TR The GAF System of Weapons Selection
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Luftwaffe Methods in the Selection of Offensive Weapons

Study Prepared at Karlsruhe

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Volume One

The Offensive Weapons of the Luftwaffe and Their Methods of Employment

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Preface

According to the exact wording of the topic it would be possible to confine the discussion and analysis to the methods employed by the Luftwaffe in the selection of available weapons for operational purposes.

The scope of such a study would not be satisfactory, however, because it would not answer a number of questions related to the selection of weapons and would not cover the topic adequately.

As early as the outbreak of war it was found that weapons needed for many strategic and tactical missions were not available or that technical developments and the measures taken by the enemy required new offensive weapons.

The development of new weapons for a specific tactical purposes often relieved the responsible commander of having to choose between a number of weapons.

Also, research and development on the one hand and tactical employment on the other often achieved the identical purpose.

For this reason the study will analyze insofar as necessary the development of new weapons in its relationship to their intended tactical use.

CHAPTER ONE

THE OFFENSIVE WEAPONS AND THEIR METHODS OF EMPLOYMENT AT THE OUTSET OF THE WAR

Section I

The Development of Offensive Weapons: Its Resumption after World War I and the Criteria Used at That Time

The Versailles Treaty interdicted Germany from possessing any military aviation and thus also the development and keeping of any aircraft weapons of any type. Most of the stocks that remained from World War I had been destroyed.

The post-war political evolution gave Germany cause to suspect that Poland might one day be carried away to use force in occupying and annexing East Prussia that had been separated from Germany. This preoccupation induced the German Reich War Ministry around 1926 -- with the consent and approval of the German Government -- to consider the question how the German Army, which had no aviation support, could be properly equipped for the event of an armed conflict that might have to be sustained in the conduct of defensive operations. A minimum requirement would be the acquisition of the aircraft that would be needed for reconnaissance purposes and for providing protection from air attacks.

For this purpose, suitable civilian aircraft were at first issued certain items of emergency equipment, including some emergency armament. After 1921 one proceeded to develop a few military prototypes -- such as fighter planes and close and long-range reconnaissance aircraft -- and to manufacture them because it had become obvious that the civilian aircraft models were almost completely unsuitable for military purposes. However, the Reich War Ministry disapproved the development and production of bombing aircraft in order not to raise any questions as to the defensive characteristics of this military aviation, which for all practical purposes was prohibited.[1] Only a two-engine reconnaissance aircraft, which could carry a number of bombs if necessary, was authorized. The design of the fighter and single-engine aircraft was also such that they could carry bombs.

The need for developing aircraft weapons and bombs therefore arose once again. The development and procurement functions were at first assigned to the Army Ordnance Office. The new weapons were first related to those used during the past war by the flying units. However, because of thei increased speed and higher altitudes at which aircraft flew, one had to use new approaches with regard to the consistency of the bombs and their controlling mechanisms.

[1] Only after the occupation of the Ruhr did the Reich President authorize the purchase of 100 Focker D XIII.

Since only a limited number of aircraft models for restricted tactical missions was produced, the development of offensive weapons remained very slight.

Section II

Tactical and Strategic Considerations in the Further Development of Offensive Air Weapons

1. The Developments up to 1934: The Period of the 100,000-Men-Army and the Initial Rearmament

The developments during that period were decisively influenced by the existing tactical doctrine regarding the employment of these aircraft with their low performance.

By assigning especially qualified officers to positions in foreign countries and by sending them to foreign air meetings and exhibitions -- such as the Air Display at Hendon (England) and the Salon de l'Aeronautique in Paris -- and by studying foreign publications one tried to continue the developments of German tactical doctrine and to align that doctrine with the concepts of countries that were capable of continuing the development of their air force without restrictions.

The German leadership thereupon arrived at the conclusion that bombs were essential for the following targets:

Against live targets -- fragmentation bombs, above all 22 pounders.

Against general ground targets -- high explosive bombs in two different sizes, the 110- and the 550-lbs bomb.

Of World-War I vintage was still the small bomb used to produce area fires, the electro-incendiary bomb B.1.E., which weighed 2.2 lbs. In 1918 it had been planned to employ the bomb against London, but the German Army High Command objected because the militarily hopeless situation of the Central European Powers would not have been affected, even if the use of the bomb had turned out to be a success. The large stocks of incendiary bombs that had been accumulated in Germany were destroyed after the war. Although the bomb had not actually been tested over enemy territory, it was certain that XX large fires could be started by dropping it en masse.

At the outset of the organizational revival of the German Air Force there were therfore four types of bombs available, whose development had been brought to a positive conclusion.

a. Who Was Responsible for Developing New Offensive Weapons at the Time the New German Air Force Was Organized?

The tactical and technical staff agencies within the Luftwaffe High Command had to cooperate closely for this purpose. In certain instances it was also necessary to obtain political guidance from top-level civilian government officials.

The General Staff established the requirements for offensive weapons on the basis of its wartime operational plans and its accurate knowledge of the enemy potential; these were included in the tactical-technical performance requirements.

The ordnance inspectorates -- for reconnaissance, fighter,

and bomber aircraft, etc.)- carried out these functions under the staff supervision of the General Staff. By using experts in their staff positions and making continuous inspections in the field, the inspectorates formed the live link between the General Staff and the flying forces in the field. They were also responsible for providing the training facilities that were needed when a new weapon was introduced.

The Chief of the General Staff then reported to the Commander-in-Chief of the Luftwaffe on the progress made.

The next step was to transmit the tactical-technical requirements to the Technical Office of the Luftwaffe High Command, which had usually already participated in the advance planning by the General Staff so that no requirements would be made that could not be technically implemented. The Technical Office had the mission to transmit the corresponding development projects to private industry.

Only if all agencies of the Luftwaffe High Command and private industry conscientiously carried out their part of the project, could the mission be successfully accomplished. If one link in the chain failed, the others could usually not compensate for such a breakdown so that wrong decisions with regard to the tactical and/or technical usefullness became inevitable.

After the first experimental type had been produced, it was technically tested by a testing or experiemental agency. If the preliminary tests were successful, the weapon was further tested

by the training and instructional unit, both from a technical and tactical point of view. Since these training units were staffed with particularly experienced, selected personnel, further tests by an ordinary field unit were necessary to find out how the average soldier, who was not particularly gifted or trained, could perform with that weapon. Only then was the introduction of the weapon decided.

After the beginning of World War II the General Staff deviated from this effective procedure in order to be able to concentrate on operational problems. This decision was incomprehensible. The ordnance inspectorates directed their tactical-technical requirements immediately to the Technical Office so that no inter-inspectorate coordination took place concerning similar weapons that were needed by more than one agency. Overlapping and confusion became inevitable. Moreover, the General Staff's position was weakened in relation to the technical agencies.

2. The Weapons Developed up to the Outbreak of World War II

(Bombs, aircraft armament, etc.)

a. The Neutralization of Live Targets: The 22-lbs Fragmentation Bomb (Ready for Introduction in 1933)

This bomb could not simply be carried by the bomb release mechanisms of the aircraft without intermediary racks. [2] For this

[2] Even in peacetime these intermediary racks caused total losses of aircraft and crews because of jamming.

reason, and also to increase the demoralizing effect by louder detonation, one proceeded to develop the ~~110-lbs~~ ~~bomb~~ -- which was ready for introduction in 1938 as fragmentation bomb against live targets, but also as a multiple-purpose bomb by using a different fuse.

b. ~~Against general ground targets one could use the~~:

(1) ~~110-lbs bomb~~ -- see above -- to destroy inanimate targets that were unprotected (Ready for introduction in 1938).

(2) Against more resistant inanimate targets:

~~110-lbs mine bomb~~ -- ready for introduction in 1933;

~~550-lbs mine bomb~~ -- ready for introduction in 1933;

~~1,100-lbs. mine bombs~~ -- ready for introduction in 1939.

The industrial production of the 550- and 1,100Ø-lbs bombs was only just getting started at the outbreak of war.

c. ~~Against Naval Targets~~: The 550- and 1,100-lbs mine bombs mentioned above. Both bombs were to be employed against naval targets that had no or only limited protective armor. Their effectiveness was considered greater if they exploded next to ships rather than by scoring direct hits.

~~To combat armor-protected ships, an 1,100-lbs armor-piercing~~ bomb was developed; it was ready for introduction in 1939, at which time it was available only in experimental samples.

d. Bombs to Produce Fires: The previously available 2.2-lbs electro incendiary bomb B.1.E. was replaced in 1939 by the

B.1, 3.E.

This had an additional explosive charge, which shortly after the bomb was lighted distributed the incendiary filling over large surfaces and endangered personnel endeavoring to extinguish the bomb.

e. Special Purpose Bombs: In addition, there were several types of bombs that were not intended for tactical purposes but rather as auxiliary weapons of various types.[3]

In summary, the Luftwaffe had six types of bombs at the outbreak of war, that is to say only two more than in 1933 when the German rearmament began.

One of these bombs was of the multiple-purpose type, another one's industrial production had only just begun, and a third one was available only in experimental-type samples.

The number of types had been restricted intentionally in order to facilitate mass production and logistics in the event of hostilities.

The tactical effect produced by the bombs could be considerably influenced by the kind of igniter used and the way it was adjusted.[4]

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[3] See Appendix I.

[4] Karlsruhe Collection, C V 3a.

At the beginning of World War II the Luftwaffe had contact and time fuses; the contact fuses could be adjusted in different ways.

Against live targets, nondelay fuses were used. The fuse responded immediately upon impact on the ground or at the application of breaking power, as for instance when the bomb hit the water. This produced the effect that fragmentation occurred at a low level above the ground and in all directions; when the bomb hit the target, the enemy could not find time to take cover.

Only if the ground was very soft, would the bomb explode after penetrating the soil so that part of its effect was absorbed by the dirt or diverted diagonally upward.

To prevent this, a simple gadget had been invented already before the war, the so-called nose rod or Dinort rod (Major Dinort invented it.). A about 8-inch long rod with a base cover was attached to the bomb fuse so that the rod would in any case touch the ground before the bomb, thus producing the explosion before the bomb penetrated into the soft soil. When it had been established that a high layer of snow greatly reduced the fragmentation effect, these nose rods were used for all kinds of bombs that were supposed to produce high fragmentation results.

Against inanimate targets one used delay fuzes. Their action occurred only shortly after impact, but mostly before the bomb reached its stagnation point. The purpose of the delay

was to produce the maximum effect of the explosive charge on the target.

For low-level attacks one used special-delay fuses to give the attacking aircraft sufficient time to leave the effective area of the bomb.

Extension of the Attack Effect by the Use of Time Fuses

Delayed time fuses were used to harrass the enemy beyond the time of the attack. They could be timed to explode after a delay from 1 - 100 hours.

Underwater fuzes were employed against naval targets; they ignited at a definite depth after having hit the surface of the water. They caused explosive pressure under water next to the veseel.

Bomb Sight Equipment

The effectiveness of the bomb sight equipment determined the type of operation to be executed and thus also the development of bombs and above all of fuzes.

The results of horizontal attacks at high altitudes were generally unsatisfactory because the bomb sight equipment had not been properly developed. [5] The Luftwaffe therefore switched temporarily to low-level attacks even before the war, developing special dive bombing tactics as time passed. This change was to

[5] The first bomb sights (Equipment G V 219 c and d) were completely unsatisfactory.

its effect on the development of bombs and the fuzes used in their assembly.

~~Special Weapons for Naval Operations~~

aa. Mine Bombs for Mining Bodies of Water;: the 1,100- and 2,200-lbs ground mine with remote-control fuzes.

bb. ~~XXXXXXX Torpedoes~~ Aerial

No suitable aerial torpedo was available at the outbreak of war. A Norwegian torpedo (Horten), the license of which had been acquired, was developed into the so-called L.T.F.5 that weighed about 1,760 lbs. The Navy, which was responsible for the development of this torpedo at the experimental station of Eckernfoerde, had not been able to produce an absolutely reliable weapon by the outbreak of war.

f. ~~Aircraft Armament Available at the Outbreak of War, Which~~ Could be Used against Targets on the Ground and in the Air

Available were a 7.9 mm machine gun (M.G.15), a 7.9 mm machine gun (M.G.17) that was either fixed or mobile, a 13 mm machine gun (M.G.131), and a fixed 20 mm aircraft machine gun (Oerlikon FF.2 cm).

~~XXXXXXXXXX~~

3. ~~In 1938 New Political Developments Put Emphasis on Different Types of Targets that Require New Offensive Weapons~~

When the British began rearming after the Sudeten crisis

in 1938 and the danger of conflict with Britain became a distinct possibility, the technical requirements established by the General Staff were geared unambiguously toward developing weapons that would predominate in a war against Britain. Armor-piercing bombs against naval targets, including armored naval vessels, and aerial mines to contaminate bodies of water became particularly important. Since these developments did not take effect until hostilities had broken out, they will be dealt with in the second chapter.

Section III.

The Diversification of Offensive Weapons Practiced at the Outbreak of War

Tactical Principles of General Applicability

The weapons available for specific types of targets were so few that major planning for their utilization was unnecessary.

The command regulations for Luftwaffe operations, L.Dv.16 (Luftwaffe Service Regulation No. 16) entitled "Air Warfare Conduct", therefore contain little information on the selection of weapons.

Paragraph 47 contains the following general statement: "The intended effect determines the type of operation and ammunition selected.* To achieve destruction, the forces must be concentrated. Often attacks will have to be repeated. Confusion and paralysis can be achieved by small forces being distributed over wide areas and by using appropriate ammunition, such as delay fuzes."

* Author's underscoring.

Paragraph 189 of the same regulations contains the following statement on the subject of retaliation attacks that were to be directed against cities:

"In selecting ammunition, the intended effect on morale as well as the types of building construction used in the cities that are to be attacked constitute the major considerations for the ratio of high-explosive and incendiary ammunition used. Buildings that are close together and of flimsy construction can develop into a sea of flames, if many fires are lit simultaneously and the wind is favorable. Time fuse ammunition increases confusion and complicates the salvage, cleaning up, and fire extinguishing operations."

On principle, Luftwaffe aircraft could not be armed with bombs until the target had been designated. The number of bombs thus depended basically on the type of target.

To provide proper technical- tactical guidance for the officers responsible for the selection of the appropriate weapons, the Luftwaffe High Command issued a special directive -- Luftwaffe Regulation No. 8/4, dated 8 June 1941, subject: "Selection of Bombs and Fuses for Air Attacks." [6] This directive defined the effectiveness of the various types of bombs available to the Luftwaffe for different targets, also indicating their most effective tactical employment.

This facilitated the proper choice of bomb for each type of target. If armed reconnaissance, for instance, could not fully identify a target, the bomb load was to be mixed.

[6] See Appendix II.

The Issuance of Orders for the Employment of Offensive Weapons

Principles: The German regulation on the conduct of air operations contains the following statements concerning the employment of offensive weapons:

Paragraph 63: Depending on the proprotions and type of the operation, the following points could be of interest in issuing operations orders (extracted): "Orders concerning the attack, targets, secondary targets, type of combat, and ammunition."

Paragraph 64: "It is often effective to precede the operations order with an advance order. This warning order contains all the information needed by the units to prepare the mission; it also contributes to preserve the troops' energy. Its content (in case of an attack) usually pertains to the target, ammunition, etc."

With regard to the order issued by the wing, par. 211 states: "The order issued by wing Headquarters may cover the following points: ..... Orders issued to the groups: targets, distribution of targets, intended effect, ammunition."

On principle each order or warning order must contain data on:

The type of target;

The kind of attack (high altitude attack, low-level, or diving attack); and

The type of ammunition to be employed, including information on the type and timing of the fuse used.

This was the only manner in which the use of the proper ammunition or rather type of ammunition could be guaranteed.

If a target designated in the warning had meanwhile changed and a different type or mixture of ammunition was needed for this target, the aircraft loads would have to be changed.

Who Issued the Orders Concerning the Types of Ammunition, Fuzes, and Timing to Be Used ?

The German regulations, insofar as they are presently available to the author of this study, avoid to pin down the responsibility for ordering which weapons, fuzes, ect., were to be used, and rightly so. Even in the regulations pertaining to orders issued by wing headquarters the term used is "may", not "must."

Inasmuch as the type of target permitted any choice in the type of ammunition or the mixture of different types, the type of ammunition to be used was determined by the headquarters ordering the attack on a designated target or groups of different targets. In the event of a major operation involving the entire Luftwaffe or at least large components or if some "special weapons", such as aerial mines and ground targets, were to be employed, the commander-in-chief of the Luftwaffe could issue the orders. The choice of attack weapons could, however, also be made by key commanders of such units as air fleets, air corps, air divisions, and air forces. Otherwise, the agency directly in command of the attack -- wing, group, or squadron -- would issue the order.

CHAPTER TWO

NEW OFFENSIVE WEAPONS AFTER THE OUTBREAK OF WAR

Section I

Causes and Motivations

For obvious reasons, new offensive weapons were developed and employed during the course of a war of long duration; even the most thorough advance planning could not change this fact.

In paragraph 3 of the German "Conduct of Air Operations" regulation -- L.Dv.16 -- this subject is dealt with as follows:

"Technical developments exert a decisive influence on the conduct of military air operations."

"Aircraft types, weapons, ammunition, signal and direction-finding equipment are in constant developmental flux. The offensive media are constantly being neutralized by defensive methods. New inventions and improvements of materiel might introduce complete changes in the combat conditions in the course of a war, switching from a feeling of superiority to the contrary and vice versa."

"The combat efficiency of the troops is always decisive."

By improving the performance of aircraft, the development of bombs was influenced insofar as the German bombers gradually became capable of carrying along larger bombs with correspondingly higher effectiveness, mainly because the engines were more powerful.

The carrying capacity of bombers and dive bombers [1] thus developed as follows:

[1] Karlsruhe Collection, C IV, 2 e.

Type of Aircraft	1939 (With limited range)	1944 (With full range)	1944 (With maximum bomb load)
Heinkel 111	4,400 lbs	4,400 lbs *	4,400 lbs
Dornier 17 (217)	2,200 lbs	2,200 lbs	4,400 lbs
Junkers 88(188)	2,200 lbs	4,400 lbs	6,600 lbs
Junkers 87 divebombers	1,100 lbs	3,300 lbs	3,960 lbs

* Heinkel 111 H 6 - H 16 with external load.

The four-engine bomber, Heinkel 177, which was developed but never committed in combat becaue it was not ready for operational use, was supposed to have been capable of carrying a maximum load of 6 tons with a range of 1,700 miles.

On the basis of expected improvements in the performance of aircraft, requirements for larger bombs were established even before the outbreak of the war.

Moreover, to achieve greater psychological impact, one developed larger bombs. In its selection and employment of bombs, the Luftwaffe attached special importance to the psychological effect, quite apart from the destructive power.

For this reason, the bombs of the dive bombers were equipped with special whistles that caused an infernal noise during the descent of the bombs. [2]

[2] The troops called them the "Jericho Whistles." Udet was considered as their inventor.

The transition from the smaller to the larger bomb, as for instance from the 22-lbs to the 110-lbs bombs, was also partly effected because of psychological reasons.

The same was true of the changeover from the C 250 to the C 500 larger incendiary bombs, whose psychological impact was greater.

The course taken by the war and the information later obtained was to prove that the Luftwaffe had been right. In many instances prisoners would describe that the effect of the bombings on the morale of the troops was greater than the actual damage done.

Available weapons were often improved by the application of technical inventions, as for instance by applying the hollow-charge principle. In addition, some entirely new weapons were created, such as rockets, V-weapons (missiles), etc.

The research and development of new weapons received its greatest impetus, however, from requirements that arose from the tactical situations. These will be dealt with in the following sections.

As an example, the number of the various models of bombers increased to 14 by 1941. [3]

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[3] The various bombers that were fully developed during the war are all listed in Appendix III.

Section II

The New Offensive Weapons for the Various Wartime Luftwaffe Missions

1. The Battle for Air Superiority

According to the command doctrine for Luftwaffe operations, as stipulated in the regulations on the "Conduct of Air Operations," the struggle against the enemy air forces was to be the primary task at the outbreak of hostilities as well as during the entire course of the war, insofar as necessary.

The Luftwaffe therefore had to make every effort to develop the aircraft and weapons in time and before anyone else, and to commit them in combat.

The fighting was directed:

a. Against Targets in the Air:

The following description pertains only to aircraft armament, not to ground weapons such as those employed by the antiaircraft artillery.[4]

Very soon after the four-engine American bombers made their first appearance in 1942 -- they were very well protected against attacks from the rear, their active defense consisting of the rear gunner and their passive defense of armored plates -- it was realized that the German fighter planes' offensive armament was insufficient.

The general in command of fighter aviation thus

[4] See Table No. 1.

requested in January 1943 the following basic weapons for the next years: [5]

Aircraft: maximum armament for fighters, including more than 5 cannons, 2 of which at least would have to be 30-mm guns.

~~Focke Wulf 190's with Daimler Benz 603 or Junkers 213 Engines~~:

2,machine guns 131 above the engine, 2 machineguns 151/20 (20-mm) at the wing tips, 2 automatic cannons 108 (30-mm) or 4 machine-guns 151 along the wings, and 1 automatic cannon 108 or 103 in the engine.

Focke Wulf 190's with Bayerische Motor Werke 801 Engine: the same as the Focke Wulf 190 with Daimler Benz 603 engine but without the automatic cannon 108 in the then engine.

Messerschmitt 209: 2 machine guns 131 above the engine, 2 machine-guns 151/20 (20-mm) at the wing tips, 1 automatic cannon 108 or 103 in the engine, 2 automatic cannons 108 along the wings.

~~Bayerische Flugzeugwerke 109 G~~: 2 machine guns 131 above the engine, 1 automatic cannon 108 in the engine, 2 automatic cannons 108 along the wings.

The same requirements pertained to the Messerschmitt 262.

~~Ammunition~~: Belts were loaded with 20-mm cartridges in the following proportion: 1 high-explosive incendiary, 2 machine-gun bullets, 1 armor-piercing high-explosive grenade, and 2 armor-piercing high-explosive bullets. In this manner, 50 percent of the ammunition was armor-piercing.

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5 Karlsruhe Collection C, V 4.

In addition to the available high-explosive projectile used for the automatic 30-mm cannon 108, an armor-piercing hollow-charge shell was required. The requirement for larger and ever larger calibers was in line with the 55-mm projectile that was being developed for the autonatic cannon 55.

The actual development of aircraft armament is described in the study, "The Status of Development of German Aircraft Armament at the End of the War" by Colonel (Ret.) Mix, 104 pages, in the Karlsruhe Collection C, V 4. This study also explains in detail the development of rockets in place of cannon.

Aircraft flying superelevated missions dropped bombs with time fuzes at the unit below. However, the introduction of fighter protection for bomber units led to the abolition of these tactics.[6]

In February 1945 another attempt was made to drop bombs with time fuzes on units below, this time by employing jet aircraft for this purpose. This was abandoned once more because the aircraft were urgently needed for other purposes.

On 14 February 1945 Air Fleet Reich , according to the war diary of the Luftwaffe High Command, was assigned one each operational squadron of Focke Wulf 190 fighter aircraft and Messerschmitt 163 jet planes, which were to test the newly developed rocket weapons "Round Billet" and "Fighter Bazooka".[7]

[6] Karlsruhe Collection.

[7] See also the report of Maj.Gen. Galland on the Reich Air Defense, 1946. Karlsruhe Collection.

Weapons Used to Disperse Bomber Units Flying In Close Formation

After 1943 the Germans were faced with a new problem -- combatting bomber formations composed of close-flying four-engine bombers protected by fighter planes. These formations had a strong defensive potential so long as they stayed close together, and they offered few if any attack opportunities to the German fighters. New weapons were needed to disperse and disintegrate the close bomber formations. In attemtping to find such weapons, the Germans used all kinds of improvisations.

The first weapon to be used in 1943 was the 210-mm mortar shell of the Army, which was equipped with a rocket launcher and which was used as 210-mm aircraft rocket with an adjustable time fuse. Individual fighter aircraft would fire them at the bomber formation from a distance of about 1,650 - 2,200 yards. Because of defective timing this method proved a failure.

Next, the Germans attempted to use fast planes flying above the formation and dragging towing ropes, to some of which bombs were attached that exploded upon contact. These ropes were towed across the bomber unit in an attempt to disperse it. How difficult it was to arrive at the proper decision is shown by the following story: At the presentation of decoration to successful fighter pilots committed in Russia, the pilots convinced Goering (it was sometime in 1943) that quick-firing machine guns were the proper equipment for fighter planes. Goering adopted

this idea and ordered its implementation to subordinate Luftwaffe agencies. He was very annoyed, when other fighter pilots shortly afterward advocated the armament of fighter aircraft with cannon, and drew the conclusion that the pilots themselves did not know what they wanted.

What he overlooked was that the first suggestion originated from fighter pilots operating in Russia, where they were opposed only by small, very maneuverable planes against which one had to use quick series of bursts before they turned away, whereas the other fighters were engaged in combat against the Allied four-engine bombers that were so well protected defensively.

b. ~~Against Targets on the Ground~~ [8]

At the outbreak of war, the bombs earmarked for use against aircraft -- either standing in the open or in hangars -- proved effective. Particularly useful was the multiple-purpose 110-lbs bomb introduced in 1939. It was very effective in destroying light, inanimate targets, such as aircraft, by fragmentation and had also great and lasting effect on aircraft located in hangars and workshops. In this manner the Germans succeeded in annihilating the Polish, French, and Russian Air Forces at the beginning of the respective campaigns. That this was not true in Britain, was to be attributed to the fact that the British Air Force was beyond the reach of the German bomber units. In 1943 during the battle for Malta the Germans encountered the first difficulties in destroying British planes with these bombs.

[8] See Table No. 2.

Whereas the II Air Corps had succeeded in destroying the British aircraft stationed on Malta during the offensive that took place in April-May 1942, the British had meanwhile taken steps to protect their planes by constructing shatterproof shelters. [9] When General Marquard, who had been responsible for developing the bombs, visited the II Air Corps, the author of this study pointed out that the available bombs would not suffice to effectively attack the planes protected by shelters. The only chance of success was to spray a large surface with a great number of bombs hitting close to one another. For this purpose the bombs had to be as small as possible so that the maximum number could be carried along and dispersed. General Marquard promised to examine the problem immediately.

Actually, the Luftwaffe had at the time large quantities -- about one million -- of small French fragmentation bombs weighing 2.2 lbs, which had been captured in France in 1940. The Luftwaffe High Command had shown no interest in this type of bomb, and the General Staff had declared the French bombs as scrap. After his return to Berlin in 1942, General Marquard tried to obtain approval for the employment of these bombs against Malta. General Field Marshal Milch, who was both Secretary of State and Chief of the Technical Office, disapproved this request because he needed the small amount of brass contained in the French fuses ~~to compensate for~~ the shortage of raw materials in Germany. [10] The

[9] See sketch in Appendix IV.

[10] See the Marquard Report in the Karlsruhe Collection.

French had intended to drop these bombs in delivery containers that obviously did not fit into the German bomb mounts. However, the bombs could be placed without difficulty in German delivery containers of the A.B. 50 type, designed for the 2.2 lbs electron bombs. The immediate use of the French bombs would thus have been possible. It was prevented by the decision of the Luftwaffe State Secretary, who should not have taken such action without consulting with the Luftwaffe General Staff.

Instead, orders were issued to develop another 2.2 lbs fragmentation bomb from the French model, but with substitute materials. This bomb was not ready until some time in 1943.

Eventually, the Germans failed to neutralize the British Air Force units in Malta, which turned out to be a decisive factor for the course of the North African campaign. However, even if the French 2.2 lbs fragmentation bomb had been made available in time, the success would have only been temporary. The British soon covered their shelters at the top, using boards and other material. The power of penetration of the 2.2 -lbs bomb would not have been sufficient to pierce the roof.

The Destruction of Runways by Bombs [11]

At the start of the war the Luftwaffe made initial attempts to neutralize enemy air forces by the destruction of runways. This type of operation required a great number of bombs and

[11] See Appendix V. Pattern of hits on a runway after an attack.

rarely achieved a full success, particularly since aircraft at that time did not rely entirely on concrete runways. The take-off strips usually remained intact or could be quickly repaired by filling the craters so that the aircraft could at least take/off and operate from another base.

Moreover, the bomb craters of the 110-lbs bomb specially designed for this purpose were too small. If 550-lbs bombs were used, their number would be insufficient because there were not enough aircraft to bring them to the target. A more suitable 220-lbs mine bomb was being developed primarily for this purpose, but this was stopped because major modifications of the aircraft would have been mandatory and because this tactical mission had meanwhile been abandoned. Subsequently, only German airfields were attacked whenever there had not been sufficient time to demolish them during withdrawals.

In 1940 a good means of neutralizing airfields temporarily was found accidentally; in particular situations -- such as the execution of German large-scale air and ground offensives -- the neutralization of airfields could be of the greatest importance, if the air defense was to be eliminated. In autumn 1940, when a 4.4-lbs fragmentation bomb to be used against live targets was to be tested by a bomber wing -- the 55th -- over Britain, the wing attacked Ipswich airfield with these bombs in contradiction to orders received. According to British reports, this attack hampered flying operations because many

of these bombs had time and vibration fuses.[12] They exploded later at the ~~XXXXX~~ slightest contact. It was difficult to locate them in the grass, and to neutralize them because of their great fragmentation effect. The same experience was made in Russia in 1941, after the Germans captured airfields against which the same types of bombs had been used by the Luftwaffe.

Since the employment of the bomb required technical modifications of the carrier aircraft and the production of this type of bomb was not too high, its use was only limited until 1943. The bombs could not be employed against Russian airfields after 1943, since the information was received that the Russians would employ German prisoners of war to clear the fields, which would have meant their certain death. The disadvantage in employing the bomb was that it had to be dropped from a low altitude because it was round and had no steering mechanism. It could therefore be sued only when the situation was in flux and the enemy had not established a firm defense.

2. ~~The Support of the Ground Forces~~

Even before World War II it was known that the available 22- and 110-lbs fragmentation bombs were effective against live targets in close formation and covering large areas, such as troop assemblies and march columns.

But since the Army asked for direct support, one had to ~~take into con~~sideration that targets might include infantry

[12] The flying personnel called them "dangerous fruit drops"

in deployment and similarly dispersed targets, often even dug into the ground. Since such targets could really be identified and attacked only by low-level flights, the mission was assigned to the so-called ground-support aviation. The Luftwaffe actually had only one ground-support group with three squadrons at the outbreak of war.

A special ground-support bomb -- a 4.4-lbs fragmentation bomb -- was developed for this aviation arm. This bomb was to be dropped in large quantities at a low level, not so much for the purpose of hitting an individual target but rather to cover entire surfaces. For this reason, no stabilizing fins were added to make the bomb suitable for precision bombing; it was shaped like a sphere.

Based on the experiences made during the Polish and Western European Campaigns, the Luftwaffe decided at the outset of the Russian Campaign that other aircraft -- fighters, dive-bombers, and bombers -- would drop this bomb. However, these planes had to be equipped with special release mechanisms.

According to a report of the Chief of Air Forces Supply and Procurement dated 17 May 1941 -- shortly before the start of the Russian Campaign, the following units had this special release equipment: [13]

Twin-engine Bombers: 5 groups of Junkers 88 and 3 groups of Dornier 17, each aircraft being equipped to load 360 bombs.

[13] Letter G.L. 3800/41, class. SECRET, Karlsruhe Collection F.V. 1 aa.

Single-engine Fighter and Dive-bomber Aircraft: 4 groups of Messerschmitt 109 fighter aircraft and 3 groups of Junkers 87 Dive-bomber aircraft; each aircraft was equipped to carry 96 bombs weighing 4.4 lbs. During July 1941, two additional groups of twin-engine Messerschmitt 110 fighter planes were to be equipped to carry 96 bombs per aircraft. While the fighting was in a state of flux, this bomb proved very effective. However, it was not available in sufficient quantity.

When the front lines became rigid, ground defenses grew too strong so that multiple-engine bombers could not conduct low-level attacks -- a prerequisite for the delivery of this type of bomb -- whereas single-engine aircraft could operate to only a very limited extent.

It was not until the end of the war, in a state of general emergency, when the German lines in eastern Europe had practically given way, that the bombs were again used more extensively.

Two orders that are still available from that period testify to this fact. One originates from the Luftwaffe High Command war diary, dated 11 February 1945, and reads as follows: [14]

"..... the Chief of the Operations Staff orders that Sixth Air Fleet use 4.4-lbs fragmentation bombs with nuisance fuses, to be dropped by ground-support units against enemy brdiges across the Oder River and troops crossing the water. The suplies of such bombs stored by Reich Air Fleet will be transferred to the Sixth Air Fleet immediately."

[14] Karlsruhe Collection C, V 3a.

13 February 1945: [15]

"Sixth Air Fleet is directed to employ the 4.4-lbs fragmentation bomb with nuisance fuse after shipments have been received from the Quartermaster General's 4th Branch; large-scale operations should be undertaken, particularly by night. At the same time the air flett headquarters was given detailed information on the most effective employment of this type of bomb."

Development of a Very Small Bomb that Could Be Dropped Even from High Altitudes

At an early date that fact that the 4.4-lbs bomb could be dropped only from low altitudes was considered as a serious deficiency. As previously mentioned in subsection a, a new small bomb that could be dropped in large quantities with special delivery containers was being developed from captured French 2.2-lbs bombs for attacks on British airfields. It is not known, when and how the idea to use this bomb against live targets originated, but actually the idea was obvious. If very small bombs had not been considered worth developing at an earlier stage and special equipment -- like deliver containers -- that made it possible to cover large areas densely with bombs was not produced, this may be attributed to the Luftwaffe's adherence to the principle that its proper targets were not on the battlefield. The Luftwaffe still considered the enemy resources situated in rear areas as the targets that could be attacked with maximum success in

[15] Karlsruhe Collection C, V 3a.

an effort to defeat the hostile armed forces. However, the weakness of the German Army and the mistakes made by the top-level command forced the Luftwaffe to select more and more targets on the battlefield.

The 2.2-lbs fragmentation bomb (S.D.1) was particularly effective after a new delivery container (A?B.250) had been produced, which was capable of carrying 225 bombs. The delivery container was shaped like a bomb and could be dropped like a bomb that was guided from the aircraft. A fuse attached to the XXXXXXX container opened same at a prearranged distance from the ground so that the bombs would continue by themselves until they hit the target.

The bombs completely covered wide areas of terrain and penetrated into positions that were open at the top. They proved most effective against live targets.

The 1st Air Division, which the author commanded in 1943, attacked at the time a forested area in the central sector of the Russian theater, in which Russian troops were massed closely, ready for commitment. After the air attack the German ground forces could enter the forest without encountering any resistance -- the forest was truly dead. Unfortunately, this bomb and the container never became available in sufficient quantities during the entire duration of the war, despite all efforts of top-level agencies. Field Marshal Milch expressed the following opinion on the production and tactical significance of this type of bomb at a

conference of chiefs of supply and procurement that took place on 9 February 1943: [16] "There is a great shortage of 2.2-lbs bombs in the field. .... What are the targets that make the employment of this bomb more than rewarding? The Russians are advancing across rear areas in thick columns. These people drive in three columns, side by side, with horses, with horse-drawn vehicles, three vehicles side by side. The infantry marches cross country in small groups of 10, 20 or 40 men, widely dispersed. One cannot achieve any results with heavy bombs. If one has small bombs, one can pelt these people with them. Once the snow has melted -- it is already thin by now -- one can achieve great results with the 2.2-lbs bomb, above all if we fly more strategic missions than we do now. The 110-lbs bomb has advantages over the 2.2-lbs bomb only if one has to pierce armor or guns or underground shelters or similar installations. For these one has to use the 110-pounder and upward, but for the many mass targets, the destruction of which is decisive for the course of operations, one has to employ the ~~2.2-lbs bomb.~~ If we can catch these people with the small bombs, this would be a major achievement. The Russians will try to attack all summer, either they will march forward and attack or we will attack and they will march backward. Then I have to hit them with the small bombs so that they lose courage. The Fourth Air Fleet and General von Richthofen have stated that they could drop 350,000 bombs a day -- the total production -- and that

16 Karlsruhe Collection C IV, 7h.

he (Richthofen) is always requesting and never getting anything. The production figure therefore seems to be far too low. In addition, there are no reserve stocks available so that the bombs cannot be distributed to the various theaters."

Frequently, however, the responsible German commanders did not realize the great effect produced by these bombs against live targets.

New Offensive Weapons against Armor

During the Russian Campaign the combatting of armor became a decisive problem. The great significance of this problem is evident, if one considers that according to post-war data the Russians apparently produced 150,000 tanks against 25,000 manufactured in Germany.[17] In addition, the Allies delivered 13,303 combat vehicles to Russia.[18]

The Army did not have nearly enough antitank weapons so that the Luftwaffe had to give assistance. Because of mistakes made by the German leadership and because some of the tank production plants were beyond the reach of the German bombers, these production facilities were not disturbed or destroyed, which would have been the most practical method of reducing the availability of tanks. Instead, the Luftwaffe had to destroy armor by painful piecemeal effort against heavy air defenses on the battlefield, killing off tank by tank.

[17] From an advance notice of Oberstlt. (Lt.Col.) Eike Middeldorf, Taktik im Russlandfeldzug (Tactics during the Russian Campaign), Mittler & Sohn, Frankfurt am Main, 1956.

[18] Extracted from the American magazine Omnibook, May 1948.

The Luftwaffe was not properly prepared for this mission. New offensive weapons had to be developed without delay. These included armor-piercing guns to be mounted on aircraft, and bombs that would prove effective even if no direct hit was scored on the tank.

Armor-piercing Weapons Mounted on Aircraft

Oberst a.D. (Col., Ret.) Rudel, who destroyed no less than 519 Russian tanks from summer 1943 to the end of the war, wrote in his book Trotzdem (Nevertheless), Duerer-Verlag Buenos Aires, 1949, pages 76 - 87, as follows on the topic of the mounting of armor-piercing weapons:

"I am to be assigned a special mission and for this reason I must report at one of the branches of the Reich Air Ministry." ....

"There are some phone calls, and then I am told to report to Rechlin after my leave; there, some tests are being made for using armor-piercing weapons from flying aircraft. Hauptmann (Capt.) Stepp, whom I know, was apparently in charge of the testing detachment, which was to move to Briansk, where the idea was to be tested in action." .....

"I do not want to go to Rechlin first, but want to move directly to Briansk. The armor testing detachment has arrived there already and has begun its experiments. They are using planes of the Junkers 88 type with a 75-mm cannon below the pilot's cockpit as well as Stuka dive-bombers, like the ones I am used to.

These dive-bombers of the Junkers 87 type are equipped with one 37-mm antitank gun under each wing. They use a special type of ammunition with a tungsten nucleus supposed to be capable of piercing any layer of armor. The ammunition does not explode until after the armor is pierced. The Junkers 87 plane, never very fast, has now become even slower and more difficult to fly because of the attached cannon. Its maneuverability is reduced and its landing speed increases considerably. But now XXX effectiveness of the weapons has priority over flying capability."

"The tests involving the Junkers 88with the large-caliber cannon are abandoned very quickly because the apparent difficulties leave little hope for success. The employment of the Junkers 87 during one operation also results only in losses. Most of the detachment personnel are very skeptical. I am convinced of the possibility of being able to hit within 10 to 12 inches of the precision target. The easily vulnerable spots of the tank would therefore be within reach, if we could only get close enough -- that is my conviction. We study the various types of Russian tanks from visual aids and learn their most vulnerable points, such as the XXXXXX location of the engine, the gasoline tank, and the ammunition storage space. To simply hit a tank does not suffice for destroying it; one must hit a place where there is inflammable or explosive material, such as gasoline or ammunition. Thus we spend 2 weeks; then the Air Ministry inquires whether we are ready to move

to the Crimea immediately. The Russians are exerting heavy pressure, and the Cirmea would be a larger and better testing ground."

"Low-level flying and strafing from an altitude of a few feet above the ground is impossible when the front lines are fixed and defensively weel protected. We know that because losses are higher than kills. If at all, the new weapons will be used only where the battle lines are in flux and the enemy defense therefore in motion. Capt. Stepp remains at Briansk and will join us later, while I fly with the combat-ready planes via Konotop and Nikolaev to Kerch in the Crimea." ....

"Comrades tell me that during penetrations Soviet tanks advance only about one-half to one mile beyond the former main line of resistance. This means that we have to attack them while they are still under the fixed and therefore strong antiaircraft protection of their forward positions."

"In this combat zone, which is very narrow, the Soviets have concentrated their defensive weapons. From the farthest easternmost areas near the Caspian Sea, where the Soviet oil resources are located, everything they have has been moved to this zone. The Russian route of advance led via Mosdok, Piatigorsk, and Krasnodar toward the Cirmea. On the first day already we make our first test south of Krymsmaya: Russian tanks that have broken through the German lines are 880 yards in front of the main line of resistance. We locate them immediately and want to see what can be done. It is very little, since while I

am still flying above our own sector, my engine is already hit by an antiaircraft projectile. Other planes fare no better. Now, enemy fighters approach, an old series of Spitfires, which I encounter in Russia for the first time." ....

"Our initial tests and our experiences are by now means promising. Wherever we appear with our birds, we are pitied and none of us is given much chance of survival. But the more effective the defense, the faster I develop my attack methods. Obviously, we also have to carry bombs to combat the enemy defenses. We cannot carry them on the aircraft equipped with cannon or else these planes get too heavy. Moreover, the Junkers 87 equipped with cannon could not be put into a dive because the tension on the wings would be too great. An escort of XXXXXX ordinary dive-bombers was therefore indicated." ...

"I took along a plane equipped with cannon and introduced it to the personnel of my squadron. Wherever I believe that the test detachment could operate, I let it take off with my unit. Later on I formed an armor-piercing unit that operated separately but was committed under my supervision and control. The detachment from Briansk also arrived, and Capt. Stepp returned to the wing to which he was assigned." ....

"Majot armored engagements took place during these operations. We had not seen anything like it since 1941. The tanks were massed in the open over wide areas, with the respective anti-

tank guns camouflaged in positions situated in their rear." ...

"When I saw these masses of tanks I remembered my plane equipped with cannon that I had used ~~XXXX~~ while I was with the testing detachment; I had taken the plane with me from the Crimea. This tremendous number of enemy tanks would make a test feasible. Even though the antiaircraft defenses protecting the Soviet armor were very strong, I said to myself that, if I did not drop like a brick from a flak hit, I would be able to return the damaged plane to my own lines with only 1,300 to 2,000 yards separating the two hostile armored forces. The first squadron loaded with bombs therefore flew behind my plane, the only one equipped with cannon. This was the way we tried it."

"During the first attempt I blew up 4 tanks with the hammer blows of my cannon, by the evening I counted a total of 12. We were all under a kind of hunting spell, having the wonderful feeling that every hit meant fewer German casualties."

"After the first day the tinsmiths and mechanics get plenty of work because the engine has been badly hit by fire from the ground. The life expectancy of such an aircraft would always be limited. But what really mattered was that we had finally found a weapon that could appear anywhere unexpectedly and successfully combat the Russian tanks whose number seemed so overwhelming. Everyone at the squadron, group, wing, and even the air corps level rejoiced over the newly won experience and the successful test.

To guarantee the flow of aircraft replacements, messages were dispatched to the other elements of the test detachments, asking them to transfer all planes with crews immediately so that every aircraft capable of commitment would become available in this sector. The armor-piercing squadron was thus created. I was given operational control of the unit."

"During the next days' engagements the experiences were amplified and further successes obtained. While the planes equipped with cannon attacked, some of the bombers attacked the ground defenses while others circled at higher altitudes like a hen over its chicks, thus protecting from above the cannon planes from air attacks by enemy fighters."

"Gradually I learned all the tricks, but often we learned only from sad experience. We lost planes in sparsely defended air spaces because we circled over territory where artillery duels took place. The artillery trajectory areas had to be avoided or else one ran the risk of being shot down "by accident."

"After a while the Soviets became adjusted to antitank fire from the air. If at al possible, they moved their flak right to the front. The tanks were issued smoke grenades so that they could lay a smoke screen or simulate a fire so that the attacker from the air would turn off, believing he had scored a success. Experienced air crews quickly learned such deceptions and refused to be tricked. A tank that was really aflame burst into high flames very soon; to imitate those was far too

dangerous. In many instances the tank would explode because the fire would make contact with the ammunition that was ordinarily in every tank. It was very disagreeable if that explosion occurred immediately and the aircraft flew only 15 to 30 feet above the tank. This happened to me twice during the first days, when I flew suddenly across a wall of flames and thought to myself: "Now it is your turn." But I emerged quite safely on the other side, even though the green camouflage paint on the plane was grilled and some tank fragments had pierced my wings and engine."

"We used to attack the armored monsters from the rear or from the side. The angle was not too steep so that we could get quite close to the ground but not experience difficulties in leveling off. If the plane pancaked too far, it would have almost been impossible to avoid contact with the ground, which is always full of dangerous consequences."

"We had to try to hit the tanks always at their most vulnerable spot. The front of the tank is always best protected, and for that reason every tank will try to oppose the enemy with its front. Its flanks are weaker, but the best spot to attack is the rear. That is where the engine is located, and, since this center of power needs to be cooled, the aromr is thin in the rear. To improve the cooling system, large holes are pierced through the armor plate. That is where the tank should be hit, for where the engine is, there must be gasoline. A tank can be easily identified from the air when the engine is running:

blue exhaust clouds will be visible. On both sides of the tank are the gasoline and ammunition reserves, but they are protected by heavier armor plating than the rear." ....

Other pilots were given Junkers 87 with 37-mm cannon on repeated occasions, but they were not really successful. Rudel, who also commanded a dive-bomber group and later a wing, remained practically a lone wolf who often decided single-handedly the issue of an engagement by his accomplished mastery of this aircraft.

The Henschel 129 with Two 30-mm Cannon

Better average results were achieved on a larger scale by employing the twin-engine Henschel 129 antitank fighter. At the end of 1942 -- beginning of 1943, a special unit, the 4th Group of the 9th Ground-Support Wing was formed with 6 squadrons. This unit was successfully committed by squadron or in its entirety wherever the Russians massed their armor. It was handicapped by the fact that the twin-engine aircraft was relatively vulnerable to ground defensive fire and was no longer being produced. For this reason, only still available planes could be used, and these were often very worn out.

The antitank combat from the air was not conducted on any really large scale until 1944, when Junkers 87 dive-bomber units were re-equipped with single-engine Focke Wulf 190's and committed as ground-support units. Rockets were placed under both wings of this aircraft to give it antitank capability. Since the change of equipment was very slow, many other targets had to be attacked by the same aircraft, and the pilots were

still inexperienced and not properly trained, this medium of antitank combat did not prove as effective as expected by the military leadership.

Bombs as Antitank Weapons

When the need to combat tanks from the air became more and more urgent in Russia, one first used large 1,100-lbs mine bombs as an expedient. Since one was fully aware of the difficulty of destroying tanks moving at wide intervals by direct bomb hits from the air, one wanted to use at least bombs with such high pressure waves that the tanks would be immobilized even by near misses. [19] As it turned out, this was effective only if the bomb dropped no farther than 13 feet from the tank and exploded directly above ground without penetrating, since the pressure would otherwise deflagrate into the air instead of hitting the tank from the side.

But such near misses could be obtained with the 1100-lbs bombs only occasionally and accidentally.

After it had been discovered that the dropping of a large number of small bombs proved far more effective and scored many more hits, a so-called antitank bomb was introduced in spring 1942; it weighed 8.8 lbs and was designated S.D.4 HL. By using the hollow-charge method, this bomb proved very effective against tanks. Armor up to 130-mm (about 6") thick

[19] See Appendix VI, Photograph taken above a tank battle in Russia in 1942.

could be pierced with that bomb. In addition, the bomb had also a fragmentation potential so that it could be directed against infantry escorting the tank.

For the employment of S.D.4 Hl bombs, the delivery container carrying 1,100 lbs proved most effective; it had an opening at the pointed end through which the bombs were dropped during a nose-dive, with 78 of them hitting the target like a mass of concentrated shrapnel. The chances of scoring direct hits or near misses were far greater than with the 1,100-lbs bomb. The 8.8-lbs bomb proved effective even at a distance of 80 feet -- against 13 feet for the large bomb -- by setting fire to the gasoline or ammunition in the tank.

The bomb was carried mainly by Junkers 87 dive-bombers. When these aircraft gradually had to be replaced by others that were not capable of dive-bombing -- this happened in 1944 when the Junkers 87 proved inferior to the Russian fighters -- the use of the 8.8-lbs bomb became very limited.

Bombs against Fixed Fortifications

While the available bombs proved quite adequate against outdated fortresses in Poland, Belgium, and Holland, they were ineffective against the modern fortifications of the French Maginot Line and such Russian fortresses as those surrounding Sevastopol in the Crimea.

General Plocher in his study*/, Die Deutsche Luftwaffe an der Ostfront (The German Air Force in Russia), Volume IV, page 122, writes on this subject as follows:

"The effect of the bombs, even of the largest 3,180 - 5,500-lbs bombs, against fixed fortifications was usually not so great that such facilities were completely eliminated, even after a direct hit was scored. Total destruction was achieved only by attacking batteries XXXXXXX positioned on open platforms." ...."Real results were obtained in all attacks against enemy batteries."

For this purpose the hollow-charge bomb S.H.250 was used.

The Chief of Air Forces Supply and Procurement commented as follows on the subject of the effect of this bomb:[20]

"By employing hollow-charge ammunition against fortified installations, effective penetrations can be achieved XXXX through a minimum layer of XXXXXX 10 feet of cement or 1 foot of armor."

From a practical point of view, these bombs were developed too late. Attacks against fortresses of this type were no longer being carried out.

3. The Support of the Navy and Luftwaffe in Naval Warfare[21]

It was not until 1938 that, because of a change in political concepts, a war against Great Britain was considered as a distinct possibility. Up to that time the Luftwaffe High Command had believed that planning for any but a minor

[20] G.L./C. Az 74 Nr.18/42 geh.Kdos. (B.7), dated 8 February 1942, Report of the Chief of Air Forces Supply and Procurement. XXX Karlsruhe Collection C V, 3a.

[21] See Table No. 4.

continental war was unnecessary. For this reason, the development of offensive weapons suitable against naval targets could not be completed in time before the outbreak of hostilities. There was a particular shortage of attack weapons against armor-clad naval vessels.

The development of new offensive weapons to be used in naval warfare therefore received top priority at the start of the war.

During the course of the war operations above the ocean assumed proportions that had by no means been foreseen in peacetime. These operations extended over the Baltic and North Seas, the Atlantic Ocean, the Mediterranean, and the Black Sea. In view of the low strength of the German Navy, which limited its field of activities to the Baltic and North Seas -- with the exception of submarines -- the Luftwaffe carried the main combat load above the ocean. But to carry out this mission the Luftwaffe lacked not only the weapons that could have produced results but also the essential flying units, which were all the more necessary because the continental theaters of war were so extensive.

Bombs against Naval Targets

The bombs available at the outbreak of war were of limited capability against naval vessels; however, new and more effective bombs for use against armor-clad ships had to be developed. By 1940 two mine bombs, weighing 2,200 and 4,000 lbs respectively, were introduced. Near misses were supposed to produce effects that were similar to torpedo or mine explosions on naval and

commercial vessels. The effectiveness of these bombs was therefore calculated not so much according to direct hits scored on a ship but rather by the pressure effect produced sideways in the water, if the bomb landed not too far from the target.

Bombs for Direct Hits on Naval Vessels

By spring 1940 the armor-piercing bom P.C.500 with rocket attachment was introduced in the field; it was primarily intended for steep dives by the dive-bomber aircraft Junkers 87.[22]

In spring 1941 the development of the armor-piercing P.C. 1000 bomb with rocket attachment was completed. The tests were conducted in 60-degree dives. These more refined requirements corresponded to the concepts of the top-level command, according to which the Junkers 88 bomber was to be operated. However, this method of attack was very rarely carried out by the crews. The bombs were also used only very seldom. The rocket attachment, which gave the bomb additional speed, also changed the trajectory of the bomb so much that a small target such as a ship could not possibly be hit.

New and Better Offensive Weapons Needed after 1943

Because of Stronger Defenses and More Effective Protection of the Naval Vessels

After the convoys across the northern Arctic Ocean had been successfully attacked during the summer of 1942 -- these convoys had transported Allied military equipment to

[22] See Appendices VII and VIII.

Russia -- this type of warfare came to a stop for all practical purposes. Fighter protection provided by the aircraft carriers and the more effective flak of the ships proper, which had adjusted to this type of attack, resulted in an increase in losses of aircraft.

In the Mediterranean area also air attacks against naval targets within range of their own fighter aircraft could be attacked only under cover of darkness. This in turn reduced the effectiveness of such attacks greatly.

Remote-Controlled Bombs

A new technical invention, the remote-controlled bomb, was to chnage this situation. The bomb was euqipped with wings and rudders so that the bomb became similar to an aircraft. By mechanical or electrical transmission the direction of the bomb could be controlled from an aircraft.

One could use the Fritz X (F.X.), wighing 3,180 lbs for this purpose; it had the same effect as an armor-piercing bomb of the same weight. During a supply and procurement conference that took place on 29 July 1944,[23] it was stated that this bomb would suffice against naval vessels of the King George type, whereas its effectiveness against the Nelson was doubtful.

The employment of the F.X. had the disadvantage that the control aircraft had to fly over the target, even though at high altitude, and that the last stage of the approach flight had to be carried out without changing the course.

[23] Karlsruhe Collection C V, 3a.

In 1943 the Italian battleship "Roma" was sunk by one single F.X. bomb.

The development of a 3,520-lbs remote-control bomb, which would have sufficed even against battleships of the"North Carolina" class was underway. Among the other remote-control bombs, the H.S.293, which had the same effect as the 1,100-lbs mine bomb, was available. In contrast to the F.X. bomb, it had a short rocket propeller so that it could be launched from the control aircraft from a distance of 8 - 10 miles. The attacking aircraft could thus stay out of range of the ship's antiaircraft guns. The bomb was capable of sinking large commercial vessels. It proved its effectiveness for the first time during an operation near the Alboran Island in the Mediterranean on 13 August 1943. At that time a sizable number of transport vessels forming an Anglo-American convoy were sunk by aerial torpedoes and remote-control H.S.293 bombs. [24]

The remote-contrd bombs' significance was not recognized in time by the Luftwaffe High Command, even though their employment resulted in 40 percent hits on enemy targets at the very outset of their development. Since the bombs' development was thus considerably retarded, they could not be committed on a large scale before the end of the war.

Despite all more recent developments, the greatest successes against naval targets were scored by the following weapons:

[24] Karlsruhe Collection.

~~against commercial vessels~~ by the 550- and 1,100-lbs mine bombs; they were most effective when loaded with trichlor-ethylene. This type of bomb had little power of penetration but contained large quantities of explosives.

Against naval vessels by the 1,100- and 2,200-lbs mine bombs as well as by the bulk of the penetration bombs, which had particularly high armor-piercing qualities so that they could penetrate armor-plated ships' decks.

The effectiveness of the bombs when used against commercial vessels and lightly armor-plated naval ships was satisfactory. Such ships sank almost each time that they received direct hits or even at near misses that exploded at up to 10 feet distance. The bombs' effectiveness increased when the ships moved or during heavy seas.

Heavily armored naval vessels, such as heavy cruisers, etc., were sunk only rarely in case of a particularly lucky hit, such as a hit scored on the ammunition storage areas.

In contrast to such reports, no battleships were sunk, whereas some were severaly damged on several occasions. As previously mentioned only the Italian battleship "Roma" was sunk by a remote-control F.X. bomb. In general, bombs were far from ideal means for attacking naval targets, since the chances of scoring hits with the available bomb sights and the then employed offensive tactics were relatively small.

Aerial Mines

Aerial mines were used to mine ports, the entrances to same, and navigable rivers.

By contrast, the Navy used mines mainly ~~along~~ oceans or open bodies of water traveled by ships.

In addition to the aerial mines already available at the the outset of the war -- the 1,100- and 2,200-lbs aerial mines with magneto ignition -- some new mines were developed during the war. These were the L.M.R.w, the L.M.A. III, and the L.M.B. III, the latter two weighing 1,100- and 2,200-lbs, respectively. The magneto ignition was later replaced by the acoustic and combined remote-control ignition for mines.

Until 1940 the Luftwaffe was responsible for developing aerial mines, at which time the Navy assumed this task.[25]

The German military leadership expected good results from employing aerial mines against the British staging ports prior to the invasion. The Luftwaffe High Command, for instance, ordered by teletype on 27 April 1944,[26] that mines be employed for attacks against the British ports in which the invasion ships were assembled. The use of D-equipment (D-Geraeten) was not contemplated. These attacks did not serve to mine bodies of water but to destroy ships and supplies of all types.

~~Aerial Torpedoes~~

At the outbreak of war the Germans did not visualize the ~~employment of~~ aerial torpedoes. Even among experts, opinions

[25] See the study on ~~Der Deutsche Luftmineneinsatz~~ (The German Use of Aerial Mines), Karlsruhe Collection C V, 3c.

[26] Karlsruhe Collection.

varied on the possibilities and prospects of employing aerial mines.

During tests made in 1939, L.T.F.5 torpedoes [illegible] fired at speeds varying between 110 and 120 miles missed in 49 out of 100 cases. These poor results as well as the assumption that the ratio of misses would rise at increased speeds of firing -- which would become mandatory if Heinkel 111 and Junkers 88 were used as torpedo carriers -- led the Luftwaffe to lose interest completely in developing aerial torpedoes. The production of torpedoes was interrupted. On the other hand, the Navy had also not realized the significance of the aerial torpedo.

According to a report written by the author of this study, the Commander-in-Chief of the Luftwaffe, Reich Marshal Hermann Goering, made the following statements on this subject:

When the combat tactics of the Luftwaffe in the Mediterranean were being discussed during a visit to Sicily made by Reich Marshal Goering in 1942 or at the beginning of 1943, the fact was mentioned that the Italian Air Force elements had scored many victories by using aerial torpedoes. In reply, Goering stated that he had unfortunately made a wrong decision soon after the National Socialists had assumed power. The Luftwaffe was now handicapped because of the bad demonstrations then made by the Navy, when that service had fired aerial torpedoes from aircraft in the Schleswig Bay. The demonstration had been so bad and so unconvincing that he had then decided to remove the aerial

torpedo from the research and development program. Research and development of the aerial torpedo had been resumed much later so that the delay that had intervened could no longer be compensated for in the mean time.

In September 1939 the North Sea air groups commanded by Naval Forces West (North Sea), which still flew outdated Heinkel 59's, were equipped with aerial torpedoes. After a number of practice runs starting in November 1939, some 164,000 tons of shipping were sunk by torpedoes. After the British had damaged the French naval vessels "Strasbourg" and "Richelieu" by aerial torpedoes fired near Oran and Dakar, respectively, at the beginning of July 1940, and had blocked the Italian Fleet in the Taranto Bay with the help of aerial torpedoes on 11 November 1940, the importance of this weapon became obvious and its development was resumed.[27]

The extent to which these torpedoes were used can be gathered from the fact that in September the maximum figure was 70.

In November 1940, however, the development of torpedoes and their production by the Chief of Air Forces Supply and Procurement Udet was once again suspended because of limitations on expenditures and research and development ordered by Hitler and Goering, respectively. A report of the General Staff[28] indicates simultaneously that the aerial torpedo F 5 had lately proved effective after a series of modifications.

But production was resumed soon afterward.

[27] See Dr. Theodor Benecke, Wehrkunde, Issue 12, December 1954

[28] Quartermaster General, 6th Branch, 27 Nov 40, Kalrsruhe Collection.

But upon orders of the Chief of General Staff the use of aerial torpedoes F 5 was forbidden until further notice, because Hitler wanted to keep these weapons for a special operation. It must be assumed that an operation leading to the seizure of Gibraltar was meant, which was mentioned in the Fuehrer Directive No. 18 of 12 October 1940.[29]

The opposition to aerial torpedoes as weapons were not definitely eliminated until 1941, when its development and procurement were given top priority.

All military matters were concentrated in the hands of the "Plenipotentiary for the Aerial Torpedo." To this late recognition of the essentiality of the weapon contributed not only the modest initial acheivements of the Germans, but also the fact that the German battleship "Bismarck" was sunk by aerial torpedoes on 27 May 1941 and that the British naval vessels "Prince of Wales" and "Repulse" also fell victim to the same weapons on 10 December 1941. When Japanese aerial torpedoes were specially brought to Germany by submarines so that they could be examined, it was found that the German aerial torpedo had meanwhile achieved equality.

The employment of torpedoes was restricted by the fact that special units had to be used for the purpose because of the training needed and the mechanical adjustment on and ~~in the aircraft~~, thus making the latter more or less useless

29 Karlsruhe Collection.

for other missions. Because of its over-all situation, Germany could reserve only one wing for torpedo carrying missions.

The 26th Bomber Wing was charged with employing aerial torpedoes; its groups operated in the North Sea, in the Bay of Biskaya, and in the Mediterranean and Black Seas. These bomber groups were very successful. In the North Sea, for instance, the convoysmoving toward Murmansk ** P.Q.16, 17, and 18 -- suffered heavy losses from aerial torpedoes launched by the local group of the 26th Bomber Wing.

At an interoffice conference on 9 February 1943 the following report was made regarding the achievements of torpedoes during the Allied landings in the Mediterranean:

"~~Successes scored by aerial torpedoes~~.

During the period from the start of the operations in West Africa to the beginning of January some 70,000 tons of commercial shipping were sunk in the Mediterranean, while 400,000 tons were damaged. On 7 January two 8,000-ton ships were sunk and a 3,800-ton ship was seriously damaged. Moreover, one heavy 10,000-ton cruiser was hit by two aerial torpedoes and two cruisers of 6 - 7000 tons were hit by one torpedo each.

Aerial torpedoes used	460
Not fired	90
Aimed and fired	284
Hits scored	61
Percentage of hits scored	21.5%
Aircraft committed	(153 Heinkel 111
	(77 Junkers 88
Aircraft lost	25

On 13 August 1943 near the Island of Alboran in the Mediterranean a great number of transport vessels belonging to a British-American convoy were sunk.

The employment of aerial torpedoes, however, soon became impossible because of the crushing superiority of the enemy defenses. They were used at dusk or dawn or with simultaneous high-altitude attacks."

Other Torpedoes Developed by the Germans

A particularly interesting development was a bomb torpedo, which came in different calibers. It was to make it possible to attack naval targets from high altitudes with fighter-bombers (Focke-Wulf 190). The weapon was to be primarily directed against the Allied invasion forces, but it did not become operational until the end of 1944 and was therefore not employed. The same was true of four other torpedoes, which were not developed in time.

Development of a Method by which a Small, Manned Aircraft Guided a Larger Aircraft that Was Unmanned and Loaded with Explosives toward a Target in an Effort to Launch Successful Attacks on Capital Ships.

This invention was made by accident and was based on the initiative of one individual. The first test pilot of the Junkers plant, Holzbaur, was testing a mirror reflex bombsight in December 1941, when he found that after having set the new automatic pilot the aircraft would fly toward its target without assistance or deviation. This experience served in the devlopment of a new system.

Statistics compiled in Germany indicated that existing attack

tactics required an average of 27 aircraft to sink one single ship. The new invention's significance was realized when it was established that a target measuring 50 by 50 feet could be hit with 100 percent accuracy. But one and one half years were lost before the Reich Air Force Minstry decided to order the first test aircraft.

At the end of 1943 some successful tests were carried out against a French battleship in Toulon. In 1944 twelve of these aircraft were employed against the Allied invasion fleet at St. Dizier. Nine of the weapons reached their targets, sinking six naval vessels, transport ships, and tankers. An additional 50 aircraft were thereupon ordered. An attack on the British battle flett at Scapa Flow was planned but not executed because of bad weather.

More details concerning the plans for employment of this weapon, etc., can be gathered from Appendix IX, Studie ueber die Einsatzfaehigkeit der Mistel (Study on the Capability of the Composite Aircraft Junkers 268).[30]

Effect on the Invasion Ports in Britain.

Among the weapons considered for employment against the British invasion ports was also the V 1. Field Marshal Milch stated on this subject as follows:[31]

"We believe that some time, probably in spring, a major

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[30] See also Appendix X.

[31] Chief of Supply and Procurement Conference on 17 December 1943.

landing will take place, probably in France or somewhere else. Obviously, the flow of supply will go through a number of British southcoast ports. The task would become simpler, if I could operate at close distance. I wouldneed only relatively little defensive altitude. This would make my task considerably easier in oversoming enemy resistance. The time during which the aircraft would be within enemy fighter and flak range would be greatly reduced. For these reasons I believe that mass employment against such ports, perhaps against the 6 to 8 principal targets, would subject them to continuous disturbance and thus result in considerable complications, greater nervous tension, and also probably in far more favorable opportunities to score hits."

However, the V 1 was actually not employed against the British invasion ports because of their inaccuracy and deviation.

4. ~~The Disruption of Communications~~ (See Table 5)

Railroads

At the beginning of the war sufficient varieties of bombs were available for this purpose so that targets of opportunity could be attacked. Only when rail lines were attacked to disrupt traffic did difficulties arise when bombs bounced off after hitting the ground and often exploded without damaging the tracks. This happened especially when the bombs were

aimed at railroad embankments, whose distruction was mostly more effective than the damages inflicted on flat tracks. To prevent them from bouncing, the types of bombs that were most frequently used for attacks on tracks were equipped with spikes by which the bomb was retained when it hit the ground.

In 1941 the Chief of Supply and Procurement ordered that test be conducted in bombing Russian railroad tracks.

~~The Results of the Tests of Dropping Demolition Bombs on Russian Railroad Tracks~~ [32]

The following is extracted from a report of the Chief of Supply and Procurement, dated 29 October 1941:

"Along the railine Orsha-Lepel some demolition and high-explosive bombs were dropped with the following results:

The S.C.10 (22-lbs) bomb (high-explosive) was unsuitable because tracks were damaged only within the immediate vicinity of the rails.

The S.C.50 (110-lbs) nose-spiked high-explosive bomb can make Russian railroad tracks useless, if it detonates between the rails or up to 5 feet next to them. The damages can be fairly easily repaired by filling the crater and exchanging the damaged ties and rails.

The S.C.250 (550-lbs) high-explosive, nose-spiked bombs caused more lasting damage to Russian tracks than the S.C.50 nose-~~spiked bombs. The~~ maximum distance at which the larger bomb

[32] Karlsruhe Collection F V, laa

can drop from the rail in order to still be effective was about 10 feet -- measured in crater radius difference -- longer than in the case of the S.C.50."

"Nose-spiked bombs should be dropped from an altitude of about 165 feet at a flight path angle of about 10 to 15 percent. In general, the bombs will be lodged upon hitting the ground, but ricochet will occur occasionally."

"After November 1941 a monthly quota of 1,000 S.C. 50's, 500 S.C. 250's, and 500 S.C. 500's are to be delivered to the Russian theater, complete with nose-spikes."

"The nose-spiked S.C.50 bombs can be carried by Junkers 87 (4 each), Messerschmitt 109 (2 bombs each), and Messerschmitt 110 (initially 4 each, and with attachments under the fuselage altogether 8 bombs per aircraft). Because of their length, nose-spiked bombs could not be placed inside the fuselage."

"The nose-spiked S.C.250 (550-lbs) could be carried by Junkers 87 (Bu R (Tr.: ?) 1 each, and D (Tr.:?) 3 each), Messerschmitt 109 (1 each), Messerschmitt 110 (2 each), Junkers 88 (4 each), and Dornier 217 (2 each)."

"The nose-spiked S.C.500 (1,100-lbs) could be carried by Junkers 87 (1 each, Messerschmitt 109 (1 each), Messerschmitt 110 (2 each), Junkers 88 (4 each), and Dornier 217 (2 each)."

Waterways

Against fixed targets, such as canal beds that served for canalizing bodies of water, bridges, locks, ship-lifting devices, port installations, warehouses, and warfts, the same bombs that were used for the destruction of other fixed targets were available.

Aerial mines were used to sink ships in large canals and bodies of water on many occasions.

In Directive Nr. 45, for instance, which was issued by the Armed Forces High Command on 23 July 1942, the following orders were given: "The traffic of ships on the lower Volga River will be disrupted by the sowing of mines." The Suez Canal was also mined.

Roads

The usual bombs were available for the destruction of dikes, ditches, crossings, etc.

Among the lessons learned in mobile warfare was that march movements could often be seriously impeded, if houses along roads that led into or out of villages could be destroyed in such a manner that the debris fell onto the roadbed. For this purpose the Germans used mainly bombs that served for attacks on cities (See next chapter).

During the entire war the destruction of man-made structures proved to be extremely effective in disrupting road traffic (the

same was also true of the disruption of railroads and waterways). The German service regulation on "Air Warfare Operations"--L.Dv16 -- contained the following on this subject in paragraph 166:

"If the necessary forces are available, the careful destruction of particularly important and large man-made structures, whose repair and restitution are time-consuming, is of great value."

However, this was less of a problem regarding bombs, which were plentiful for this purpose, than a question of scoring hits, that is to say it concerned attack procedures and bomb sights.

This was altogether different when emergency field bridges, particularly floating bridges, were being attacked. Chemical agents and strong ground defenses often prevented the aircraft from successfully attacking the bridges in aimed high altitude or dive-bombing assaults.

The Commanding general of the Sixth Air Fleet reported to the Luftwaffe High Command on 8 March 1945 on this subject as follows: [33] Aircraft flying direct assaults on the Russian-held bridges across the Oder could hardly execute their missions because the Russians put up smoke screens at the approach of the aircraft. It was suggested that the bridges be attacked with water balloons [34] (a code designation for a special type of mine with little draft) or other suitable river floating media and special combat weapons.

[33] Karlsruhe Collection

[34] For more details, see information on water balloons in Section 5 "Attacks on Sources of Energy."

As early as 11 February 1945 the Commande-in-Chief of the Luftwaffe had put at the disposal of the Sixth Air Fleet altogether 200 ball floating mines from Army stocks, which were to be used against the Oder River bridges. Around 16 - 17 April 1945 they were used against pontoon bridges,[35] but no data are available on the results that were achieved. Because of the urgency of the situation, it was decided to use composite aircraft against the bridges during the night of 14 - 15 April 1945. Since it was impossible to establish the results achieved, the Chief of the General Staff ordered that the remaining 38 composite aircraft be employed against other targets.[36]

No suitable means of destroying these bridges were therefore available.

Means for Destroying Torpedo Nets and Other Protective Nets Used to Keep Bridges Intact

As a countermeasure against floating and drifting mines the enemy soon resorted to protecting upstream bridges with torpedo and other nets.

In January 1945 attempts were made to destroy the torpedo nets screening the Nymegen Bridge in Holland by using water balloons. A boat was used for this purpose. The attempts failed when the boat was attacked by bombs and sunk by artillery.

[35] 7./K.G.4

[36] Extracted from the war diary of the Commander-in-Chief of the Luftwaffe, 1945. Karlsruhe Collection.

5. Attacks on Sources of Energy [37]

The 550-lbs bomb was the standard bomb used by the Luftwaffe against fixed targets of all types. About 80 percent of the German production of bombs consisted of this weapon. One of the important prerequisites for the effectiveness of this bomb was its employment in large quantities so that the pressure waves would interact and thus increase the effects considerably.

The Luftwaffe High Command had not fully realized this requirement until 1942. In an effort to destroy the vital parts of a major target by scoring exact hits with a minimum number of bombs and thus put the entire installation out of operation, the Germans had developed the twin-engine Junkers 88 dive-bomber as well as the Junkers 87.

The former Chief of Intelligence of the Luftwaffe -- General Schmid (Ret.) -- commented on this subject as follows: [38]

".... It is a known fact that General Jeschonnek advocated the development of a bomber capable of diving even before the war. He made every effort to substitute the commitment of small and minimum units, consisting of 1 to 3 bombers, for mass attacks. These individual aircraft were to destroy key elements of a facility, and thus paralyze the entire plant. The attempts made during the Battle of Britain are reminiscent of this concept."

[37] See also Table 6.

[38] Karlsruhe Collection.

"In addition, so-called nuisance raids were to be conducted by individual aircraft during daytime. Highly qualified crews were to take advantage of bad weather and attack British key industrial plants -- crankshaft and aluminum factories -- thus worsening existing bottlenecks in war production (From a contribution to the operational study Die Luftwaffenschlacht um England (The Air Battle for Britain), prepared by General Schmid.)"

"The best crews were assigned to these missions, which were executed after long and exacting preparations when skies were clowdy and the aircraft could approach through the clouds and dive from the clouds onto their target. Even though hits were scored on key parts of the target -- aerial photographs often confirmed the facts -- it so happened that the plants continued to operate without or with only a short interruption."

During the first phase of the Battle of Britain the Germans thus committed more than 1,000 individual aircraft without scoring a proportionate success. British post-war military historical works confirm this statement.

It was not until larger bombs procured during the war were used and these bombs were dropped by unit formations that the operations became effective.

Special Weapons to Paralyze the Supply of Electricity of a Country

Because of the effect produced by the disruption of the

flow of electric power on the war production of a number of countries, special weapons were developed after 1943 for this purpose and existing weapons were examined for their suitability for this type of operation. The weapons were to be used mainly for attacks on Russian electric power installations, but their employment against British plants was also under consideration.

To destroy high-tension wires, the Germans developed a special so-called wire-bomb. After it was dropped at low altitude, the bomb unleashed a long steel rope that crossed the high-tension wires and burned them out. Lateral tension caused by the absence of wire connections then led to the fall of the high-tension poles. On 13 January 1944 the Commander-in-Chief of the Luftwaffe stated in a letter that "The wire-bomb had been tested as to its effectiveness and had proved a complete success." [39]

So-called water balloons were developed as means of attacking electric power plants generated by water. This was the code designation for the aerial mine B.M.1000, a special type of [illegible] The bomb was divided into two parts, one of which only was filled with explosives. It was dropped by parachute, like the ordinary B.M.1000. Because of its peculiar center of gravity, situated deep down and to one side, and because it carried 2 to 6.6 lbs of ballast, the bomb deviated from the vertical onto a nose, penetrating only very little into the ground. When this bomb fell into the water rushing into the hydro-electric plant,

[39] Karlsruhe Collection, C V, 3a.

it was carried toward the grating of an operating turbine by a current flowing at more than 63 feet per second. The bomb easily skipped over minor obstacles in the riverbed. When the bomb finally exploded at the grating of the turbine, the pressure wave spread through the entrance channel and destroyed the housing of the turbine. The turbine proper, if it was in operation, was destroyed by itself.

Another mine, capable of penetrating layers of ice up to 20 inches in thickness and of exploding subsequently, was developed for the winter. To prevent the mine from exploding upon hitting the ice, the weapon was equipped with a parachute break. To distinguish it from the other bomb it was designated the "winter balloon."

Although they were initially developed for use against hydro-electric plants, these bombs were never employed for this purpose, insofar as is known.

In April 1945 altogether 12 Junkers 290 aircraft were earmarked for an attack on Russian hydro-electric plants (Operation GISELA). Allied low-level attacks on north-German airfields resulted in the destruction of six of these planes. On 14 April 1945 the Luftwaffe Chief of Staff therefore ordered that the preparations for Operation GISELA be discontinued, since -- probably because of the over-all situation -- it could no longer produce any tangible effects.[40]

[40] Extracted from the war diary of the Luftwaffe High Command, 1945. Karlsruhe Collection.

Special Means for Destroying Other Electric Power Plants

The composite (Mistel) aircraft were to be used for this purpose. These planes had originally been developed for commitment against large battleships (See preceding subsection 3). In spring 1944 tests were made at a point on the chalk cliff of the island Moen, which was then in German hands.

According to the war diary of the Luftwaffe High Command, 130 Mistel aircraft were under construction on 2 February 1945, to be completed shortly. Reich Marshal Goering disapproved Reich Minister Speer's plan to produce 100 additional Mistel's because he wanted to keep the production capacity for other purposes.[41]

Because of the unfavorable developments in the over-all situation, this weapon also was never put to use. East Prussia, which was needed as jump-off basis, had fallen into Russian hands.

Attacks on Sources of Nutrition

Luftwaffe experts repeatedly examined the question to what degree it would be possible to destroy grain crops before they could be harvested. The air warfare directive -- L.Dv.16 -- states on this subject in paragraph 156 as follows:

'One might consider how parts of the harvest could be destroyed before the crops are brought in, especially in dry years and under otherwise favorable conditions."

[41] Karlsruhe Collection C IV, 2a ?? or d ??

No acceptable solution was found for this problem. Russian attempts to destroy the crops before the harvest, which were made in the German-occupied grain region of the Ukraine, were unsuccessful. The Russians used small incendiary disks.

6. Weapons for Attacking Government and Administrative Buildings in Major Cities and for the Purpose of Retribution [42]

The same weapons that were employed against fixed targets, such as industrial plants, etc., were also used for attacking individual targets within cities.

After the British had started openly to launch terror attacks on German cities as early as 1940, retaliation attacks by the Germans became more and more important. Since the Germans were trying to destroy as large areas as possible in carrying out these attacks, fires and their effects were of decisive importance, which in turn necessitated the development of new offensive weapons.

In the fall of 1940 a so-called major-charge bomb containing 70 percent explosives was developed; it was a blast bomb that had maximum effectiveness and surface coverage, and could be aimed with great precision. [43]

Incendiary Bombs

In additiona to the already available incendiaries, some new incendiary bombs were developed during the course of the war.

[42] See also Table 7.

[43] Appendix XI.

To achieve the proper proportion of incendiary and high explosive bombs to be dropped presented certain difficulties. The experience of the British air attacks on German cities had demonstrated that a 1 : 1 ratio was best.

The Dropping of Aerial Mines on Cities

It was about August 1940 when Hitler authorized by teletype message from the Armed Forces High Command that mine bombs with the old-type fuses -- that is to say the L.M.9 (1,100-lbs) and the L.M.B. (2,200-lbs) -- be used for the impending major assault of London. One anticipated a particularly strong explosive and morale effect from the use of these weapons. Shortly afterward the L.M.B. "W" was added to these bombs; it was an aerial mine charged up to 70 percent with high explosives. However, the accuracy of these mines on ground targets was very small.

Preparations for the Use of Chemical Agents as Means of Retaliation

The air warfare operations regulation -- L.Dv.16 - states on the subject of retaliation attacks with chemical agents in paragraph 189 as follows:

"The degree to which chemical ammunition can be used, will depend on international agreements and their observance by the enemy during preceding terro attacks. Strong effects are to be expected only if the wind and weather conditions are favorable."

Before the war the Luftwaffe had about 250,000 empty K.C.250 containers in storage which could be filled with mustard gas at any moment's notice. Additional containers were ordered. During

the war approximately 15,000 phosgene bombs were manufactured as well as 50,000 tear-gas bombs filled with clarazetophenon and 10,000 K.C. 250's with concentrated mustard gas to contaminate terrain for a prolonged time. During 1942-43 large quantities of chemical bombs were filled with alkylfluorophosphonate. Also available were sprays that would have permitted the spraying of chemical agents from aircraft.

In contrast to World War I, no chemical agents were employed during the Second World War.

V-Weapons for Retaliation Attacks on London

The V-weapons that had meanwhile been developed were used for retaliation attacks on London. Their lack of accuracy did not matter too much for this purpose. In a Chief of Supply and Procurement conference that took place on 17 December 1943, Field Marshal Milch who was presiding stated as follows:[44]

"... eben if some of the missiles do not hit the London area proper, but are dispersed in all directions, suburbs, etc., which surround the city over an extensive area, just like in Berlin. Even hits scored in the vicinity at least cause extraordinary nuisance effects. Here we pursue the same ideas that are followed by the employment of our emergency bombers. The nuisance effect is surely insupportable even for troop units. I know that from discussing it with Rommel in Africa in detail. The percentage of hits was very small, but the constant dis-

[44] Kalrsruhe Collection C VI,6.

turbance throughout the night deprived the troops of their sleep and affected their nervous system. This is even more true of civilian populations. The question arises: should one sound the alert or not? The people are under continuous pressure. I do not want to insinuate that hitting the target is of secondary importance, but even without doing so one achieves a certain effect. The only argument against it, would be an excessive expenditure of aircraft, gasoline, and explosives. They must be related to the effect produced, with the expenditure resulting at least in a proportionate loss of morale..."

On 12 June 1944 the first attack on London with V-weapon V 1 took place.[45] The effect produced by these weapons can be gathered from an article entitled "V-Weapon Projects that Could No Longer Be Realized":[46]

"Altogether 1,050 such giant missiles landed on British soil. They were 57 feet long and carried 2,200 lbs of explosives. They approached at a speed that was four times that of sound, dropped from an altitude of 50 - 60 miles, and led to the failure of all air raid warning systems. On 27 March 1945 the last V-2 dropped at Springton (Kent). More than 200,000 buildings were destroyed by V-weapons, with an additional million building being damaged. The British population suffered 2,754 killed and 6,523 wounded -- all victims of the V-2."

[45] Appendix XII.

[46] Die Deutsche Soldatenzeitung, Thrusday, 23 July 1953.

CHAPTER III. LESSONS BASED ON EXPERIENCE

Section I. Technical Problems

Timely Realization of the Need to Develop New Weapons Or to Take Advantage of New Technical Developments

The Luftwaffe High Command did not always recognize in time the necessity of developing or taking advantage of new technical possibilities.

In this connection one might remember the belated development of weapons for combat above oceans, for attacking infantry in dispersed formation, or dug into the ground, and for assaults on armored vehicles.

Among the failures to realize the significance of new possibilities are primarily the V weapons, the guided missiles, and the Mistel aircraft.

With regard to the development of the V weapons, General Halder -- the former Chief of the Army General Staff -- wrote in his booklet Hitler als Feldherr (Hitler as a Great Captain), Dom Verlag, Munich, on pages 18 - 19:

"Just a few words referring to the so-called wonder weapons. Hitler was not their creator. They were created by German scientists working together with German technicians. How usefulness this cooperation was for military purposes was not realized by Hitler until late. Then, however, he put his

full energy and will power behind their development. At the same time he based boundless hopes on these weapons and ~~XHX~~ fooled the German people, including many military experts, with them."

"Rocket testing started way back in 1937, when rockets were first used to propel guided missiles. These tests were very quietly sponsored by Von Brauchitsch, who later was appointed field marshal. It was not until 1939 that Von Brauchitsch informed the then Chief of the Armed Forces, Hitler, of the advanced research and development achieved. Instead of the expected interest he encountered brusk disapproval. The dictator felt hurt that new things had been developed without his contribution. ~~He actually ordered all research and development to be stopped~~. It was not until Field Marshal von Brauchitsch had left that Hitler resumed the development of the new weapons, which were now advanced by all available means because they were "his." But two decisive years had been lost. When the "wonder weapons" were employed as V 1 and V 2, the heavy shadow of enemy air superiority loomed over their production and commitment."

The problem of the guided missile was significantly illustrated by a report,[1] which was submitted to Himmler on 15 August 1944, shortly before the end of the war (sic) by a group of engineers working for the Luftwaffe testing section. Himmler was at that time also commander of the territorial army in addition to being the ~~Reichsführer~~ of the SS. The report read as follows:

[1] Karlsruhe Collection C V, 3a.

"The tremendous significance of the guided missiles for the German conduct of operations has not been realized by the present leaders. The achievements -- 40 percent hits scored against enemy targets, even though the bulk of the crews had little practical experience and the successes were obtained under the most difficult operational conditions -- have not been recognized by those who matter. The Reichs Marshal's order to stop any further development and use of guided missiles immediately was executed by scrapping weapons that were even 80 percent complete. Aircraft that had been fully equipped to drop these weapons were changed over once more to terror attacks on London. The situation today is therefore that the troops who still are committed to operating the weapons do not even have practice equipment at their disposal."

It is a known fact that the development of the weapons was also delayed by 1 or 2 years because of a variety of circumstances.

After the Mistel (composite aircraft) had been developed, it took one and one-half years until the aircraft manufacturer Junkers was given a production order. It was not until 1943 that the first test were made with a Messerschmitt 109 attached to a Junkers 88.[2] The Air Force Ministry first ordered only the modest number of 15 Mistel aircraft.

[2] See Photograph, Appendix X.

Favorable and Unfavorable Factors in the Development of New Weapons

Politics naturally exerted a strong influence on this development. It was the political leadership's task to inform the Armed Forces with which country or coalition of countries potential military conflicts might occur. Special weapons might be required, depending on the structure, geographical position, military and economic potential, armed forces, and probable conduct of operations of the country or countries involved. The present study has already mentioned the effect produced when the German political leadership unexpectedly considered a war against Britain in 1938. It is furthermore necessary to realize that such a switch in the development of weapons for the armed forces requires several years.

World War II, in particular, has shown how quickly and unexpectedly political situations might change. In this connection one might remember the alliance between National-Socialist Germany and its ideologically greatest enemy -- Communist Russia -- in 1939, and the cancellation of this alliance in 1941 when Germany attacked Russia.

One might therefore pose the question whether the armed forces of a country in conjunction with the political leadership should not assume the mission of preparing for every possible contingency without consideration of the political situation. This would be done for all measures whose readjust-

ment would be time-consuming in case of a change in the situation. Obviously, this could be done only within the budgetary means available. As a rule, this action will be restricted to items whose development will require most time without producing finished weapons.

After all, it is the task of any responsible political leadership and armed forces always to be prepared for the worst.

~~The failure of the political leadership to correctly evaluate the political situation affected the development of new weapons very unfavorably~~.

Many political and military documents prove that the German political leadership considered the war as won in 1940 after the defeat of France. These men still believed the same thing during the first three months of the Russian campaign. For this reason they did not follow the old maxim "After the victory, fasten your helmet tighter!" but ordered another research and development stoppage on 11 September 1941. This caused a long delay in the completion of new weapons' developments, which later became essential. The production of the jet aircraft Messerschmitt 262, the V weapons, etc., was also greatly delayed.

Goering issued the first order to stop research and development on 9 November 1940, probably after receiving verbal instructions from Hitler. He should have prevented such a stoppage or, if he was not able to do so, he should at least have exempted certain weapons whose future potential was particularly great.

The savings achieved in the spheres of personnel and materiel by stopping the development of precisely these weapons was in no relationship to the damages that might thus be caused and eventually were caused.

~~Effect of the Top-Level Command's Concepts on the Pro-~~

bable Conduct of Warfare in a Future War

The example of Germany shows very clearly how the concepts held by the German command on the future conduct of air warfare, that is to say on the employment of weapons, exerted a decisive influence on subsequent research and development.

Thus Oberst (Col) Jeschonnek, the then Chief of the Luftwaffe General Staff, held the opinion before the war that, because the then available bomb sights made high-level accuracy very difficult, low-level attacks or diving attacks would be the offensive methods of any future war. This concept was opposed by the then Inspector of Bombing Aviation, whose opinions, however, were rejected since he was outranked.[3]

Obviously, these attack methods were extensively reflected in the development of bomb sights, in the manner in which bombs were suspended and the mechanisms devised for that purpose, in the types of bombs developed, and finally also in the fuses employed.

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[3] Appendix XIII.

During the course of the war it eventually turned out that at least the German bombers usually did not attack at low levels or out of diving flights. The effects of this change in offensive tactics can be gathered from a conversation between the Chief of Supply and Procurement, Field Marshal Milch, and General Marquard, the Chief Engineer, who was responsible for developing bombs. The conversation took place in 1942.[4] General Marquard stated that the 3,080-lbs bomb was not absolutely shockproof, i.e. that it occasionally burst open upon impact, regardless whether it was dropped out of a dive or horizontally.

When Field Marshal Milch objected that the entire bomb development program was faulty and that different types of bombs should be produced, Marquard replied that the General Staff had always refused to make any changes because both training and bomb sights would not permit successful horizontal bomb releases and the bombs therefore had to be dropped out of diving flights.

Field Marshal Milch then stated that, so long as only aircraft and bombs for diving flights were available, the crews had refused to dive on principle. Lately some of the crews who had been influenced by their unit commanders had begun to dive more frequently. A maximum of 20 percent of all multiseater bombers were diving. One should therefore develop bombs for both horizontal and diving attacks. The tacticians had hitherto had completely wrong ideas on this

[4] Karlsruhe Collection F V, 1 aa.

Many a time diving was th wrong procedure. Whereas a bomb dropped in horizontal flight (Milch probably meant from the same altitude) often penetrated the target, the same bomb dropped from a diving flight hit the target but its penetrating power was not sufficient to pierce it.

One may speculate whether a useful bomb sight for horizontal flights could not have been developed before the war, if all the effort devoted to making a multi-engine bomber relatively capable of dive bombing had been used for developing that type of equipment.

Major Hermann made the following report in a supply and procurement conference on 15 June 1943: [5]

"Since the bomb sights were not sufficiently accurate, one chose dive-bombing tactics before the war. Meanwhile, however, excellent scores were obtained in aimed horizontal flights with bombs dropped from high altitudes on point targets, as for instance along the Volchov. In attacking from high altitudes, one has to take into account a long time of fall. This can be done without difficulties if the target is fixed. If it is mobile, the XXXX time of fall must be held to a minimum to prevent the enemy from escaping. In attacks on moving targets the General Commanding bomber aviation has abandoned attenuated dives in favor of attacks from a 30° angle at full speed. The chances of hitting have thus been increased while the tactical danger involved is far less than in diving. Simultaneously, a saving of 70 percent in time and fuel during training is achieved.

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[5] Minutes of Supply and Procurement Conferences, Karlsruhe Collection C IV.

Moreover, it is intended that 90 percent of the bombing units attack horizontally and be equipped with bombsights without exception."

"The Heinkel 177 aircraft are to be employed primarily against naval targets in horizontal attacks from altitudes varying from 8,250 to 13,200 feet."

This wrong evaluation of the proper methods of employment was primarily to be attributed to the three following causes:

a. The Junkers 88, which was to become the standard bomber of the Luftwaffe, was actually tested by only a few specialists who were particularly gifted for diving flights. The aircraft was not tested by a flying unit with average pilots.

b. The effectiveness of the ground defenses was underestimated.

c. The effect of bombs in different types of targets was not sufficiently tested. One would otherwise have found out that individually dropped bombs of the 550-lbs caliber -- which initially could be used only by employing Junkers 88 -- were not really effective against a variety of targets. The Luftwaffe Operations Branch had repeatedly urged in 1936 and at the beginning of 1937 that the necessary large-scale tests be staged.[61] The evacuation of the civilian population from major areas so that they could be used as training areas would have made it possible to carry out such tests against different types of buildings, etc. Since this was not done, the great destructive power of bombs dropped ~~en masse~~ because of the cumulative pressure effect was not realized by the Luftwaffe Command.

[61] According to the author's recollection.

Section II. Timely Procurement as Basis for the Employment of the Proper Weapons

Another reason why the proper weapons could often not be employed was that they had not been procured in time.

This was no doubt one of the most difficult problems of the pre-war period of the war itself.

Procurement planning was based on the following procedure: The Luftwaffe Operations Staff (Operations Branch) established requirements that were based on the expected conduct of operations.

The Chief of Supply and Procurement (Branch IV, Replacements and Supply) calculated thereuppn the types and quantities of ammunition needed on the basis of the number of aircraft that were available and the different loading capacities of the various models as well as the different types of targets that were supposed to be attacked. (For more details, see the German service regulation L.Dv.g 90/2, classified SECRET (German) and entitled Die Versorgung der Luftwaffe im Kriege (Air Force Logistics in Wartime), (Supply Regulation), Part 2).

The requirement thus established was then passed on to the Procurement Branch of the Technical Office, Chief of Supply and Procurement. The necessary requisitions were then directed from this office to the industrial plants via the Armament and War Economics Office.

The scarcity of raw materials and the limited production

facilities available in Germany would not permit to establish sufficient basic reserves of all types of bombs and ammunition to satisfy every need and contingency and then to gradually adjust the production to actual needs. On the contrary, it was necessary to get along with small stocks and to properly calculate the actual needs.

Considerable difficulties might arise, if bombs suddenly were no longer produced in wartime, for instance because of safety reasons when a production deficiency suddenly developed, or if important plants were destroyed or the requirements were wrongly calculated, mainly because production priority changes were so complicated.

Even though the Luftwaffe actually never suffered a direct shortage of bombs, the most suitable bombs for specific targets were not always readily available. Expedients often had to be employed.

Since the production of bombs had not been geared to an extended war in time, such expedients had to be used soon after the start of hostilities. Thus, instead of the multiple-use 110-lbs bomb, a cement bomb with fragmentation filling had to be procured because it could be delivered without delay and in maximum quantities by the cement plants. During the campaign in the West in 1940 only a small number of these bombs were dropped over enemy territory. The remainder were later salvaged when sufficient multiple purpose bombs were being produced.

The percentage breakdown of the total quantity of different types of bombs

which had been established by the Luftwaffe Operations Staff very soon proved to be wrong. Since the bombers were essentially equipped for carrying 550-lbs bombs -- the reasons for this have been mentioned previously -- 80 percent of the total production of bombs was devoted to this type. As a result, other types of bombs, such as the 1,100-lbs S.D.500 and S.C.500, were not produced in sufficient quantities.

A real bottleneck developed in 1941 shortly after the outset of the Russian Campaign. During the rapid advance through western Russia in 1941 numerous march columns were easy targets during the first weeks of the campaign until the Russians learned to march by night in developed formation.

Despite the experiences of the French Campaign, the 110-lbs S.D.50 bomb, which was the most suitable weapon for this purpose was still not being produced in sufficient quantities. There were, however, large quantities of the very effective 22-lbs bombs available. As previously mentioned, these bombs could not be directly packed into the bomb bays but had to be put into special racks to be released. After extensive use these became bent -- they were not always handled with expert care -- so that it happened that these bombs with their very sensitive fuses got stuck in the release mechanism. When attempts were made to release them or if the aircraft landed with bombs that were wedged in, the bombs would often explode, destroying the aircraft and its crew. For this reason the 22-lbs bombs had to be discarded in this unique situation.

The S.C.250, which was available in sufficient quantities, was therefore being employed. Roads were difficult to hit even though cross-ways stick bombing was carried out. But if the bombs missed the roads, they usually penetrated the soft soil, whereupon they finally exploded. Instead of laterel fragmentation effects, the bomb produced diagonal ones, directed upward. During the first weeks of the Russian Campaign one could therefore observe large bomb craters near the roads, which had not resulted in any losses to the Russians. Great opportunities to inflict damage on the enemy -- opportunities that were not to recur -- were thus lost.

The production of small fragmentation bombs against enemy forces that were dispersed or dug into the ground also proved to be insufficient in comparison to the demand.

Because of the increased demand expedients had to be used in the bomb production field during the course of the war. General Marquard reports on this subject as follows:

"At this time increasing needs for supporting the Army in its struggle against superior enemy forces required the use of an expedient. Rejected ammunition, that is to say ammunition which could not be fired but could be dropped, such as 50- and 80-mm mortar as well as 88- and 105-mm artillery shells were equipped with bomb fuses and packed into drop containers to be used as 2.2-, 6.6-, 19.8-, and 33-lbs fragmentation bombs. This improvisation proved very effective both from a technical and military -economic viewpoint."

In another study Marquard deduced from this experience that in future planning the Army and Air Force should generally try to use similar weapons insofar as possible. [7]

Section III. The Possibility of Choosing the Proper Bombs for Attacks Was also a Supply Problem

A prepequisite for being able to employ the bombs that corresponded to the designated targets was that these bombs be available at the air bases or emergency fields of the bomb carrying units or that they could at least be moved up. The matter method was time-consuming and possible under certain circumstances only. Since decisions concerning types of targets were made at short notice, especially when the attacks were directed against mobile targets, the logistical support organization had to take these factors into account.

During periods of mobile warfare, such as advances, etc., the supply service therefore did not allocate individual types of ammunition but supplied the airfields of the bomber units with so-called bomb packages. These were established according to experience factors for each theater of war or part of same, and consisted of a certain number of various types of bombs, such as fragmentation, mine, and incendiary bombs, which were delivered in a fixed ratio. Obviously, units that conducted air warfare occasionally or entirely above oceans had bomb

[7] Extracted from General Marquard, Kurzer Ueberblick ueber die Bomberentwicklung (Short Survey of Bomb Research and Development), Karlsruhe Collection C V, 3a.

packages that differed from those that were composed for units assigned to support only ground forces.

During quiet periods, when stocks could be replenished, the basic load was reconstituted by requisitioning the proper types of caliber. Special bombs need for specific occasions could be moved up by airlift. Expedients were planned for special instances.

From among the many examples of situations, in which suitable bombs were available but not moved up to the point where they were required in time, one is chosen that occurred during the fighting in the Black Sea are on the Crimea in February 1943. It is described in General Plocher's ~~Krieg im Osten~~ (War in Russia) as follows:

"The complicating factor was that ..... the 3d Group of the 27th Bomber Wing frequently lacked bombs and fuses that were suitable for attacking ships. The same shortage of suitable bombs also handicapped the 3d Group of the 51st Bomber Wing, which had been once more subordinated to the headquarters after 9 February and which had been particularly trained for attacking naval vessels."

At the beginning of 1944, however, there were so many special bombs for attacking ships in the Crimea -- among them 2,200-lbs S.C. 1000 bombs with trichlorethylene fillers -- that these bombs had to be released for other

purposes, such as for operations against the troop billets in the city of Kertsch. This was done because their number exceeded by far the needs anticipated for the future and their removal was no longer feasible because the overland communications with the Crimean peninsula had been cut off. Nevertheless, a certain quantity of these bombs feel into Russian hands when the Crimea was evacuated because the bombs could not be blown up in time. The last German defense line passed directly by the ammunition dump. The Russians probably used the bombs during night attacks launched with former German aircraft turned over to the Romanian Air Force.

Section IV. Operational Problems

The Availability of Mass Destruction Weapons to Both Adversaries May Lead to Their Non-Employment

In World War II both sides were equipped with extremely effective poison gases.

Since it could be expected that the enemy would use the corresponding countermeasures if gases were employed, neither side wanted to take the first step. No use of this most destructive weapon was thus made.

The same was true of bacteriological warfare. In this case one was also afraid of impairing one's own armed forces. The epidemic of so-called Spanish influenca that broke out during World War I, causing many deaths, had shown that con-

tagious diseases are not arrested by the trenches separating the two front lines. On the contrary, they transcend such trenches in a multitude of ways.

Surprise -- an Essential Prerequisite of Success

The element of surprise is of decisive importance in employing new weapons. Even the development of new weapons must be kept a strict secret. An example of the disastrous consequences that arise when research and development as well as the locality where they take place cannot be kept secret, can be gathered from the effects of Allied air attacks on the German experimental station at Peenemuende in 1943, where the V-weapons were being developed.[8]

The following report shows that the lessons from that experience had obviously been learned:

An Example of Measures Taken to Maintain the Secrecy of Other New Weapons[9]

In spring 1944 a Mistel (composite) aircraft whose carrier plane was equipped with a hollow charge took off for a test flight. The attached Junkers 88 detached itself because of a mistake made by the operator and dropped on the island of Ruegen. It exploded, leaving a mushroom of smoke rising to an altitude of 2,500 feet. When one looked for remnants on

[8] See Winston S. Churchill, The Second World War -- Italy Capitulates, pp. 262 - 278. Karlsruhe Collection F IX (Employment of V-Weapons).

[9] According to the report, Feuer fiel vom Himmel (Fire Fell from Heaven) by Dr. Karl Bartz, Illustrierte Woche, No. 5, 29 January 1955, p. 121.

the island, the Junkers 88 was found to have simply ~~XXXX~~ disintegrated. An enormous crater proved its crash. In an effort to maintain the secrecy of this test flight, the burial of the "crew killed in the crash" was simulated.

"The Intended Effect Determines the Type of Operation and Ammunition"(Extracted from the Air Warfare Regulation, L.Dv.16, Paragraph 47).

The employment of weapons will depend on the over-all situation and probable future developments. During an advance of friendly troops one will not destroy bridges, if one might be able to capture them intact. The same is true of industrial facilities.

During the advance into Russia in the summer 1941, garrisons and camps at Smolensk were being attacked by the Luftwaffe. The officer reporting on Luftwaffe matters was greatly surprised when the general commanding an armored corps -- General Guderian -- suddenly interrupted with the exclamation: Do not destroy the quarters in which we might have to spend the winter." The author still remembers the surprised faces of the officers attending the conference. Only a few months later, events proved how right the general had been.

An example pertaining to the same topic has been extracted ~~from the following~~ report: [10]

[10] Extracted from a report of the Testing Agency Rechlin covering the period 1941 and concerning the destruction of Russian railroads by the dropping of bombs. Karlsruhe Collection.

"The damages inflicted by attacks on Russian railroad installations with nose-spiked 550-lbs S.C.250 or 1,100-lbs S.C.500 bombs were in some instances so great that repairs by German troops that moved in required considerable time and materiel, such as sand and rock bedding, ties, and rails. It was worth examining whether the Russian railroad facilities could not be put out of commission temporarily by the use of smaller caliber bombs so that the repairs of the damages would not be unnecessarily complicated."

New Weapons Employment Must Be Properly Timed, i.e. When Their Effect Would Be Decisive.

The top-level command had a tendency of using new weapons as fast as possible, even if they were not available in sufficient number or if the situation would not permit a decisive result. One of the outstanding examples occurred in World War I, when the Germans first used poison gas in 1916 in the Champagne battles. The first employment of gas on a small scale had a telling effect. In the sector that was under attack, no German reserves whatsoever were available to exploit the success. Subsequent attacks on a larger scale no longer achieved such a telling effect because countermeasures had meanwhile been taken (gas mask). By its premature test, Germany had deprived itself of a means to win a battle or even the war.

World War II also offers a number of examples in this field.

General Marquard, for instance, reports in his study ~~Leistungen und Schwaechen der in der 'Luftschlacht' um England' eingesetzten Bomben~~ deutschen (Performance and deficiencies of the bombs employed by the Germans in the Battle of Britain):

"L.M.A. and L.M.B. were 1,100- and 2,200-lbs ground mines with remote-control fuses that could be deposited by parachute at relatively low altitude outside enemy ports and along key ocean traffic routes. Until spring 1941 essentially only aerial mines with magnetic fuses were used, which exploded according to the setting of the contact counting mechanism either the first time a ship passed over them or one of the subsequent times."

"Because of the premature employment of aerial mines, these weapons were captured by the enemy already in November 1939 even though they were equipped with operational switches and removal locks -- items that were to prevent that the mine could be recovered and taken apart. As a result, the British had been able to take countermeasures to clear the mines when the large-scale bombing attacks began. The new acoustic and combined remote-control mine fuses were introduced too late to make the mine operations during the air battle for Britain more effective."

Operations and the System of Expedients

In his well-known book Vom Krieg (Of War) Clausewitz stated: "War is a system of expedients," a statement which is particularly

true in relation to the problem of selecting weapons. No organization, however good it might be, can avoid using expedients, if only temporarily.

Among the many examples that prove this point, only two will be given in the following:

During the attacks on Malta it was found that a large subterranean aircraft hangar was available at the northernmost airfield. Its approximate size could be gauged from measuring the dirt removed on the basis of area photographs (stereometrical photos) taken with a special Zeiss aeroscopic camera. It was established that the hangar was sufficiently large to receive a number of fighter aircraft. Unless this hangar and the fighter planes therein could be eliminated, the revival of the British fighter resistance on Malta was inevitable. To destroy this hangar by air, the Germans tested bombs against rocks in southern Italy, which were similar to the Maltese rock formations. The 2,200-lbs armor-piercing bomb with rocket propulsion was tested for its penetration power. These tests showed that the bomb penetrated 60 feet into the rock, whereupon only it detonated. This would be sufficient to penetrate into the hangar or at least to bring the rocks to cave in -- on the assumption that the ceiling of the hangar xxx consisted of covered rock and was not reinforced by manmade material.

During the dusk attack that opened the major offensive on Malta on an April day in 1942, a specially selected crew flew the mission against the hangar, equipped with an armor-piercing bomb. Since the hangar was underground and the ramp leading to

the hangar was on a steep incline, napalm incendiary bombs were also dropped against the hangar entrance in such a manner that the burning oil would flow into the hangar. During the following days the hangar was actually out of commission. Whether this was caused by the armor-piercing bomb or by the burning oil or by both has never been known (Tr: to the Germans).

Another example of the successful use of expedients occurred in 1943: [11]

"General Raus, the commanding general of an armored corps, had observed near Poltchani west of Kharkov that the enemy had massed a great number of tanks in the village and its outskirts. German antitank weapons ware scarce. If the enemy armor penetrated the German front, the lines near Kharkov would be ripped open from the west and all troops east of the city would be cut off."

"The VIII Air Corps, which supported the armored corps, could not be of any assistance because all its forces were fully employed. The air corps therefore contacted a bomber group located at Uman, which was not among its subordinate units. The group commander realized that special circumstances prevailed and carried out the mission. Since he had no suitable bombs at the airfield, he ordered the aircraft to outload aerial mines that were stored at the field. With these mines he swept the Russian armored attack that was just starting right off the ground. The pressure and explosive effects were

[11] From General Plocher's, Der Luftkrieg im Osten (Air Warfare in Russia), p. 186.

tremendous, even according to General Raus' description. The Russian tanks were blasted off their tracks, the infantry were destroyed."

So much for this report. This very valuable experience was unfortunately not transmitted to the other air corps committed in Russia. This might have offered a possibility to neutralize effectively future Russian armored attacks in the entire theater, instead of chasing individual tanks.

Section V. The Training Problem as Cause for Not Always Selecting the Proper Weapons

Even though the Luftwaffe attempted to draw the attention of the commanders in the field toward the proper selection of weapons and to inform them sufficiently by disseminating directives and memoranda and issuing instructions, it was a known fact that officers who were engaged in frontline operations had neither the time nor the inclination to study written or printed material.

The top-level command probably realized that its attempts were unsuccessful. This is shown by Goering's orders issued on 16 February 1941 -- attached as Appendix XIV -- in which he goes into great detail in explaining how to properly select the weapons to be used.

During a conference in Paris on 14 March 1941, [12] he told

[12] Conference Minutes in Kalrsruhe Collection.

the air corps commanders and other generals in the audience to move around constantly and transmit among other matters also "the knowledge of the effect produced by the weapons."[13]

In the author's opinion -- who spent almost five years of wartime service in a great variety of theaters -- it would have been more important and successful if the respective commanders had been called together from time to time to be oriented on new weapons in addition to all other matters.[14]

A basic mistake made by the Luftwaffe was to neglect the training of leadership personnel and top-level commanders during the war. This mistake contributed greatly to diminishing the successes and increasing the losses. Except for the training of a few general staff officers, higher training of officers of all ranks was practically non-existent during the war.

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[13] See also Appendix XV.

[14] Only for unit commanders up to and including group commanders were "~~Zuendertuschiete~~" (a certain type of map exercise) conducted as form of training. For this purpose the so-called Bomben-Knemeyer (Bomb Knemeyer) -- a disk-shaped chart established on the basis of the Knemeyer navigational aid -- was being used.