ANTIAIRCRAFT ACTION SUMMARY • WORLD WAR II

October 1945
Headquarters of the Commander in Chief
UNITED STATES FLEET
UNITED STATES FLEET
HEADQUARTERS OF THE COMMANDER IN CHIEF
NAVY DEPARTMENT WASHINGTON, D. C.

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C. M. COOKE, JR., Chief of Staff.

8 OCTOBER 1945

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FOREWORD

This is the last of a series of Antiaircraft Action Summaries, issued as Confidential CominCh Information Bulletins and as Secret CominCh publications.

This publication summarizes the Fleet's anti-aircraft experience from Pearl Harbor to Japan's surrender on 14 August 1945. It estimates the number of enemy aircraft shot down by ships' guns, and enemy success in damaging and sinking naval vessels.

The development of our own weapons and tactics is traced from the beginning of the war, and an attempt to forecast future developments is made. Enemy weapons and tactics used in attacking our surface forces are treated similarly.

Previous publications in this series include CominCh Information Bulletins Nos. 20, 22, 24, 25, 27, 28, CominCh P-009 and P-0011.
Chapter I

THE HISTORY OF AA.
IN WORLD WAR II

Introduction

Surface vessels during World War II fought and won two major defensive battles—one against submarines and the other against aircraft.

The Navy’s own air arm played a major role in the defeat of both enemy weapons. However, much of the defensive effort against these weapons devolved upon the ships themselves. For example, between 7,500 and 8,000 enemy aircraft—enough to sink any fleet in the world but our own—got through our air cover to attack our surface vessels between Pearl Harbor and the end of the war.

Whereas Germany placed emphasis on the use of the submarine to prevent logistic support of our allies, and later of our own forces, the Japanese relied chiefly upon their air power to protect their island empire.

Japan’s strategy for conducting the Pacific war soon became clear. After sinking the major part of our fleet at Pearl Harbor, she quickly acquired an island empire in the North, Central, and South Pacific, and built scores of air strips from which to attack our fleet, if and when it recovered.

That the Japanese plan of defense, built around her unsinkable aircraft carriers, was defeated, was due to an important extent to effectiveness of fleet AA.

History of AA. Actions

First year of war.—At Pearl Harbor ships’ gunfire was of little help in their protection. Many guns were not manned, and ships were at anchor. There was no air support. Attacks were made by skillfully handled planes in large numbers. An estimated 43 planes were shot down, 27 of them with .50-caliber machine guns, 8 with 5-inch, 6 with 3″/50 and 2 with 1″/1. It was the Navy’s most overwhelming defeat.

Hit-and-run tactics by light task forces built around one or two carriers characterized our actions during the following 6 months as we felt out our enemy. We found him determined and especially strong in the air.

During the last 6 months of 1942 we took the offensive, stopping the enemy’s threat to Australia by invading Guadalcanal, and initiating a second front in North Africa.

AA. actions during the year occurred at Pearl Harbor, Solomons, Wake Island, the Coral Sea, Midway, Dutch Harbor, Kiska, Gilbert Islands, North Atlantic, Santa Cruz, and North Africa. An estimated 246 enemy planes were shot down.

Second year of war.—As the second year of our participation in the war got underway the fleet not only had recovered fully from its initial severe setback at Pearl Harbor, but had entered an offensive-defensive stage. It had passed its prewar strength, and rapidly was being expanded as new combat vessels were placed in commission almost daily.

The first 6 months of 1943 saw the Japanese eliminated from Guadalcanal and its development as a base from which to conduct offensive operations. Occupation of the Russell Islands and New Georgia group followed in the same period. Severe air opposition was experienced both in the Solomons and in the Mediterranean, where the North African campaign was completed.

Sicily was invaded in July, and Italy at Salerno in September, and in the Pacific the Solomons campaign was continued, culminating in the invasion of Bougainville in November. Also in November the Fifth Fleet began its march across the Central Pacific, invading Tarawa and others of the Gilbert Islands.

During the year the fleet added 372 enemy planes to its bag—80 of them German and Italian, and 292 of them Japanese.

Third year of war.—With the opening of 1944 the Pacific fleet began offensive operations in earnest, invading the Marshalls, Green Island,
and the Admiralties, and making strikes against Truk and the Marianas in January and February. In the Mediterranean a second beachhead was established in Italy, this one at Anzio.

March and April saw carrier strikes against the Palaus, landings at Hollandia and Aitape, New Guinea, and a second strike against Truk.

With offensive operations against Germany and Japan moving into full swing, fleet AA activity increased sharply in May and June, which saw the occupation of Biak Island, New Guinea, the invasion of France at Normandy, and the invasion of Saipan in the Marianas.

Except for attacks against UGS convoys in the Mediterranean and ships spearheading the invasion of Southern France, AA activity during the second half of 1944 was confined to the Pacific. Morotai and Palau were invaded, and carrier strikes against Formosa and the Philippines preceded the invasion of Leyte in mid-October.

The Philippines invasion inspired the enemy's use of suicide tactics, which proved effective, although no more so than conventional air attacks by our own planes against enemy shipping.

During 1944 our ships knocked down 481 planes.

Fourth year of war.—January of 1945 saw the conclusion of the naval phase of the Philippines campaign, accompanied by suicide attacks at increasing tempo. Iwo Jima was invaded in February, with Task Force 58 spearheading the way by strikes against Tokyo and Kyushu. Few enemy aircraft opposed this operation.

The Okinawa campaign, most difficult of the war, got underway the latter part of March, and continued until the end of the war. More planes were knocked down by AA. during this operation than in any previous year of engagements with the enemy.

Final AA. Action

The final antiaircraft action of World War II occurred at 1316 on 15 August, when a DD picket station attached to Task Group 38.3 was attacked by a lone Judy. Four destroyers were on Tomcat duty, 100 miles southeast of Honshu.

The sky was completely overcast, but the target was picked up at 17 miles. At eight miles it emerged from the clouds, ducked into the clouds again, and about a minute later started its attack run in a 20-degree glide, speed 200 knots, from an altitude of 8,500 feet. The destroyer group, on circle 0.8, increased speed to 25 knots.

First to open fire was the Heermann (DD 532) at a range of 8,000 yards. A VT burst was seen to knock off part of the plane's wing or tail, and the Judy went into a slow spin. The Black (DD 666) and Ballard (DD 660) also claimed hits. The target swerved to the right, and splashed about 200 yards from the Ballard.

The commanding officer of the Heermann, commenting on the action, reported: "In accordance with verbal instructions from Commander Third Fleet, the Judy was splashed 'in a friendly manner.'"
Chapter II

OWN AND ENEMY SUCCESS

Own Success

Although the burden of ship defense against enemy air attacks fell largely upon our own carrier and land-based aircraft, approximately 7,600 to 7,800 enemy planes came within shipboard AA range during the 45 months of the war.

Of these, an estimated 2,773, or 36 percent, were shot down by naval and merchant ships. In addition to these, the enemy expended 314 planes and pilots in suicide crashes on ships.

AA successes for the war by 6-month periods follow:

<table>
<thead>
<tr>
<th>Period</th>
<th>Fliersбиты</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearl Harbor</td>
<td>26</td>
</tr>
<tr>
<td>First half 1942</td>
<td>56</td>
</tr>
<tr>
<td>Second half 1942</td>
<td>146</td>
</tr>
<tr>
<td>First half 1943</td>
<td>72</td>
</tr>
<tr>
<td>Second half 1943</td>
<td>300</td>
</tr>
<tr>
<td>First half 1944</td>
<td>171</td>
</tr>
<tr>
<td>Second half 1944</td>
<td>310</td>
</tr>
<tr>
<td>First half 1945</td>
<td>964</td>
</tr>
<tr>
<td>July and August 1945</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>2,056</td>
</tr>
<tr>
<td>Grand Guard total</td>
<td>200</td>
</tr>
<tr>
<td>Grand total</td>
<td>2,256</td>
</tr>
</tbody>
</table>

The “kills” listed in the foregoing table occurred within sight of the ships being attacked. The 5,500 planes not shot down immediately were so harassed by antiaircraft gunfire that comparatively few were able to carry out their missions successfully. Damage to ships caused by enemy planes is outlined later in this chapter.

It has been the experience of our own aircraft with enemy AA that 70 percent of them fell at or in the vicinity of the target. The remaining 30 percent either crashed en route back to their bases or were so badly damaged that they had to be stricken after arriving at their bases. It appears justified to conclude, therefore, that except for suicide planes, which by their nature are committed to destruction, those enemy planes which fell within sight of ships were about 70 percent of the total knocked down by gunfire.

Non-suicide kills witnessed by ships totaled 1,329 (1,179 by naval and 151 by merchant ships). Of those which were taken under fire but were not shot down immediately, an estimated 565 fell while returning to their bases. Adding to these the 878 suicide kills the total AA success for the war amounts to 2,773.

It will be noted that more than 50 percent of all antiaircraft kills were scored during the last 12 months of the war, which was highlighted by the Philippines and Okinawa campaigns. This period also witnessed all of the fleet’s antisuicide experience.

A total of 999 planes attempted to crash into ships, and definitely were identified as suiciders. Of these, about 314 or 31 percent hit ships; 160 or 16 percent missed ships but damaged them; and 526 or 53 percent missed ships and caused no damage.

The box score for suicide attacks by months follows:

<table>
<thead>
<tr>
<th></th>
<th>Suicide attempts</th>
<th>Hits on ships</th>
<th>Damaging near misses</th>
<th>Nondamaging misses</th>
<th>AA successes</th>
<th>Ships sunk</th>
</tr>
</thead>
<tbody>
<tr>
<td>October</td>
<td>42</td>
<td>17 (40%)</td>
<td>8 (19%)</td>
<td>19 (45%)</td>
<td>25 (60%)</td>
<td>3</td>
</tr>
<tr>
<td>November</td>
<td>26</td>
<td>28 (37%)</td>
<td>12 (16%)</td>
<td>36 (47%)</td>
<td>47 (63%)</td>
<td>3</td>
</tr>
<tr>
<td>December</td>
<td>111</td>
<td>34 (31%)</td>
<td>17 (15%)</td>
<td>90 (80%)</td>
<td>77 (70%)</td>
<td>11</td>
</tr>
<tr>
<td>January</td>
<td>97</td>
<td>91 (42%)</td>
<td>22 (33%)</td>
<td>64 (35%)</td>
<td>56 (35%)</td>
<td>3</td>
</tr>
<tr>
<td>February</td>
<td>17</td>
<td>8 (47%)</td>
<td>7 (41%)</td>
<td>9 (53%)</td>
<td>9 (53%)</td>
<td>1</td>
</tr>
<tr>
<td>March</td>
<td>35</td>
<td>11 (31%)</td>
<td>7 (20%)</td>
<td>17 (49%)</td>
<td>24 (69%)</td>
<td>1</td>
</tr>
<tr>
<td>April</td>
<td>354</td>
<td>87 (32%)</td>
<td>52 (15%)</td>
<td>215 (60%)</td>
<td>267 (75%)</td>
<td>13</td>
</tr>
<tr>
<td>May</td>
<td>214</td>
<td>72 (34%)</td>
<td>31 (14%)</td>
<td>111 (52%)</td>
<td>182 (86%)</td>
<td>8</td>
</tr>
<tr>
<td>June</td>
<td>40</td>
<td>12 (30%)</td>
<td>7 (17%)</td>
<td>21 (53%)</td>
<td>26 (67%)</td>
<td>3</td>
</tr>
<tr>
<td>July</td>
<td>4</td>
<td>2 (50%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>2 (50%)</td>
<td>1</td>
</tr>
<tr>
<td>August</td>
<td>9</td>
<td>2 (22%)</td>
<td>2 (22%)</td>
<td>5 (56%)</td>
<td>7 (78%)</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>999</td>
<td>314 (31%)</td>
<td>160 (16%)</td>
<td>525 (53%)</td>
<td>683 (68%)</td>
<td>46</td>
</tr>
</tbody>
</table>

In addition to the obvious suicide planes, which revealed their intentions by attempting to crash into ships, there were a certain number of others which were shot down by AA before they could demonstrate their intentions. These uncertain
kills are separated into suicides and non-suicides by dividing them according to the ratio of known suicides to known non-suicides in any given period.

Following is a break-down, according to the foregoing formula, for the period October 1944 to August 1945:

Total planes attacking: 3,924  
Total suicide planes: 1,192 (30% of total)  
Total non-suicide planes: 2,732 (70% of total)  
Suicide AA. kills: 878 (74% of suicides)  
Non-suicide AA. kills: 450 (17% of non-suicides)  
Suicide hits on ships: 314 (26% of suicides)  
Non-suicide hits on ships: 62 (2% of non-suicides)

Ammunition Performance

Huge quantities of ammunition were fired at enemy aircraft during the war. Much of it was fired at targets well out of range, and as the enemy threat from the air increased the rounds required to destroy a plane increased sharply for virtually every size of ammunition.

The following tables show expenditures, planes destroyed by ammunition types, and rounds per bird.

<table>
<thead>
<tr>
<th>Rounds</th>
<th>5&quot; Com.</th>
<th>5&quot; VT.</th>
<th>3&quot;/50.</th>
<th>40 mm.</th>
<th>1&quot;.3</th>
<th>20 mm.</th>
<th>.50 cal.</th>
<th>.30 cal.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kills</td>
<td>15,119</td>
<td>3,840</td>
<td>5,250</td>
<td>57,133</td>
<td>155,065</td>
<td>339,817</td>
<td>56,940</td>
<td></td>
</tr>
<tr>
<td>R. P. B</td>
<td>60</td>
<td>21</td>
<td>2</td>
<td>38</td>
<td>86</td>
<td>35</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

| Rounds     | 27,242  | 9,128  | 7,289  | 114,866 | 10,727 | 697,955 | 88,178   |
| Kills      | 46      | 61     | 30     | 81     | 4     | 116     | 9        |
| R. P. B    | 517     | 153    | 241    | 1,020  | 2,082 | 8,017   | 9,786    |

| Rounds     | 72,902  | 32,820 | 7,540  | 432,630 | 8,530 | 1,182,028 | 118,214  |
| Kills      | 63      | 78     | 6      | 183    | 4     | 118     | 4        |
| R. P. B    | 1,157   | 421    | 1,257  | 2,364  | 6,348 | 29,252  |

| Rounds     | 108,516 | 75,981 | 10,906 | 718,099 | 9,308 | 1,303,570 | 163,630   |
| Kills      | 173     | 207.5  | 30.5   | 476.5   | 2.5   | 297.5    | 14.5     |
| R. P. B    | 627     | 369    | 350    | 1,068   | 3,728 | 4,360    | 11,284   |

Totals for War

| Rounds     | 223,770 | 342,670 (15%) | 340 |
| Kills      | 117,915  | 340.5 (15%)  | 340 |
| R. P. B    | 29,614   | 87.5 (4%)    | 338 |
| 40 mm.     | 1,271,844 | 742.5 (33%)  | 1,713 |
| 1".3       | 83,880   | 44.5 (2%)    | 939 |
| 20 mm.     | 3,364,456 | 637.5 (26%)  | 5,267 |
| .50 cal.   | 729,836  | 85.5 (3%)    | 11,143 |
| .30 cal.   | 112,590  | 4.0           | 28,127 |

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Rounds per bird, except for 1945, increased for all types of weapons as the war progressed. This was the result of the following factors:

1. Increase in the number of weapons installed on all ships.
2. Increase in the number of ships firing at each target as operations increased in size.
3. Increase in the number of night attacks, in which fire control was less accurate.
4. Increase in speed, maneuverability and armor of enemy planes.
5. Adoption of doctrine calling for opening fire at extreme range.

During the 8 months of 1945, when approximately half of the war's kills were made, rounds per bird dropped off. Except for those attacking the fast carrier force, many enemy planes were outmoded types, comparatively slow and operated by unskilled pilots. Gunners had improved in accuracy as a result of increased experience in action and increased training.

The 40 mm. developed into the most effective weapon in the fleet. The 20 mm., which was the most important weapon during the first 2 years of the war, was passed by both the 5-inch and 40 mm. in the percentage of planes knocked down during 1944 and 1945.

Five-inch guns destroyed 30 percent of all "sures" during the war. VT-fuzed projectiles, used in only 35 percent of 5-inch rounds, were responsible for 50 percent of 5-inch kills.

The indicated performance of the 3"/50, which boasts a lower R. P. B. than even the 5-inch VT, is considered a statistical casualty as a result of poor reporting by ships.

The 6"/47, lacking an AA. computer and VT fuzes, was used but rarely against aircraft. It was responsible for two "kills." Both a computer and VT fuzes have been developed for this weapon.

### Merchant Ship Experience

Armed Guard crews on merchant ships shot down an estimated 200 German and Japanese aircraft during the war, and assisted in the destruction of many others.

Merchant ships took a mauling first from submarines and then from aircraft. An estimated 124 were sunk or damaged by aircraft alone. The following table shows the number of merchant vessels sunk and damaged, according to type weapon, since the beginning of the war:

<table>
<thead>
<tr>
<th></th>
<th>Bombs</th>
<th>Torpedoes</th>
<th>Suicides</th>
<th>Miscellaneous</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1942</td>
<td>2</td>
<td>11</td>
<td>7</td>
<td>4</td>
<td>21</td>
</tr>
<tr>
<td>1943</td>
<td>12</td>
<td>7</td>
<td>5</td>
<td>2</td>
<td>21</td>
</tr>
<tr>
<td>1944</td>
<td>10</td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>1945</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>31</td>
<td>32</td>
<td>28</td>
<td>15</td>
<td>124</td>
</tr>
</tbody>
</table>

Total damaged, 75.
Total sunk, 49.

The most striking fact revealed by the foregoing table is that for every type of weapon employed by the enemy except suicide planes, more ships have been sunk than damaged. The increase in casualties in 1944 and 1945 may be attributed entirely to the introduction of suicide tactics.

Until the invasion of the Philippines the most harrowing of the convoy routes was that to Murmansk, Russia, by way of North Cape, where ships were constantly under attack by planes, submarines, and surface vessels.

Merchant ships also found the Mediterranean a "hot" spot, when they provided logistic support for the landings at Sicily, Salerno, and Anzio. At Bari, Italy, 14 ships, of which 5 were ships of United States registry, were sunk in an attack by 32 German bombers on 2 December 1943.

During the invasion of the Philippines many suicides attacked the lightly armed merchant vessels. There and at Okinawa suicide planes damaged or sunk 28 of them, causing 20 percent of all merchant vessel damage.

A typical Armed Guard crew consisted of 1 officer, 24 gunners and a 2-man communications unit. This crew was supplemented by Merchant Marine personnel.

Armament on a typical merchant ship consisted
of a 5-inch DP, 5-inch SP, 4-inch SP or a 3"/50 AA, gun aft, a 3"/50 on the bow, and eight 20-mm. guns. Armament was placed on over 5,300 merchant vessels.

**Enemy Success**

Since the primary purpose of the fleet’s anti-aircraft is the protection of ships, the effectiveness of AA defense is reflected not only in the number of planes shot down, but also in the damage suffered by ships from enemy aerial weapons—bombs, torpedoes, suicide planes, and others.

Approximately 478 United States naval vessels were sunk or damaged by enemy aircraft during the war. Of these 115 were sunk and 363 damaged. In addition, 49 merchant ships were sunk and 75 damaged by enemy aircraft.

A surprisingly large percentage (45 percent) of the naval vessel casualties represented combatant ships of DD size or larger. However, these ships were only 29 percent of naval vessels sunk, as compared with 50 percent of the total damaged.

It is interesting to note that suicide planes were responsible for 64 percent of all naval ship casualties from air attack. The following table is a break-down of ships sunk and damaged, according to type weapon:

<table>
<thead>
<tr>
<th></th>
<th>Bomb</th>
<th>Torpedo</th>
<th>Suicide</th>
<th>Strafing</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunk</td>
<td>50</td>
<td>18</td>
<td>46</td>
<td>3</td>
<td>114</td>
</tr>
<tr>
<td>Damaged</td>
<td>93</td>
<td>33</td>
<td>396</td>
<td>3</td>
<td>535</td>
</tr>
<tr>
<td>Total</td>
<td>143</td>
<td>51</td>
<td>352</td>
<td>3</td>
<td>549</td>
</tr>
</tbody>
</table>

Approximately 25 percent of all ship casualties were suffered by destroyers, of which 25 were sunk and 95 were damaged. Other classes sunk and damaged included: Landing ships and craft, 67; AP's 46; auxiliaries, 32; BB's, 25; CV's 23; CL's, 23; escort vessels, 24; DM's & DMS's, 21, and AM's 15.

Listing the number of ships sunk and damaged does not give the complete picture of the enemy's effectiveness, since many ships were hit by two or more planes during the course of the war. The number of enemy planes scoring hits or damaging near misses offers a more accurate criterion of enemy attack efficiency.

Of 7,600 planes coming within gun range, 715, or 9 percent, scored hits or damaging near misses on naval and merchant vessels; of the 715 which inflicted damage, 474 or 66 percent were suicides; 160 or 22 percent made bombing attacks; 65 or 9 percent made torpedo attacks; 16 or 3 percent made miscellaneous attacks.
Chapter III

TACTICS AND EQUIPMENT

Own Tactics

The fleet’s antiaircraft tactics differed according to the types of ships involved and to the different situations prevailing. For purposes of simplification these tactics may be divided into those of (a) the fast carrier task force, and (b) other forces.

The fast carrier task force, which boasted heavy AA firepower, high speed, maneuverability, and the latest available radar equipment and AA directors, operated normally 60 miles or more from land. This force fought enemy aircraft aggressively.

Using antiaircraft dispositions, task groups placed battleships, cruisers and destroyers in the same circular screen, with aircraft carriers at the center of the disposition. Doctrine called for opening fire at 12,000 yards or more, using a high percentage of VT fuzes.

Destroyers were employed as connecting links between task groups, and took under fire planes attempting to pass between them. Picket stations, stationed in the direction of expected attack, were employed to extend the task force’s radar range. Usually consisting of a division and sometimes a squadron of destroyers under its division or squadron commander, the picket station took enemy planes under fire, directed fighters assigned to it, and served in a traffic-director capacity for returning strikes.

Early in 1945 fast carrier task groups developed AA coordination plans, designed to provide concentrated 5-inch gunfire against targets at long range, guarding at the same time against further undetected attacks.

This plan called for a task group AA coordinator, through whom all target information filtered to and from ships over a special VHF circuit. The task group was divided into four sectors, and ships in each sector, when alerted, would supplement search radars with fire control radars. The plan imposed no restrictions of freedom of action by individual ships in repelling air attacks.

Forces other than the fast carrier force, for the most part, opposed enemy aircraft less aggressively. This was a result of their being less well equipped with radar, armament, and fire control gear, their comparative lack of speed and maneuverability, and the necessity for them to operate close to land.

These forces consisted of bombardment, amphibious, CVE’s, DD pickets, auxiliaries, convoys, and other ships. Most of these ships anchored overnight, and depended for protection against air attack at twilight and night more upon smoke and concealment than upon firepower.

Because these forces operated close to land, and therefore were subject to surprise attack, they established picket stations, which served to extend the radar coverage around points of invasion. DD radar pickets also served as fighter-director ships, and engaged with gunfire all enemy planes coming within range. At Okinawa these picket stations, composed of one to three DD’s, supplemented by landing craft, halted many attacks and saved ships in the transport area from more severe raids.

Tactics of all ships were similar in combating suicide attacks. They called for maximum speed, placing the target on the beam for maximum firepower, opening fire at long range, using a high percentage of VT fuzes, and maintaining heavy gunfire until the target splashed.

Many ships placed 5-inch batteries under the control of manually operated auxiliary directors as a method of engaging enemy planes with gunfire under surprise conditions. In the event the target was picked up at long range, control was shifted to the main director.

Every effort was made to speed up gunfire. This involved early detection of the target, CIC-gunnery coordination, releasing batteries for
sector control, opening fire without waiting for good solution, having a projectile in the tray, using slew-sight control, etc.

**ENEMY TACTICS AND EQUIPMENT**

**German**

German air attacks against our surface forces were more effective than those of the Japanese, prior to the latter's use of suicide tactics, for the following reasons:

1. German aircraft were superior.
2. German pilots possessed greater skill.
3. German attacks were more highly coordinated.
4. Our own air defense was weaker.
5. Our surface forces were not as modern or heavily armed as those in the Pacific.

Early German attacks were conducted against convoys en route to Murmansk, USSR, by way of North Cape, and many merchant ships were lost from hits by bombs and torpedoes.

During the North African campaign dusk and night attacks were made by flare-dropping twin-engine bombers against shipping congregated in harbors.

At Sicily, Salerno, and Anzio the enemy launched heavy attacks against shipping at the beachheads. Dive- and high-level bombing and strafing tactics were employed. In the summer of 1943 the Germans began to use glider and rocket bombs. These pilotless, radio-controlled bombs were released from parent planes, and were directed chiefly against convoy escort ships.

During the invasion of Normandy the Germans changed their tactics, resorting almost exclusively to aerial mining. Many ships were sunk and damaged by mines, and the new German tactic is believed to have been their most effective use of air power against surface vessels. The invasion of Southern France was lightly opposed from the air.

During the final phase of the war the Germans employed V-1 and V-2 bombs. These were directed chiefly against land targets, but ships had experience with them in the English Channel, in the Thames at London, and in the Harbor at Antwerp, Belgium.

**Japanese**

In the Pacific our surface forces also underwent several types of air attacks.

At Pearl Harbor, and for a year afterward the Japanese employed conventional dive-bombing and torpedo tactics. The planes used were comparatively slow, but were flown by skilled pilots.

Because of the effectiveness of our day air cover and AA, the enemy began to employ night torpedo attacks early in 1943. Bettys, their targets frequently exposed under brilliant flares, attacked with considerable effectiveness. Night torpedo raids were to be continued for the rest of the war, although after the early part of 1944 they were largely superseded by other forms of attack. Snoopers with small bombs, harassing sometimes continuously at night, continued throughout the war with little success.

During the invasion of the Marianas the enemy stressed the use of fast, maneuverable fighter-bombers. These planes would approach at high altitudes and appear out of clouds, dropping their bombs and departing before they could be taken under concentrated fire.

The Japanese air force began a desperate attempt to halt our air power during the Philippines campaign. This effort, built around suicide tactics, was continued until the Okinawa operation was completed and Japan collapsed.

As a feature of their suicidal effort the Japanese introduced the Baka bomb, a piloted rocket plane carrying a large warhead. Released from the underside of a Betty or other twin-engined plane, it had a maximum range of 55 miles and maximum speed of 618 miles per hour. Used against ships in 13 instances, it scored 4 hits, 1 damaging near miss, and 8 misses causing no damage.

As the war ended the Japs were using float planes and trainers for suicide attacks.

**Evaluation of Tactics**

The two most effective antishipping tactics employed by the enemy during the war were: By the Germans—air mining; by the Japanese—suicide crashes.

**Aerial mining.—** Germany's depleted air force confined its defensive tactics during the invasion of Normandy to laying aerial mines in the English Channel off the landing beaches.

These mines, laid at night, are believed to have been very effective. Several bombardment, support ships, and landing craft were sunk or damaged by mines, the most of which are believed to have been of the aerial-laid variety.
Suicide crashes.—Deliberate crashing of aircraft into ships was undertaken by the Japanese during the invasion of Leyte in the Philippines in October 1944. The use of this tactic increased steadily until the latter part of January, when resistance to naval forces halted in the Philippine area. A total of 326 planes made suicide attempts, 120, or 37 percent of them, scoring hits in this campaign.

Suicide tactics dropped off sharply until the beginning of the Okinawa campaign the latter part of March. In April of 1945 the enemy made his supreme effort, using single- and twin-engined planes and Bakas in an effort to defeat the naval operation.

Directing his efforts chiefly at DD radar pickets and noncombatant vessels, he succeeded in making the operation costly. However, defense was better than in the Philippines, and suicides were 29 percent successful in scoring hits—8 percent less effective than in the earlier campaign.

Suicide tactics were three to four times more successful in scoring hits than the conventional bomb and torpedo attacks, 10 percent of which resulted in damage to ships.
Chapter IV

DEVELOPMENT OF AA. WEAPONS

At the beginning of the war the fleet was woefully weak in antiaircraft firepower and fire control. Since World War I the aircraft had doubled its speed, range, and hitting power. Defensive weapons had not kept pace.

Chief shipboard weapons at the time of Pearl Harbor were: 5"/25 and 5"/38 dual-purpose guns; 3"/23 and 3"/50 dual-purpose guns; 1"/1, .50-caliber and .30-caliber machine guns. The 5-inch guns were controlled by the Mark 19, 33, and 37 directors and Mark 1 computer, also used for surface fire. There was no director for the 3-inch gun.

Although the .50-caliber machine gun destroyed more enemy planes than any other weapon at Pearl Harbor, it long had been appreciated that the weapon was obsolete because of its short range and light hitting power.

Issue of the first production 20-mm. singles, controlled only by forward area sights or by observation of tracer streams, coincided almost exactly with the start of the war. The 30-caliber gun that had found its way into many emergency armaments was rapidly removed to make room for more effective weapons.

By the end of the first year of the war the following improvements had been made:

1. Radar direction and range for 5-inch batteries.
2. Increase in ratio of 5"/38 guns to 5"/25's.
3. Production of VT ammunition for 5-inch projectiles.
4. Replacement of 1"/1 by 40-mm. antiaircraft guns in many combatant ships.
5. Issue of Mark 14 automatic lead-computing sights to 20-mm. antiaircraft guns.
6. Replacement by the 20-mm. of nearly all the caliber .30 and .50 machine guns.
7. Introduction of Marks 49 and 51 AA directors for control of 40-mm. mounts.
8. Increasing of number of all antiaircraft weapons mounted.
9. Proper arming of all merchant vessels and auxiliaries.

The most important AA development during the first year of the war was the VT fuze for 5-inch projectiles. These eliminated fuze-setting errors, one of the major drawbacks of time fuzes, and were accepted with enthusiasm by the fleet. The Helena (CL 50) is believed to have been the first ship to use the ammunition successfully, shooting down a dive bomber with a Mark 32-fuzed projectile off Guadalcanal on 5 January 1943.

Another major development of the year was that of the Mark 14 gunsight. Approximately 90,000 of these gunsights, which use 2 air-spun gyros to compute lead angles in elevation and traverse, and the principle of the disturbed line of sight, have been procured during the war. Deliveries were commenced in 1942 for the control of 20-mm. guns.

Development of Directors

Closely related to the Mark 14 gunsight was the development of gun director Mark 51 for the control of 1"1 and 40-mm. guns. It long had been apparent that improved control would result if sights were removed from the gun mount to a point relatively free from blast, smoke, and vibration. Shortly after the introduction of the Mark 14 sight, this one-man, hand-operated director was made available to the service. More than 13,000 of these directors have been produced, and statistics indicate that guns controlled by this director shot down more aircraft than any other AA fire control combination in the fleet.

The next most urgent requirement was a lightweight, intermediate range AA director for 5- and 5-inch guns for DE's and auxiliaries. Gun director Mark 50, originally designed to meet this need,
proved unsatisfactory because of production and maintenance difficulties. As a temporary expedient, the Mark 14 sight, with modified ballistics, and the Mark 51 Mod. 2 director were used for this purpose.

This combination was not considered desirable because of the limited optical range of the gunsight and its short time of flight characteristics—approximately 5 seconds, or a range of 4,200 yards for the 5"/38 guns. To overcome these difficulties the gunsight Mark 15, with a 5.8 power telescope and 5-inch ballistics (range 7,500 yards and time of flight 13 seconds), was developed for use with the Mark 51 Mod. 3 director. Wind corrections were supplied by the wind transmitter Mark 4.

The next step in this direction was the gun director Mark 52, which was, in effect, a Mark 51 Mod. 3 director with a Mark 26 (range only) radar. Approximately 500 Mark 52 director systems have been delivered to the fleet since late 1943.

Although radar equipments for blind fire control had been installed in gun directors Marks 33 and 37, the need developed, as a result of enemy emphasis on night attacks, for a lightweight, blind firing director for the control of automatic and heavy AA batteries.

Two completely blind-firing, manually operated, lightweight director systems made their appearance in the fleet almost simultaneously early in 1945. They were the Mark 57 and Mark 63 directors.

The Mark 57 is an intermediate range, manually operated, optical or blind firing system having selective control for either 40-mm. or 5"/38 guns. The Mark 63 system, having similar characteristics, is an outgrowth of the Mark 51 and 52 directors, and is designed for control of 40-mm. batteries.

Reaching the design completion stage at the end of the war was the Mark 56 director system. It is a 12,000-yard range director for 5-inch and heavy machine gun batteries with fully automatic radar tracking features and fast solution times. It is capable of handling targets moving at speeds up to 600 miles per hour.

VT Fuzes

The VT fuze was the most important AA development of the war. This "proximity" fuze, built around a miniature radio transmitter and receiver carrying its own power supply, proposed by the Navy in August 1940, was developed by the National Defense Research Committee of the Office of Scientific Research and Development.

By September 1942, the project had progressed to a point where the Navy had VT fuzes in production. In December 1942, fuzes were sent to the fleet, and on 5 January 1943, the first Japanese plane to be shot down by a VT-fuzed projectile was destroyed by the cruiser Helena.

These fuzes overcome the major disadvantage of "time" and "contact" fuzes. The value of "time" fuzes has been limited by the necessity of setting fuzes, the inherent variations in time-fuze mechanisms, and the fire-control difficulty of computing range accurately. As an AA weapon the "contact" fuze also has major disadvantages. Against aircraft a direct hit must be scored before the projectile will detonate, which means that even minor fire-control errors will cause it to miss its target altogether.

As an example of the advantage of using VT fuzes, comparisons have been made of the lethal radius of a 5-inch VT-fuzed projectile and the 40-mm. contact-fuzed projectile. A twin-engined bomber in a head-on aspect presents a lethal area of approximately 90 square feet to the 40 mm. To the Mark 53 fuzed projectile, on the other hand, the bomber presents a lethal area of 3,900 square feet. This is figured on a basis of 65 percent operability for the VT fuze.

Because investigation of German military developments has indicated that the principle of the VT fuze was well known, although the enemy was incapable of its production, release of the fuze's method of operation has been made previously. Briefly, the fuze contains a continuous wave high-frequency transmitter. Reflection of the radio wave back to the fuze is received, and interacts with the outgoing impulses to cause a doppler "ripple." Suitably amplified, this "ripple" energizes a thyratron tube, which acts as an electronic switch. This releases the electrical energy stored in a charged condenser which, in turn, operates an electrical detonator called a squib. The blast from this squib operates a standard detonating fuze, which sets off the main explosive charge in the projectile. The whole process of detonation requires an infinitesimal fraction of a second.

The first major improvement in VT fuzes came with Mark 32 Mod. 40, designed to operate against low-flying planes. These had an average radius of operation of 60 feet, and would not
activate prematurely as a result of proximity to the sea.

Because dry batteries in the early fuzes had a tendency to lose their energy, they were replaced with wet battery fuzes, the first of which was Mark 32 Mod. 30, to be followed in 1944 by the Mark 40, which had the Mark 32 Mod. 40 feature of AVC (automatic volume control), and increased sensitivity, its average radius of operation being 70 feet.

The final improvement of VT fuzes for 5-inch projectiles was represented in the Mark 53, which had still greater sensitivity, its radius of operation being up to 100 feet and arming range 500 yards. This fuze also had improved fragmentation characteristics.

VT fuzes also were developed for 3- and 6-inch projectiles. The Mark 45 for 3-inch projectiles was the equivalent of the Mark 32, and was replaced by Mark 58, with a radius of operation of 75 feet and arming range of 600 yards. For 6-inch projectiles the Mark 47 was developed, with a 100-foot radius and 800-yard arming time. Mark 59 was developed for the 5"/54 gun.

A self-destruction feature was in process of being added to VT fuzes as the war ended. This feature would permit firing in the direction of our own ships with less danger of damaging them. Projectiles containing this feature would destroy themselves at 8,000 yards. The arming time of these projectiles was lowered to 400 yards.

VT fuzes proved approximately three times as effective as time fuzes in the destruction of enemy planes, operational analysis indicates.

**Armament**

The trend in armament during the war was toward heavier guns, increased velocity, range, destructiveness, and rate of fire.

Also, the policy was established to install as many guns as space, weight, and personnel limitations would permit.

In the rapid regunning of ships after Pearl Harbor the .30- and .50-caliber and 1"/1/75
machine gun were the first to go. The .30- and .50-caliber guns were replaced by 20-mm. singles, and the 1".1 quads by 40-mm. quads and twins.

For the heavy AA. batteries the few remaining 3"/23 were replaced by the 3"/50, and where possible the 5"/25 by the 5"/38 twin.

Before the end of the war the regunning of destroyers was undertaken. One torpedo tube was removed from 692 and 445 class DD's and replaced by a 40-mm. quad. All torpedoes were removed from other classes in favor of increased 40-mm. batteries.

The general policy was established at the same time of replacing 20-mm. guns with 40-mm. quads wherever possible, and installing 20-mm. twins in the place of the remaining 20-mm. singles.

As the war ended development was underway on a 3"/70 automatic twin with a cyclic rate of 180 rounds per barrel per minute, a 20-mm. quad on turret-type mounts, and a rocket launcher for use of 5-inch spin-stabilized rockets against planes at close range.

Postwar development must be toward extremely high-velocity, long-range AA. fire, with projectiles considerably more destructive than those presently used.

Typical armament of various types of combatant ships as it existed on VJ-day, follows:

BB—(165 barrels)—10 5"/38 twins; 20 40-mm. quads; 49 20-mm. singles, and 8 20-mm. twins.

CA—(83 barrels)—6 5"/38 twins; 12 40-mm. quads; 23 20-mm. singles.

CL—(50 barrels)—6 5"/38 twins; 4 40-mm. quads; 6 40-mm. twins; 10 20-mm. singles.

CB—(102 barrels)—6 5"/38 twins; 14 40-mm. quads; 34 20-mm. singles.

CV—(136 barrels)—4 5"/38 twins; 4 5"/38 singles; 17 40-mm. quads; 56 20-mm. singles.

CVL—(40 barrels)—2 40-mm. quads; 9 40-mm. twins; 8 20-mm. twins.

CVE—(37 barrels)—1 5"/38 single; 8 40-mm. twins; 20 20-mm. singles.

CVB—(158 barrels)—18 5"/54 singles; 21 40-mm. quads; 28 20-mm. twins.

DD—(42 barrels)—3 5"/38 twins; 3 40-mm. quads; 2 40-mm. twins; 10 20-mm. twins.
Chapter V

AA. EXPERIENCE AT OKINAWA

General

More enemy planes were fired upon by our ships in the Okinawa campaign than in any previous campaign, and there were more AA. actions in April 1945 than in any other month of the war. During this month there was an all-out attempt by the enemy to prevent us from securing our position on Okinawa. During May, the enemy effort against ships decreased by about 50 percent as compared to April, and during June the number of enemy planes fired on by our ships was only about 10 percent of the number fired on during April.

Since the suicide attacks in the Philippines had caused much more damage to our ships per plane attacking than conventional bombing and torpedo attacks, it was to be expected that suicide attacks would continue to the maximum possible extent. As a matter of fact, a higher percentage of suicide planes were used in Okinawa than in the Philippines. However, both suicide and conventional attacks were less successful in the Okinawa campaign than they had been earlier in the war. This was probably due in part to the decreasing level of training of the enemy pilots after the great attrition in the Philippines but a more important factor was undoubtedly the greater skill with which our antiaircraft was used, as a result of previous battle experience, especially in the Philippines campaign.

A new suicide weapon—the Baka—was tried out by the enemy in April and May. As noted previously in this report, this was not very effective for two reasons. In the first place, the planes which carried the Baka near enough to the ships to allow them to attack were slow and extremely vulnerable to the CAP and consequently only a small number of Baka were brought near enough to be launched at ships. Secondly, although the very high speed of the Baka made it a difficult AA. target, it was apparently very difficult to maneuver, so that even when not deflected by AA., it often failed to hit the target ship.

Enemy Effort

Table I gives a measure of enemy effort during the Okinawa campaign. Numbers of planes fired on by ships are given by month, for both suicide and non-suicide attacks. Since some planes which had suicide intent were shot down by AA. before demonstrating their intent, the number of suicide planes includes not only all planes which were obviously making suicide dives but also an appropriate fraction of the planes shot down at a distance, based on the ratio of known suicide to known non-suicide planes attacking.

<table>
<thead>
<tr>
<th></th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>Total for Okinawa</th>
<th>Total for Philippines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suicide planes</td>
<td>26</td>
<td>380</td>
<td>311</td>
<td>54</td>
<td>4</td>
<td>5</td>
<td>786</td>
<td>364</td>
</tr>
<tr>
<td>Non-suicide planes</td>
<td>81</td>
<td>784</td>
<td>200</td>
<td>96</td>
<td>8</td>
<td>8</td>
<td>1,240</td>
<td>592</td>
</tr>
<tr>
<td>Total</td>
<td>107</td>
<td>1,474</td>
<td>511</td>
<td>150</td>
<td>12</td>
<td>12</td>
<td>2,027</td>
<td>1,956</td>
</tr>
<tr>
<td>Percentages of suicide planes</td>
<td>24%</td>
<td>34%</td>
<td>61%</td>
<td>43%</td>
<td>33%</td>
<td>33%</td>
<td>50%</td>
<td>28%</td>
</tr>
</tbody>
</table>

The tremendous scale of enemy effort is indicated by the fact that there was an increase of 49 percent in the number of planes fired on at Okinawa as compared to the large number of planes in the Philippines campaign. Thirty-nine percent of the planes were suicide-ers, as compared to 26 percent in the Philippines.

Suicide Attacks

Of the 793 suicide planes which arrived over ships in the Okinawa area, 181 (23 percent) hit ships; 95 (12 percent) did not hit, but caused...
damage by near misses; 517 (65 percent) missed ships completely, and did no damage.

Suicide planes tended to concentrate on smaller ships in the Okinawa actions. Eighty-six percent of the suicide planes aimed at DD’s or smaller ships, as compared to 61 percent in the Philippines. This may have been partly due to opportunity and also to the fact that the enemy concentrated much effort on radar picket ships. The comparative AA success (percentage of suicide planes which failed to hit ship targets) of various types of ships was comparable with the results in the Philippines, except that the over-all average was higher in Okinawa, 77 percent, as compared to 68.4 percent in the Philippines.

**Non-Suicide Attacks**

Although the number of non-suicide planes which attacked ships in the Okinawa campaign rose to unprecedented magnitude, they accomplished very little damage to our ships. The 1,234 such planes fired at by AA sank no ships,

<table>
<thead>
<tr>
<th>Month</th>
<th>Number of A/C final at</th>
<th>Planes shot down</th>
<th>A/A success</th>
<th>Number of A/C damaging ships</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td>74</td>
<td>13</td>
<td>18</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>April</td>
<td>700</td>
<td>122</td>
<td>22</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>May</td>
<td>209</td>
<td>74</td>
<td>27</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>June</td>
<td>65</td>
<td>15</td>
<td>23</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>July</td>
<td>6</td>
<td>1</td>
<td>17</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>August</td>
<td>5</td>
<td>1</td>
<td>20</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>1,119</td>
<td>250</td>
<td>23</td>
<td>16</td>
<td>1.4</td>
</tr>
</tbody>
</table>

Table II.—Non-suicide planes

Since a large percentage of the planes attempting to attack our forces were shot down outside of AA range of the ships by CAP, the number of planes lost as given in table III is not complete. If we assume that 60 percent of the planes which sortie are lost to CAP, then the total losses to the enemy per ship damaged is 88 planes for non-suicide attacks and 8.7 planes for suicide attacks.

**Suicide vs. Non-Suicide Attacks**

The relative effort expended by the enemy in suicide and conventional attacks has been shown in table I. Table III shows the cost to the enemy at Okinawa in both types of attack per ship sunk or damaged.

<table>
<thead>
<tr>
<th>Table III.—Cost to enemy per ship sunk or damaged</th>
<th>Non-suicide</th>
<th>Suicide</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Average number of planes per ship sunk or damaged...</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>2. Percentage of planes which damaged ships.........</td>
<td>2%</td>
<td>100%</td>
</tr>
<tr>
<td>3. Percentage of planes lost to AA, or in suicide crashes...</td>
<td>20%</td>
<td>100%</td>
</tr>
<tr>
<td>4. Average number of planes lost to AA, or in suicide crashes per ship sunk or damaged...</td>
<td>10.5</td>
<td>3.5</td>
</tr>
</tbody>
</table>

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Chapter VI

FAST CARRIER TASK FORCE DEFENSE

Task Force 38/58 was the most efficient and powerful offensive naval force to be developed in the history of sea warfare. Composed of approximately 120 of the Navy's fastest and best-equipped ships, it spearheaded the drive across the Pacific, and during the last weeks of the war was bombarding Japan itself.

Carrying with it 1,200 to 1,500 fighters, bombers, torpedo and scout planes, this force boasted approximately 952 5'/38 barrels, 3,136 40-mm. barrels and 2,936 20-mm. barrels, as its anti-aircraft armament. Fire control was the best available, and on some ships included the Mark 57 and Mark 63 directors.

Since improvement of antiaircraft performance in the fleet will have to start from the performance of AA as it existed at the end of the war, the following study of the fast carrier task force's experience with enemy aircraft should be of value as indicating a point from which improvement must start.

This analysis starts with Task Force 38's decisive defeat during 23–26 October 1944, of the Japanese fleet units which attempted to disrupt the Leyte landings, and concludes on 21 March 1945, just before the Okinawa campaign commenced. Actions during this period saw the beginning and expansion of Japanese suicide attacks, which were to reach their climax at Okinawa in April.

During the period 29 October to 24 December, Task Force 38 supported the Leyte and Mindoro landings. From 30 December to 21 January the force supported the Luzon phase of the Philippine operation. At midnight on 26 January, Task Force 38 became Task Force 58, which supported the Iwo Jima operation and made strikes against Tokyo and Kyushu.

Suicide Attacks

In the 5-month period between 24 October and 21 March, 14 ships of the fast carrier task force were damaged by suicide hits or near misses. All targets, except 2 destroyers, were carriers. No ships were sunk, and of those damaged 5 carriers and both destroyers were put out of action.

It is estimated that 43 aircraft with suicide intent arrived over the task force. What happened to these planes is shown below with results of all suicide attacks during the Philippine campaign from 17 October to 13 January.

Table I.—Ship damage by suicide planes

<table>
<thead>
<tr>
<th>Fast carrier task force</th>
<th>All ships, Philippines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of suicide planes taken under fire</td>
<td>43</td>
</tr>
<tr>
<td>Number which hit ships</td>
<td>13 (30%)</td>
</tr>
<tr>
<td>Number scoring damaging misses</td>
<td>4 (9%)</td>
</tr>
<tr>
<td>Number missing without damaging</td>
<td>29 (67%)</td>
</tr>
</tbody>
</table>

Note:—In a later period, using an AA coordination plan for the first time, the fast carrier performance improved its defense against suicide planes. The record for the period February–April follows:

<table>
<thead>
<tr>
<th>Planes attacking</th>
<th>Planes hitting</th>
<th>Planes missing</th>
<th>Percentage AA success</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast carrier</td>
<td>64</td>
<td>9</td>
<td>55</td>
</tr>
<tr>
<td>Other forces</td>
<td>276</td>
<td>88</td>
<td>188</td>
</tr>
</tbody>
</table>

Non-Suicide Attacks

In the actions against non-suicide planes for the period October–March one ship, the Princeton, was sunk and seven were damaged. Only in the case of the Franklin was a damaged ship put out of action.

A comparison of the results of these actions with similar actions against “All Ships, Philippines,” follows:

Table II

<table>
<thead>
<tr>
<th>Fast carrier task force</th>
<th>All ships, Philippines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of planes attacking</td>
<td>174</td>
</tr>
<tr>
<td>Number of planes lost per ship sunk, damaged</td>
<td>5.7</td>
</tr>
<tr>
<td>Average number of planes per ship sunk, damaged</td>
<td>23</td>
</tr>
<tr>
<td>Percent of planes damaging ships</td>
<td>4.6%</td>
</tr>
<tr>
<td>Percent of planes destroyed by AA</td>
<td>20.6%</td>
</tr>
</tbody>
</table>

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**Enemy Tactics**

Out of a total of 33 suicide attacks, 31 were aimed at carriers, and out of 9 damaging non-suicide attacks, 8 were against carriers. Carriers are the most strategically important ships, and because of their size the most vulnerable targets in the fast carrier task force. Thus the enemy's concentration on carriers was highly to his advantage.

Most suicide and non-suicide attacks were made during the daytime. Night and twilight attacks were pressed less vigorously than against other surface forces in the Philippines campaign, being largely of a snooping nature.

The percentage of non-suicide planes shot down by fast carrier forces was considerably greater than other forces during the daytime—33 percent as compared with 18 percent—but about the same for all periods combined—23 percent vs. 18 percent. However, in daytime attacks the fast carriers shot down only four planes per plane damaging ships—about the same as other ships.

**Effectiveness of AA. Defense**

“Rounds per bird” is a rough measure of the effectiveness of an AA projectile. The following table presents, for the four major weapons used in AA defense, the average RPB in both suicide and non-suicide actions. A satisfactory result for 5-inch VT ammunition, especially in suicide actions, is indicated.

**Table III**

<table>
<thead>
<tr>
<th>Type of ship</th>
<th>Number of ship-plane actions</th>
<th>Number of ship-plane actions</th>
<th>Number of ship-plane actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>BB</td>
<td>37</td>
<td>7.9 (27%)</td>
<td>65</td>
</tr>
<tr>
<td>CV, CVL</td>
<td>88</td>
<td>6.8 (21%)</td>
<td>65</td>
</tr>
<tr>
<td>CB, CA, CL</td>
<td>47</td>
<td>5.8 (22%)</td>
<td>55</td>
</tr>
<tr>
<td>DD</td>
<td>81</td>
<td>2.6 (22%)</td>
<td>55</td>
</tr>
</tbody>
</table>

It is interesting to determine the "expected" distribution of kills by type of ship, and to compare it with the actual distribution. The "expected" kills are obtained by assuming that in each ship AA action the "rounds per bird" are the same as the over-all average for the particular range of opening fire involved. The following comparison is for suicide actions:

**Table IV**

<table>
<thead>
<tr>
<th>Type of ship</th>
<th>&quot;Expected&quot; kills</th>
<th>Actual kills</th>
<th>Ratio actual to expected</th>
</tr>
</thead>
<tbody>
<tr>
<td>BB</td>
<td>3.8</td>
<td>7.8</td>
<td>200</td>
</tr>
<tr>
<td>CV, CVL</td>
<td>4.0</td>
<td>9.8</td>
<td>98</td>
</tr>
<tr>
<td>CB, CA, CL</td>
<td>5.8</td>
<td>2.8</td>
<td>95</td>
</tr>
<tr>
<td>DD</td>
<td>4.4</td>
<td>2.5</td>
<td>87</td>
</tr>
</tbody>
</table>

Thus, in suicide actions, battleships appear to have shot down twice as many planes as would have been expected on the basis of their opening ranges, the amount of ammunition they fired, and the average success attained by all ships under similar conditions.

The assignment of kills in suicide incidents results in the conclusion that about 40 percent of the planes shot down in suicide actions were destroyed by the target ships, and about 60 percent by screening ships. Since on the average, four ships in addition to the target ship fired at each attacking plane, this means that each supporting ship was about one-third as effective in defending the target ship as was the target ship itself.

**Summary and Conclusions**

In both suicide and non-suicide attacks the AA. defense of the fast carrier force during the period 24 October 1944 to 21 March 1945 appears to have been no better than that of ships engaged in the Philippines campaign between 17 October 1944 and 13 January 1945.
The volume of ammunition fired per ship-plane action by ships which were attacked but not hit was considerably greater than that fired by ships which were hit, indicating that the volume of ammunition which a ship under attack was able to fire at the plane had a definite effect upon the plane's success.

In general, there appears to have been little difference in the AA effectiveness of various task groups within the force. However, Task Group 58.1 had a notably high ratio of planes shot down to planes scoring hits on ship. This ratio was 13 to 1, as compared with other task groups' records varying between 1 to 1 and 7 to 1.
A discussion of the trend of antiaircraft for the defense of naval ships in possible future wars requires first an analysis of the shape of weapons likely to be employed against ships. These weapons will unquestionably include:

1. The atomic bomb.
2. Guided missiles with atomic or less powerful warheads.
3. Balas or similar high-speed, suicide planes, with greatly extended range.
4. Attacking planes with speeds approaching or in the supersonic range.
5. Rocket-propelled flying projectiles launched from shore.

The first of these weapons alone—the atomic bomb—has been widely advertised as the doom of seapower as we know it. The same outcome was predicted as a result of the growth of air power before the war which recently ended. However, such improvements in ship defenses as the VT fuze, fire control, radar detection of aircraft and radar control of guns, were sufficient to diminish to an important extent the effectiveness of those enemy aircraft which avoided our CAP and came within gun range.

In a discussion of atomic bombs, several basic factors must be taken into consideration. They include:

1. Atomic power is important for its strategic value rather than its effectiveness when applied to tactical uses.
2. Because of the limited number of atomic bombs which will be available to an aggressor nation, and because of the high cost of their construction, it is not likely that atomic bombs would be wasted against ships unless by so doing a certainty existed of destroying a number of important ships with a minimum number of bombs.

Dispersion of ships, therefore, both in peacetime and in war, is the first essential in the Navy's defense against atomic explosives.

Such dispersion, employed tactically, implies that each ship, rather than depending upon mutual support, must be capable of defending itself to a greatly increased extent.

Atomic bombs may be carried to their objective by aircraft or very accurate guided missiles.

Although far exceeding in power any other known explosive, the atomic bomb has definite calculable limitations on its effective radius. If ships are separated by a somewhat large, but still tactically practical interval, it is estimated that not more than one could be sunk by any one bomb. An aircraft carrying an atomic bomb must be destroyed beyond the bomb's effective range if its target is to escape damage. This distance is well within the range of antiaircraft fire as it now exists. However, since near misses will be just as destructive as hits, and since atomic bomb-carrying planes must release their weapons at high altitudes, or from long ranges if guided missiles are employed, antiaircraft defense of ships in the future means that AA weapons must extend their range and accuracy to an important extent over their present performance.

Even antiaircraft weapons boasting extremely high velocity and high accuracy may not be sufficient to cope with this menace. Guided missiles having supersonic speeds and high performance VT fuzes will be required if planes carrying atomic bombs are to be destroyed at a safe range from ships. Such missiles, under development, will be difficult to jam from a target plane.

Because of the intense heat and blast generated by an atomic bomb's explosion, ship's topside characteristics may well require extensive modification for the protection of personnel, fire control, and radar equipment. Streamlining of the topside seems indicated, with fire control and
radar equipment, together with their operating personnel, largely below decks. Radar antenna may require vastly more structural strength and protection than they now have if they are to survive. Possibly, cooling of the topside and automatic vent closure immediately and automatically after a ship is subjected to an atomic bomb attack may be required.

Other weapons to be used against surface ships in the future will be similar to those used in the past but of increased speed and accuracy. As a defense against them, shipborne antiaircraft gunfire must assume the following characteristics:

(a) Greatly increased long range effectiveness.
(b) Projectiles with greater destructiveness and VT fuzes of greater operability.
(c) Shell velocities approaching 10,000 feet per second.
(d) High volume of fire.

(e) Fire control with fully automatic features, great accuracy, quick solution time.

While the possibilities of attack from air by such weapons are staggering, no offensive means has yet gained an overwhelming advantage in war against a determined aggressive defense. When the offensive guided missile or super-altitude bomber becomes a practical threat, we must also have supersonic fighters and airtight radar intelligence to make full use of them. Air defense cannot consist of improved antiaircraft alone, but must be a coordinated effort such that the potentialities of both may be fully realized. Neither the super-fighter nor the antiaircraft guided missile, or super-velocity gun alone can insure protection. An alert, aggressive effort in development and training can ensure accomplishment of the mission of the fleet in the future as did the effort in antiaircraft defense summarized above.
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