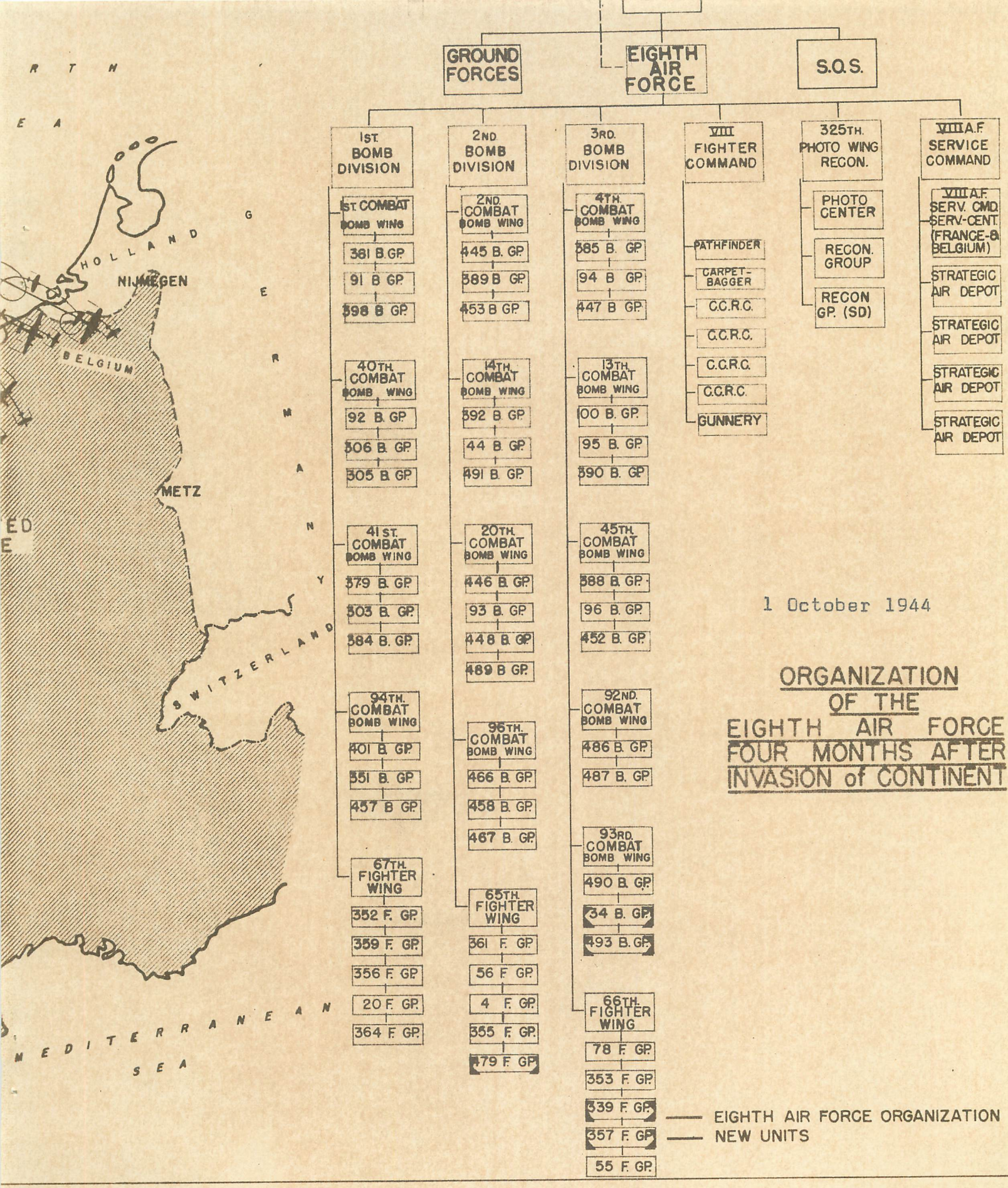


6 March 1944
ORGANIZATION OF THE 8AF AFTER FORMATION OF USSTAF
IN PREPARATION FOR CONTINENTAL INVASION



1 October 1944

ORGANIZATION OF THE EIGHTH AIR FORCE FOUR MONTHS AFTER INVASION of CONTINENT

BOMBER MODIFICATIONS

January-March 1943 -- Twin .50 nose gun installations in center of nose comprtment over bombsight.

March-April 1943 -- Twin guns superceded by single gun mount.

February 1943 -- Waist gun relocated to a position nearly level with the fuselage.

February 1943 -- Waist gun ammunition increased to 600 rounds.

July-August 1943 -- N-8 optical sight in tail.

August 1944 -- Tail gun increased to 90° cone of fire.

September 1944 -- Sperry K-13 sights replaced Iron sights.

April 1945

November 1943 -- Tokyo tanks

Various mentings and methods tried to extinguish wing fires

Spring 1944 -- all electric bomb release installed.

1943 -- Armor plate installed

February 1943 -- flak suits

Late 1943 -- flak curtains

1943 -- Low pressure oxygen systems

Closed radio hatch, closed waist windows.

Spring, Fall 1944 -- new radio jamming equipment