Report Number 114

HUMAN IMPACT OF TECHNOLOGICAL INNOVATION ON THE BATTLEFIELD

Final Report

Gay M. Hammerman
Brian Bader
Trevor N. Dupuy
Charles R. Smith

15 March 1985

Supported by

U. S. ARMY MEDICAL RESEARCH AND DEVELOPMENT COMMAND
Fort Detrick, Frederick, Maryland 21701

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T.N. Dupuy Associates, Inc. (TNDA)
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The study examines the psychological impact of new weapons on troops and commanders through case studies on eight weapons: lung-injurant gas, mustard gas, tanks, flamethrowers, aircraft as a weapon against ground troops, the proximity fuze, jet aircraft, and improved munitions technology (ICMs and the Beehive round). The study finds that in at least half of the cases studied there was panic among enemy troops when the weapon was first introduced

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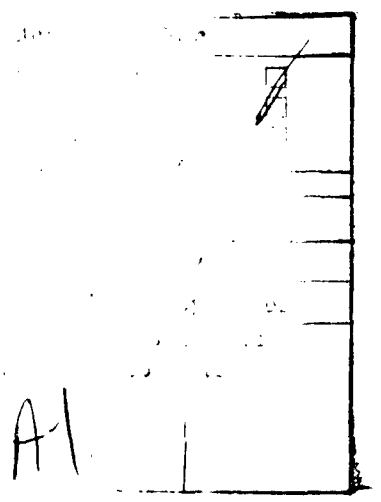
19. conventional munitions (ICMs), improved munitions technology (IMT).

20. and that there was panic in all cases in which it was immediately clear that a distinctly new weapon was being used, but that in most cases, whether or not there was initial panic, troops adapted quickly to the new weapon.



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Summary

The objective of the study was to learn as much as possible about the reactions of troops and commanders to new weapons when these were first introduced in combat, and about the longer-term adaptations to these weapons. A case-study methodology was employed. The following cases of new-weapon introduction were studied: lung-injurant gases, mustard gas, tanks, flamethrowers, air attack on ground troops, the proximity fuze, jet aircraft, and improved munitions technologies (IMT).

The study found that there was panic in at least half the cases studied when the new weapon was first introduced. In all cases in which there was unquestionably panic it was immediately clear to the attacked troops that a distinctly new weapon, never before experienced, had been used against them. Troops and commanders generally adapted quickly to the new weapon, improvising protective measures and/or tactics and weapons for attacking it within a few days to a few weeks.

It was concluded that a new weapon may have one or more of three separate characteristics that have an impact on attacked troops: newness, high lethality, and terror-evocation. Quickly giving troops authorized procedures to follow in dealing with the new weapon can help prevent future panic, and leadership, training, and esprit de corps also seem to play a significant role. Disfigurement of the wounded and killed by a weapon seems to be an especially horror-evoking characteristic of the weapon, and fire seems to be inherently frightening, apart from its lethality and apart from the novelty of the flamethrower when it was first introduced.

With regard to the impact of new weapons on troops using them, in most cases the using troops welcomed new weapons in the belief that they would reduce friendly casualties. In some cases there was apprehension about dangers the weapon posed to the users, and in two instances weapons were removed from use because of this danger. Some new weapons had a much more positive image with using troops than others, and this image seemed to be at least as closely associated with symbolic connotations of the weapons as with effectiveness and safety for the user. In the case of most new weapons, including those that were especially dangerous to the users, the specialist troops that employed the weapon developed a high esprit de corps.

Foreword

The special assistance given by the following persons in research for this study is gratefully acknowledged:

Mr. John Harding and Mr. Paul Beaven, Army Historical Branch, Ministry of Defence, London

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The authors wish to acknowledge the extraordinary competence and devotion of Miss Lucille Petterson, who conducted all tne research in German sources for this study. She located, examined, translated, and abstracted a massive amount of valuable material, always searching out and identifying what was significant with unerring professional judgment. The study has been greatly strengthened by her work.

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T.N. Dupuy
Gay Hammerman, Principal Investigator

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HUMAN IMPACT OF TECHNOLOGICAL INNOVATION ON THE BATTLEFIELD

REPORT

Objective of the Study

The objective of this study was to learn as much as possible about the reactions of troops and commanders to new weapons when these were first introduced in combat, and about the longer-term adaptations to these weapons. The reactions of troops and commanders using the weapons for the first time, as well as those being attacked by the weapons were to be examined.

Methodology

The case study approach was suggested by HERO as most appropriate for this study, and was mandated by terms of the contract. The study was carried out in three steps:

- o Selection of cases for study
- o Preparation of case studies
- o Analysis of case studies

Selection of Cases

HERO staff historians and other historians and military specialists were asked to suggest examples of introduction of weapons that were clearly different from others in use at the time, and from which information of value about troop reactions could be learned. A total of 18 possible cases for study was assembled. (Annex A)

Criteria were then established for selection of cases. A number of criteria were considered, including the inherent horror-evoking nature of the weapon, the achievement of surprise in the introduction of the weapon, and the introduction of the weapon in enough mass to have a significant tactical or strategic effect. However, it was decided that all these criteria would beg questions that the study should examine; for example, was the human impact of the weapon different when surprise was achieved? In the end, only three criteria were established:

- o Availability of adequate data. This criterion meant that cases were limited to those in which the sources were in English, French, German, or Russian, and preferably the first three languages. HERO sought cases with US sources to simplify research, but found that many of the new weapon introductions came in World War I, and before the United States entered that war. Soviet sources were generally inaccessible, or, for the period before World War II, largely destroyed. Records of the Vietnam War are generally not well

organized, and the interrogations of Viet Cong and North Vietnamese prisoners that would give information on human impact of new US weapons are not indexed or organized at all. Since accounts of the psychological reactions of troops -- beyond, at best, statements that unauthorized withdrawals took place -- appear only rarely in official records, it was necessary to search out personal first-hand accounts of experiences with, or observations of, the introduction of new weapons. The likely availability of this kind of data was a strong argument for including a case.

- Clear-cut newness of the weapon. It had to be a distinctively new weapon, employing a new principle, and not just a modification in degree of an existing weapon.

- The primarily military nature of the target. Since the purpose of the study was to determine how troops and commanders responded to introduction of new weapons, weapons whose chief first effect was on civilians were not included.

Although these were the only firm criteria, it was decided that an effort would be made to achieve some chronological spread in the cases selected, that is, to have several different wars represented, and to have some cases from recent wars.

In order to test which cases best met the criteria, preliminary research was carried out on the cases on the preliminary list. For 16 of the most promising cases, the results of this research were summarized on the first quarterly report to the sponsoring agency. On the basis of this research, the following cases were selected for case studies:

- Lung-injurant gases; focus on chlorine cloud attacks (World War I)
- "Mustard gas" (World War I)
- Tanks (World War I)
- Flamethrowers (World War I)
- Air attack on ground troops (World War I)
- Jet aircraft (World War II)
- Proximity fuze (World War II)
- Improved munition technologies (ICMs and Beehive rounds) (Vietnam War)

Although only four case studies had been projected in HERO's original proposal, and the contract required no specific number of studies, it was decided to pursue all eight of these studies, primarily to include cases from more recent wars. It will be noted hat the first five case studies are all from World War I.

This is due to the large number of distinctly new weapons introduced during that war, and to the large body of good secondary sources and well-organized records available in English, French, and German. It was clear that it was the World War I cases that could be done in greatest depth. It was thus judged to be especially important to include at least a few cases from later wars, and to explore them as fully as possible, given the time constraints and research problems involved.

Preparation of Case Studies

The first step in preparing the case studies was the development of an outline. (Annex B) With some adjustments, the outline proved adequate for all the case studies.

The cases were then researched, in these two phases:

- Background research to establish the facts of the case.
- Search for personal accounts or observations to discover psychological reactions of troops.

Extensive research was required for the first phase, especially to establish the facts and circumstances from the German and French points of view. However, the far more difficult area, and the key research problem for the study, was the location of the personal accounts. The following steps were taken to find personal accounts:

- The catalogs and stacks of the Army Library at the Pentagon, the Library of Congress, and the library of the Military History Institute at Carlisle Barracks, Carlisle, Pa., were searched, and research librarians at these institutions were consulted.
- The catalog of the Hoover Institution on War, Revolution and Peace was consulted, and assistance from the curator of the appropriate collections there was obtained by correspondence.
- A Senior Historian of the Canadian National Defence Headquarters Directorate of History was consulted. He provided copies of relevant documents and published memoirs, and made arrangements for HERO to employ a researcher to search the Canadian archives.
- The Army Historical Branch of the British Ministry of Defence was consulted. Its historians recommended the Imperial War Museum in London as the best source of personal accounts in the form of sound recordings (interviews) and memoirs, journals, and letters. These sources were consulted personally by the HERO principal investigator, and about 30 useful personal accounts of early experiences with lung-injurant gases, mustard, and tanks were found. Official records of actions involving first uses of these and other weapons were

consulted at the Public Record Office, Kew; published materials on early air attacks on ground troops were consulted at the RAF Museum, Colindale; and interviews were conducted with a veteran of the chlorine cloud attack of 24 May 1915 and with a World War I gas training officer.

- A senior HERO staff member examined both French published sources and official documents on the 22 April 1915 gas attack and on development and early use of the flamethrower at the French archives at the Fort de Vincennes, Paris.

- The bulk of the official German Imperial military archives containing World War I data, at Potsdam, was destroyed by Allied air bombardment in World War II. However, HERO's German-language researcher ascertained that the best general collection of existing German materials on World War I was in the Bibliothek fur Zeitgeschichte at Stuttgart, and consulted all available materials there that time allowed, focussing on unit histories and also finding a number of valuable studies that were not available in the United States. She also consulted and found useful material in the Wuerttemberg State Archives in Stuttgart and the Bavarian State Archives in Munich, both of which include the archival material for the Wuerttemberg and Bavarian units in World War I, since this material had not been stored at Potsdam.

Following completion of research, the eight case studies were prepared in accordance with the outline.

Analysis of the Case Studies

The case studies were then analyzed to find patterns, especially in the response of troops and commanders to the several weapons whose introduction had been examined. A matrix was prepared to aid in organizing characteristics of the several weapon introductions.

Analysis

The basic question of this study is, "How have troops responded to new weapons when they were first introduced on the battlefield?" The research team was especially interested in identifying signs of panic, fear out of proportion to the lethality of the weapon, anger, horror, or hopelessness in those attacked by the weapon, and in learning how the weapons and/or the emotional response to them affected the troops' military behavior. That is, did the attacked troops continue to perform their military tasks to the best of their physical ability or did they break and run, become inactive, or report themselves sick or wounded? Did troops using the weapon show apprehension, fear, or scruples of conscience about using it, or did they welcome the opportunity to use the new weapon?

The Artillery Shell as Base for Comparison

In judging apprehension, panic, fear, or horror in response to new weapons, some kind of baseline has first to be established, since all weapons of war elicit these emotions. High-intensity military combat is one of the most stressful of human experiences. One typical description of World War I combat -- even without gas or tanks -- is "Hell with the lid off." The metaphor of men mowed down like grain by machine guns as they advanced is often used, and there are descriptions of the dead lying in cone-shaped patterns before machine-gun emplacements, or horribly mutilated by high-explosive shell fragments. There were many instances of troops panicking and running in World War I before gas was introduced. It is in this context that reactions to new weapons must be examined.

It was the high-explosive artillery shell that caused the largest number of casualties and fatalities in World War I, and there is no doubt that artillery caused tremendous emotional stress to World War I troops.(1) Artillery shells also caused the largest number of casualties in World War II.(2) Thus the high-explosive artillery shell has been used in this study as the weapon to which new weapons are compared, as to casualty-causing capability, lethality, and evocation of emotional response. These comparisons cannot be quantified within the time and funds constraints of this study even for lethality, much less for degree of fear or other emotion evoked. The reasons for the difficulty in quantifying relative lethality are discussed in the case study on lung-injurant gas. However, such quantification can and should be carried out for both World Wars through future research designed and funded for this purpose. The data is adequate to permit preparation of a chart showing relative lethality, fear evocation, and panic(3) production of the weapons examined in this study that were used by ground troops against ground troops, with the high explosive artillery shell used as a base for comparison.

Variables to Consider

In order to identify responses to new weapons, and differences in responses among weapons, it is necessary to recognize and allow for a number of other variables present in the combat situation that may strongly affect the troops' reactions. For example, if troops are poorly trained and exhausted, the fact that they panic and run when a new weapon is introduced may not be significant; they might well have panicked under any attack. The following variables were kept in mind in examining the reactions of attacked troops:

- Variables related to troops
  - quality; discipline, training, leadership
  - condition; fresh or exhausted

- o Variables related to the weapon
  - extent of difference from weapons currently in use
  - horror-evoking characteristics
  - relative lethality
- o Variables related to circumstances
  - extent to which surprise was achieved
  - quantity or mass in which weapon was used

Definition of First Use

First use of a new weapon is here defined as the first instance in which the weapon was used in combat. Every effort has been made to find evidence of the psychological impact of the weapon on the occasion of first use, thus defined. However, in many cases, information about the weapon spread slowly, and troops who experienced it days, weeks, or even months later may have had little or no previous knowledge of it, so that their first experience with it approximated the psychological circumstances of first use. To provide as much relevant experience as possible, many examples of this kind of "delayed first use" are included in the case studies. The circumstances are always clearly set forth.

In the case of the tank, two separate "first uses" are discussed. Tanks were first used as individual weapons at the battle of Flers (Somme offensive) September 1916, and continued to be used, with limited effectiveness, during the following year. Then, on 20 November 1917, they were used in a mass attack, and the tactical and psychological effects were strikingly different. The tank used in mass and coordinated with infantry was, in effect, a new weapon system, different from the single tank.

The Cases Compared

The following matrix (Table 1) was prepared as an aid in finding patterns in the psychological impact of the new weapons that were examined.

To begin with column 1, surprise is here defined as a condition that exists in a military force when it is confronted, as a result of hostile action, with a situation or circumstances that are unexpected, and for which adequate provision has not been made. The surprise may be achieved through action at an unexpected time or place, or in unexpected numbers, weapons, or combat performance. Surprise often results in disruption, here defined as impaired combat effectiveness in a military force resulting from inhibition of the planned and/or anticipated operational capabilities of one or more of the component elements of the force. Principal manifestations of disruption are

*Table 1: Characteristics of Weapon Introductions

Weapon	(1) Surprise	(2) Panic	(3) Offense/Defense	(4) Anger	(5) Seemed invulnerable	(6)Casualties' appearance	(7) Clearly new weapon	(8) Users' attitude	(9)Danger to user	(10) User Unit esprit
Lung-injurant	yes	yes	offense	yes	yes	yes	yes	-	yes	no/yes
Mustard	yes	no	defense	?	yes	yes	no	+	yes	no
Tank	yes	yes	offense	yes	yes	no	yes	+	yes/no	yes
Flamethrower	yes	yes	offense	?	yes	yes	yes	?	yes	yes
Air Attack	?	?	offense	?	?	no	no(?)	?	yes	yes
Proximity Fuze	yes	?	defense	?	?	no	no	+	no	no
Jet Aircraft	yes	no	defense	?	yes	no	yes	+	yes	yes
IMT	yes	yes	defense	?	?	yes	yes	+	no	no

*See text of report, pp. 12-16, for explanation of column headings.

confusion, reduced communications capability, reduced leadership control, reduced movement capability, and panic.

Surprise was achieved to some extent in the introduction of almost all the new weapons studied. It is not certain whether the organized, large-scale air attacks on ground troops in the summer of 1917 can be said to have achieved surprise, since they are reported matter-of-factly by Allied officers in their war diaries, with no indication that something new had happened. It seems likely that the various prior individual instances of aircraft bombing or strafing ground troops had desensitized troops and commanders to the idea of attack from the air, so that there was no true surprise. In the case of jet aircraft, the weapons were introduced singly, so that once the first encounter had taken place Allied intelligence was able to alert Allied airmen, but despite this fact, many airmen did not get the word, or were surprised tactically by the jets, or were unprepared for the jets' appearance and performance.

Panic in the individual may be defined as extreme and uncontrolled fear that can result in irrational, counterproductive, and/or militarily deviant behavior. As stated earlier, panic in a military force is here defined as sudden, widespread, unauthorized withdrawal or surrender. In this case, of course, an emotional state is being defined in terms of its behavioral manifestation, and this seems reasonable, since it is usually impossible to learn the feelings of large groups of people, and in view of the fact that in a military context, behavior is what counts.

It will be noted (column 2) that there was evidence of panic, in either individuals or groups, in the case of most of the weapons studied. In the case of mustard, even though surprise was achieved in the introduction of the weapon, the weapon's inherent characteristics made panic unlikely. Its effects were very mild at first, with their full force not being experienced for hours. Many of the men exposed to the weapon wore varying degrees of protection, so that some were affected more than others. There was never any moment when a large number of troops suddenly realized that a new weapon was being used.

Not enough information is available on air attacks on ground troops or the proximity fuze to state whether or not there was panic. In the case of jet aircraft, only individual, not group, panic was possible because of the nature of air-to-air combat. In individuals, although there was fear, there was no behavior suggesting panic. This may be largely attributed to the selectivity and training involved in the formation of military pilots, who must be conditioned not to react with strong emotion to any combat situation. In practice, Allied fighter pilots reacted primarily with curiosity and took the superior performance of the jets as a challenge to their skill. Bomber crewmen experienced more fear and were more impressed with the maneuverability of the weapon.

It will be noted, in column 3, that half the weapons studied were first used in offensive actions while the other half were first used in a defensive posture.

Columns 4-7 deal with reactions of attacked troops. In two cases specific evidence was found that some troops reacted with anger. Anger was not found in the same troops at the same time as was panic. Anger seemed to make troops more determined to perform effectively. No evidence on anger, one way or the other, was found in most cases.

Most of the new weapons studied appeared invulnerable -- or irresistible -- to the troops attacked by them when they were first introduced. Attacked troops experienced a feeling of helplessness, believing there was nothing they could do to fight back against the weapon. In several cases they took counterproductive measures, as when troops buried their faces in soil in an effort to escape gas or left their trenches in an effort to escape flamethrowers. All these weapons were in fact vulnerable to countermeasures, and protective measures could be devised against all; within days to months countermeasures or protective expedients had been developed, often by the troops themseves. The studies on lung-injurant gas, tanks, flamethrowers, and jet aircraft, especially, contain many examples of effective improvisation and adaptation by those subjected to attack.

Probably the characteristic of the new weapons studied that evoked most horror was the appearance of the men the weapons had killed or injured. Although high-explosive shell casualties might well be as horror-evoking to a civilian, men in combat became familiar with this kind of casualty, while the sight of gassed men, for example, was clearly disturbing. This was probably also true for men charred by fire, and the appearance of men killed by the Beehive round in Vietnam, which was stunning to American troops, was probably also especially psychologically stressful to North Vietnamese troops. Three of the four cases in which there was panic were also cases in which the appearance of casualties was horror-evoking.

In all four of the cases in which there was clearly panic among attacked troops, the weapon was not only a distinctly new weapon -- it also clearly appeared to be a new weapon, never before experienced, to the troops being attacked by it.

Attitudes of users of new weapons are reflected in columns 8-10. As indicated by column 8, users' attitudes toward the new weapon were generally positive (indicated by +). Only in the case of lung-injurant gas were users judged to have a predominantly negative attitude, an attitude which probably reflects the danger it posed to the user and which may also reflect a distaste for a weapon that was considered unfair, although there is little evidence on this latter point. In general, troops using or attacking along with a new weapon were delighted to have something that they believed would be effective against the enemy. There are very few recorded instances of moral scruples or re-

morse about using a new weapon. One pilot carrying out an early attack on ground troops expressed regret about the horses he killed and injured, but reacted to the men in the trenches he was strafing only as dangerous enemies, to whom he felt especially vulnerable.

Most of the new weapons were dangerous to the user. Tanks were not so inherently, but when used at Flers with a column of infantry accompanying each tank, the tank did attract enemy fire to the infantry. Danger to the user does not usually seem to be associated with a negative attitude toward the weapon on the part of the user, although in the case of lung-injurant gas it was certainly a significant factor in the negative reaction. Mustard had to be handled and fired with great care to avoid friendly injuries, but its success in silencing enemy artillery batteries made it welcomed by the troops.

The user unit esprit shown in column 10 refers not to the occasion of first use but to the adaptation period. In a number of cases, new weapons were handled and fired by a specialist corps of troops, often highly trained in skills required by the weapon. In all these cases, evidence was found of high esprit de corps and pride in service. The "no/yes" for lung-injurant gas means that while infantry attacking behind gas were not enthusiastic about the gas, the special engineer troops who handled the gas did have good esprit. The "yes" for air attacks reflects the fact that the World War I airmen had a very high esprit de corps. However, the research team for this study found, on the basis of very limited evidence, that attacks on ground troops were felt to be a distasteful assignment without the prestige and satisfaction that air-to-air combat carried.

The weapons in which there was not any especially high user esprit were munitions that were fired by artillery, more or less like any other round.

It is of some interest that all the new weapons that required special skills were, within a matter of months, the responsibility of specialist troops with a high esprit de corps, despite the fact that most of them were more dangerous to the user than were other weapons in use at the time. In some cases, as the case studies show, the danger of the weapon to its user seems to have heightened user esprit.

Assessment of Weapon Effects

In addition to the analysis of the experience of troops and commanders to the introduction of these new weapons, it was believed desirable to undertake an assessment of the implications of the weapons and their results from a historical perspective. This assessment considers the following questions:

- Did the weapons achieve the results expected?

- Were the actual results the optimum results under the existing circumstances?

- Was the weapon inherently effective by reason of high lethality and/or terror evocation, or was it only temporarily effective by reason of novelty?

- Was the weapon revolutionary or evolutionary in battlefield effects?

Expected Results

More than half of the weapons achieved more-or-less the expected results when they were introduced. In some instances this was due mainly to the lack of preparation of the troops against whom the weapons were employed; in others it was due to the inherent effectiveness of the weapon; in most instances of first use it was a combination of both. Only the tank, the flamethrower, and the jet aircraft can be considered not to have come close to achieving what had been anticipated by the designers and/or users of the weapons. (Table 2).

Optimum Results

In half of the examples studied -- four out of the five noted above in which the initial results could be assessed as "good" -- the user of the hitherto untried weapon achieved as much of an advantage from its employment as he had any right to expect. The one significant exception was the first employment of lung-injurant gas, when the Germans had not had enough confidence in such good results as to be ready to exploit initial success.

It is significant, however, that of the four of these weapons that could be considered as "revolutionary" in their effect upon warfare (see below) in only one case did the initial use come close to demonstrating the potentiality of the weapon. That one exception was the employment of aircraft against ground troops.

Inherent Effectiveness

It can be seen from the discussions that there were three principal reasons for the initial effectiveness of the weapons considered in this study. Some of the weapons were effective

Table 2: Assessment of New Weapon Results

Weapon	Expected Results	Optimum Results	Inherent Effectiveness	Revolutionary / Evolutionary
Lung injurant gas	yes	no	no	Rev
Mustard	yes	yes	no	Ev
Tank	no	no	yes	Rev
Flamethrower	yes	no	yes	Ev
Air attack on ground troops	yes	yes	yes	Rev
Proximity fuze	yes	yes	no	Ev
Jet aircraft	no	no	no	Rev
IMT	yes	yes	yes	Ev

largely because of their novelty, and because of a lack of preparedness for their effects on the part of those against whom the weapons were used. Some of the weapons had increased inherent lethality. Some had inherently terrifying characteristics, such as fire, seeming invulnerability, or attack from above. These inherently more lethal and inherently terrifying weapons may be said to be inherently effective. Against them there could be no preparation but training (to avoid surprise due to novelty), discipline, and strong leadership. Four of the weapons fitted into this category: the tank, the flamethrower, the ground-attack aircraft, and the ICM. It will be noted below that three of these (not including the flamethrower) were weapons which were intrinsically revolutionary in their battlefield effects.

Revolutionary or Evolutionary

For the purposes of this assessment, a weapon can be considered to have been revolutionary if it had a significant effect upon the nature of the battlefield, or upon the tactics employed on the battlefield. Four of the weapons considered in this study can be considered to have been revolutionary in their ultimate effects, even if they failed to achieve their full potential in early use. These were lung-injurant gas, the tank, the ground-attack aircraft, and the jet aircraft. All of these were destined to change substantially the way in which wars were fought.

Evolutionary weapons, then, are those that provide an enhancement in effectiveness (usually in terms of lethality), but not in such a way as to require a complete or substantial change in tactics or doctrine. Among our eight examples, then, the following can be considered to have been evolutionary: mustard gas, the flamethrower, the proximity fuze, and the ICM. The reasons why the flamethrower has not (after two world wars) had a greater effect on the battlefield, despite its inherent lethality and terrifying effects, are mainly three: relatively short range; cumbersome, clumsy nature; and vulnerability of the user.

Conclusions

The following tentative patterns emerge from an analysis of the case studies:

With Regard to Attacked Troops

- There was panic among attacked troops in at least half the cases. Only in the case of mustard, in which the weapon's effects are delayed, and of jet aircraft, in which most of the attacked troops were combat pilots (a group selected and trained not to experience strong emotional reactions in combat), is it clear that there was no panic.

- In all cases in which there was unquestionable panic, it was clear to the attacked troops that the weapon was distinctly new (never experienced before).

- A newly introduced weapon may have one of more of three separate characteristics that have an impact on attacked troops: newness, high lethality, and terror-evocation.

- Within a relatively short time, which has not been established in all cases but which could be as brief as a few days to a month, troops and commanders had adapted well to the new weapon, improvising protection against it and/or tactics and weapons for attacking it.

- Newness alone can result in extreme stress and panic associated with the absence of an authorized coping procedure. Quickly establishing a set of rules to follow seems to prevent future panic.

- Disfigurement of the wounded and killed by a weapon seems to be an especially horror-evoking characteristic of the weapon to other troops.

- Fire appears to be inherently frightening. The flamethrower is the only weapon of World War I, including gas, that seems to have been more fear-inducing, even long after its initial introduction, than the high-explosive artillery shell.

- There is some evidence to suggest that leadership, training, and esprit de corps had a significant positive impact on the speed with which troops adapted to new weapons. However, good training and leadership -- at least by reputation -- did not keep the 45th Algerian Division from panicking on the occasion of first use of a new weapon.

With Regard to User Troops

- In most cases, troops using new weapons welcomed them, believing they would reduce friendly casualties. Almost no moral compunctions are evidenced about effects of new weapons on the enemy.

- There was apprehension in some cases about danger of the weapon to the user, and this perceived danger did lead to the abandonment of new weapons in two cases (cloud gas attacks by the Germans and flamethrowers by the British in World War I).

- Some weapons had a much more positive image with troops using them than others, and the image seemed to be at least as closely associated with symbolic connotations of the weapons as with effectiveness and safety for the users. The most striking example is the very positive image of the tank in contrast to the apprehension and lack of enthusiasm user troops often felt for gas.

- In the case of most new weapons, including those that were especially dangerous to the users, the specialist troops that employed the weapon developed a high esprit de corps. This esprit was a separate phenomenon from the hightened morale user troops generally experienced when a new weapon was introduced.

Notes to Report

1. Dorothy Clark estimates that artillery shells caused 56.6 percent of wounds in World War I (Effectiveness of Chemical Weapons in World War I, p. 101). Denis Winter, who read over a hundred memoirs for his book Death's Men, says, "According to almost every memoir of the Great War, shelling was the greatest inducer of fear." (p. 117).

2. Beebe and De Bakey, Battle Casualties, charts, pp. 129, 131.

3. Panic is here defined as sudden, unauthorized, widespread withdrawal of troops.

ANNEX A

Preliminary List of Possible Case Studies

- gas (chlorine)
- gas (phosgene)
- mustard
- tanks
- jet aircraft
- proximity fuzes
- Katyusha (multiple rocket launcher)
- T-34 tank
- machine gun
- machine gun with barbed wire
- flamethrowers
- carpet bombing
- ICM ammunition (multiple submunitions)
- PGMs (smart bombs)
- FAEs (fuel air explosives)
- air attacks on troops
- napalm
- trichothecene toxin

ANNEX B

Draft Outline for Case Studies

A. Introduction. Reasons for selecting this case study for analysis

B. The Weapon

1. Description and purpose:

   a. Brief technical description; physical, chemical, and/or mechanical nature of the weapon
   b. How the weapon appeared to the attacker (user)
   c. How the weapon appeared to the defender
   d. Means of delivery (for munitions)
   e. Military purpose for which the weapon was designed

2. How the weapon differed from other weapons already in use at the time it was introduced

   a. Lethality
   b. Suppression- and disruption-causing capability
   c. Painfulness
   d. Disfiguring effects
   e. Seeming invulnerability to defensive efforts
   f. Noise
   g. Other fear- or horror-inducing characteristics
   h. Real or seeming violation of international agreements or moral codes.

C. Circumstances of first use

1. Brief account of first use: war, date, place, user of weapon, force against which the weapon was used
2. Specific strategic/tactical purpose of this use of the weapon
3. Specific objectives of user (Map)
4. Specific attacking and defending units
5. User's preparations for employing the weapon
6. Did the user have adequate reserves for exploiting a possible breakthrough, and plans to use them?
7. Did the user achieve surprise in introducing the weapon?
8. Did the defender have protective devices or means of defense?
9. Did the defender have similar weapons for retaliation?
10. Environmental factors affecting the effectiveness of the weapon

D. Defenders' Response

1. Initial response of troops.
2. Initial response of commanders.
3. Casualties.
4. Did troops' and commanders' responses indicate panic, or fear out of proportion to the casualty-causing effect of the weapon?
5. What was the reaction of nearby units that did not actually experience the attack?
6. What was the initial tactical effect of the attack?
7. How much time elapsed before the military situation was stabilized?

E. Attackers' Response

1. Attitude of attacking troops toward weapon before using it.
2. Attacking troops' initial response to appearance of weapon in use, and to effect on defending troops
3. Were attacking commanders aware of the extent of tactical success that resulted from weapon use?
4. To what extent was the success exploited?
5. Were the predetermined tactical objectives of the attack achieved?

F. Adaptation

1. How much time elapsed before second use of the weapon by the original user; what differences were there in this employment of the weapon as compared with the first use?
2. How soon did the original defender provide troops with protective devices, means of defense, and/or training in defending against the weapon?
3. How soon did the original defender acquire and use the weapon?
4. Were later uses of the weapon more or less tactically successful than the first use?
5. What changes in doctrine and tactics were made by both sides to assimilate the new weapon?
6. How much time elapsed before the weapon was assimilated into doctrine and tactics, and was regarded as a weapon like other weapons, rather than as a new weapon, different from other weapons?
7. Did an attitude of fear or horror remain with the troops after the weapon appeared to be tactically assimilated? What evidence is there that this was true?

G. Summary of the impact of first use of weapon on troops involve

Lung-Injurant Gas

Introduction

Lethal lung-injurant gas was first used in warfare by German troops against French troops near Ypres, Belgium, on 22 April 1915. The introduction of gas was selected for a case study because it is one of the most clear-cut instances discovered of the first use of a distinctively new weapon; because the weapon's first use can be pinned down to a specific day and time; and because a considerable body of data, both secondary sources and first-hand accounts, could be located for the first month of the weapon's use.(1)

This case study focuses on the gas chlorine, which was the only gas used during the first eight months of gas warfare on the Western Front, and which was delivered exclusively by release in cloud form from charged metal cylinders during this period. The case study deals only with use of gas on the Western Front, because of the much greater availability of data for this front, although lethal gas was also used on the Eastern and Italian Fronts. Thus, most of this case study deals with chlorine cloud attacks on the Western Front. In the section of the case study on adaptation, the introduction of other lung-injurant gases, beginning with phosgene in December 1915, and of lethal lung-injurant gas shells in the summer of 1916, will be discussed, along with the development of specialized tactics for gas. The persistent chemical agent known as mustard gas is treated in a separate case study.

The Weapon

Description

Chlorine, a chemical element, is a greenish-yellow gas at usual environmental temperatures and pressures. It has a strong, distinctive odor. It boils at -33.6 degrees C. at standard pressure, and is liquefied at 6 to 8 atmospheres of pressure at usual environmental temperatures. Because it is quite dense (two and one-half times as dense as air), it tends to stay close to the ground, rising quickly only if it is moved upward by a strong air current. It is not persistent; that is, it disperses fairly quickly, so that troops using the gas against an enemy could follow up the attack within minutes rather than hours or days.

Chlorine is a highly reactive element, and thus readily combines with molecules of human protoplasm in a number of ways, causing irritation, edema, and destruction of tissue. Its victims experience severe pain to the eyes, nasal passages, larynx, and lungs; coughing and vomiting; and, in cases of strong concentration, death from asphyxiation. Concentrations of 3.6 parts per million parts of air irritate the respiratory tract, and a concentration of 35 to 40 parts per million is the strongest an unprotected person can tolerate for 60 seconds.(2) Because chlorine is highly reactive, it can be readily

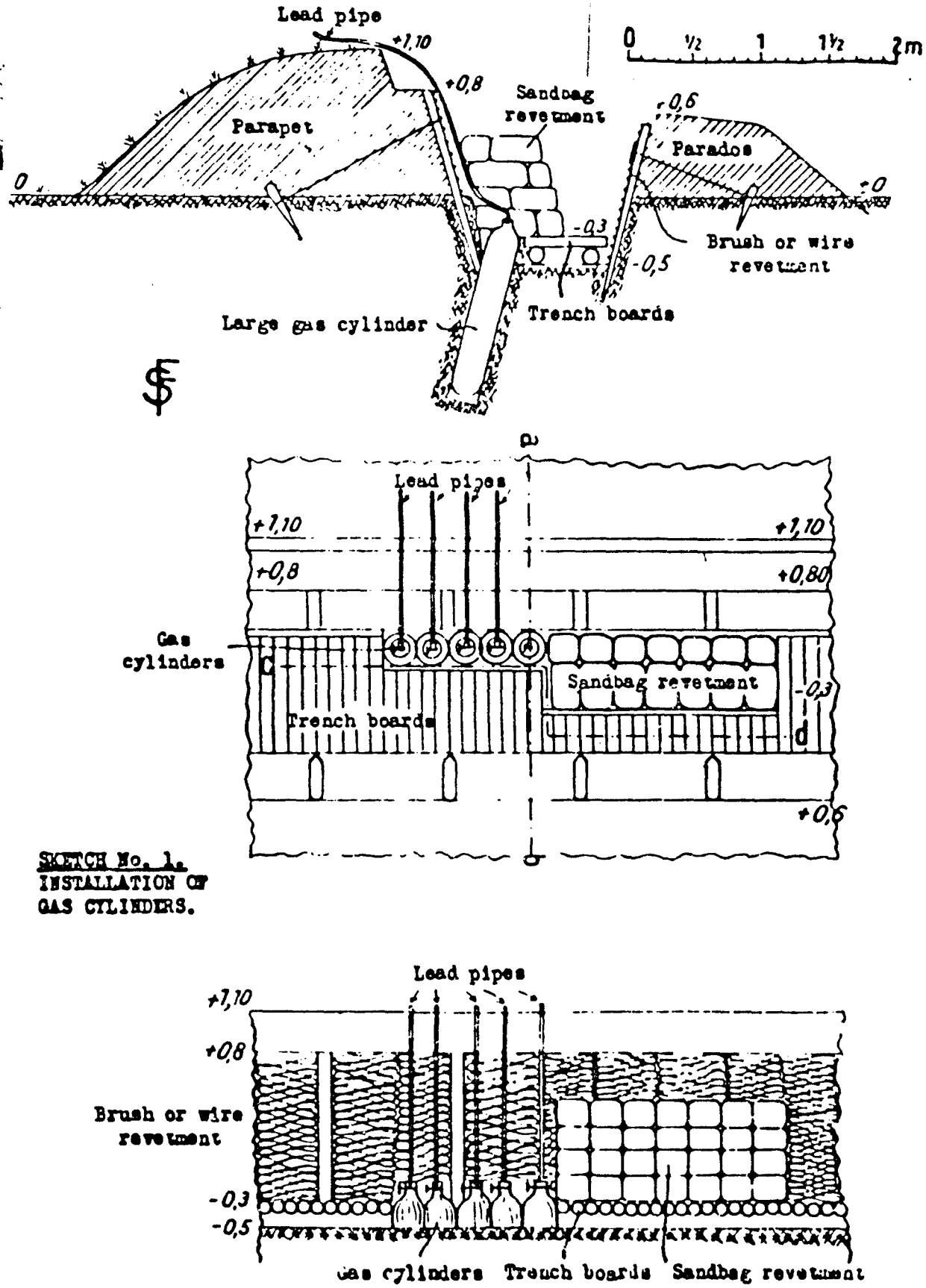
neutralized, and this was important in devising defensive measures. For example, neutralizing chemicals could be placed in gas-mask filters, rendering the chlorine harmless.

Under pressure, in liquid form, chlorine does not react with steel, and could therefore be stored and transported to the front in steel cylinders (which the Germans, as an additional precaution, lined with lead), and released from these cylinders by opening stopcocks at the time of the attack. The gas was delivered to its target by the wind. Thus gas attacks were extremely dependent upon favorable weather. The Germans considered a steady wind blowing toward the enemy at 1.5 to 3 meters per second (3.24 to 6.48 miles per hour) to be most desirable. Wind that was too strong would tend to disperse the gas or blow it past the enemy troops before it could be effective, while a slow or uncertain wind would endanger the attacking troops.(3)

Appearance of Gas to Attackers and Defenders

Before the first attack, what the attacking troops in the front trenches would have seen of the weapon was the cylinders, which were emplaced as shown in the diagram (Figure 1). Once they were installed -- 1,000 of them to each kilometer of front -- they were invisible. (The lead pipes that appear in the diagram were screwed on immediately before an attack.) At the time of the 22 April attack, many of the attacking troops would have heard the characteristic whistle, or hiss, of the chlorine as it was released from the cylinders and assumed gaseous form. They saw the chlorine move toward the French lines as a wall of white-yellow clouds, carried by the wind, on that day, at 2 meters a second (or about 4.3 miles per hour).(4)

Some of the defending French troops must have heard the hiss of the escaping gas on 22 April, but there is no record of this. The appearance of the gas as it approached was described by an officer on the scene as "immense columns of yellowish smoke."(5) Another source describes it as a "reddish" smoke,(6) while the official French history calls it a "yellow-green cloud" that "rolled" toward the French trenches.(7) A Canadian observer saw two clouds of yellowish-green smoke which spread rapidly laterally until they formed one cloud.(8) Once the cloud arrived, the physiological impact was overwhelming. The men must have been aware of the distinctive chlorine smell; survivors of early attacks experienced panic symptoms when getting a whiff of it later.(9) These survivors found it hard to describe the sensations, partly because the gas invaded in so many ways, searing the eyes, throat and lungs, choking off breathing, and also causing severe nausea and vomiting.(10) The men who got the full impact of the attack must have immediately experienced searing pain in the throat and lungs and inability to breathe.



SKETCH No. 1.
INSTALLATION OF GAS CYLINDERS.

Figure 1:
Installation of Gas Cylinders

Source: Hanslian, Chemical Warfare, p. 3

Military Purpose

By early 1915, World War I on the Western Front had settled into a stalemate between two well-dug-in opponents who faced each other in unbroken parallel trench lines from neutral Switzerland to the North Sea. There was no way either side could outflank the other, and every attempt to achieve a breakthrough by concentrating artillery and troops at one point had failed. The preparatory high-explosive bombardments of 1914 and 1915 had proved to have only limited effect against defenders in well-prepared trenches, and had even been counterproductive by forcing the attacking troops to struggle across terrain that had been severely cratered by the shells of their own artillery. The German high command hoped that gas would effectively soften enemy resistance and make possible the long-sought breakthrough.

How the Weapon Differed from Others Already in Use

The relative lethality of the weapon is the first characteristic to be considered, and several points must be made in assessing the lethality of gas in World War I, and of chlorine cloud gas in particular:

o A few minutes' exposure to chlorine gas in the concentrations the Germans intended to deliver to the Allied trenches in spring 1915 would be absolutely lethal.

o A direct hit from a high-explosive artillery shell -- the weapon causing the largest percentage of casualties in World War I -- would also be lethal.

o Cloud gas affects every person (who does not have respiratory protection devices) within the area it strikes. There is no possibility of taking cover from it or experiencing a near miss.

o Nevertheless, presumably because of variations in the wind and of individual susceptibility, far from every man in the front trenches that were attacked on 22 April 1915 became a fatality or a casualty.

o There are no reasonably reliable figures for casualties and deaths from gas in the first day or the first month of gas cloud attacks. Estimates for the first day vary wildly, from the early and often-cited estimates of 5,000 killed and 15,000 total casualties to German reports that of 200 seriously gassed French soldiers who were captured only 12 died, and French figures indicating comparable ratios. Groehler cites the Stockholm Peace Research Institute (SPRI) as estimating 3,000 deaths and 7,000 wounded.(11) A French brigade commander whose troops were among those taking the brunt of the attack estimated that his three front-line battalions suffered about 60 percent casualties, not breaking them down into killed and wounded, or gas casualties and gunshot casualties.(12) T.N. Dupuy, of HERO, has estimated, on the basis of French records, that there were 4,500-5,500 total

French casualties from all causes between 1700 and midnight (French times) on 22 April.

o Casualties and deaths from gas were very closely associated with lack of protection, more so than was true of any other weapon of the period. In the first attack, 22 April, troops had no protection at all. In later attacks during the first month, they had only very primitive protection, but even this much protection apparently reduced casualties and fatalities markedly. The major British source estimates a total of 7,000 British gas casualties for six attacks in April and May, and does not attempt to estimate fatalities.(13)

o Chlorine clouds, and the phosgene clouds that were introduced in late 1915, were much more lethal than the gas shell attacks made later in the war. Shells were adopted because they were much easier and safer to use and made possible much more finely orchestrated tactical effects, not because they caused more casualties or fatalities. Table 1, below, which shows British casualties only, gives a rough idea of the numbers of casualties from chemical weapons and ratio of fatalities to casualties for the entire war. Much of the analysis that has been carried out on the casualty-producing effects of gas deals with data from late in the war and thus tells little about the effects of the first gas used.

o There is no question that, for the war as a whole, chemical weapons caused many fewer deaths in relation to casualties than high explosive or impact gunfire. For example, one specialist has estimated that for every American killed in action by gunshot, 4.3 were wounded by gunshot, while for every American killed in action by gas, 70.4 were wounded by gas. Since gas caused only about 31.49 percent of all US casualties,(14) and since relatively few of the gas casualties died, it seems clear that, at least for the last year of the war (the year Americans fought) gas was much less lethal than artillery and machine-gun fire.(15) As another example, Figure 2 shows the ratios of wounded to killed in a number of wars, and shows that for US troops in World War I this ratio was unusually high, unless gas casualties are discounted. However, this does not tell us anything about the lethality of cloud attacks, which were not used during the period when US troops were fighting. It also tells us nothing about the lethality of gas relative to the number of men exposed to it; much less gas than gunshot ammunition was used in the war as a whole.

Thus, although it is important to form a reasonably accurate estimate of the relative lethality of the chlorine cloud weapon used in the spring of 1915 if one is to judge the importance of lethality in contrast to other factors in the psychological impact of the weapon's use on troops, it is very difficult to do so, and the research and analysis that would be required are beyond the scope of this study. It seems reasonable to assume that chlorine gas, as used by the Germans in April 1915, was extremely lethal but no more lethal than the major weapons

	Total Casualties	Total deaths	Deaths per 100 casualties
6 cylinder attacks, April and May 1915	*7,000	*350	---------
5 cylinder attacks, December 1915 to August 1916	4,207	1,013	24.0
Gas shell, July 1916 to July 1917. "Lethal" shell (phosgene, etc.)	8,806	532	6.0
Gas shell, July 1917 to November 1918, mustard-gas period	160,526	4,006	2.5
16 projector attacks, December 1917 to May 1918	444	81	18.2
Total	180,983	6,062	----------

*Approximate figures for casualties admitted to Medical Units only; many casualties died on the field or were taken prisoner.

Table 3

British Gas Casualties in World War I

Source: Gilchrist, Comparative Study of World War Casualties, p. 11; apparently based on Foulkes, "Gas!", Chart facing p. 332.

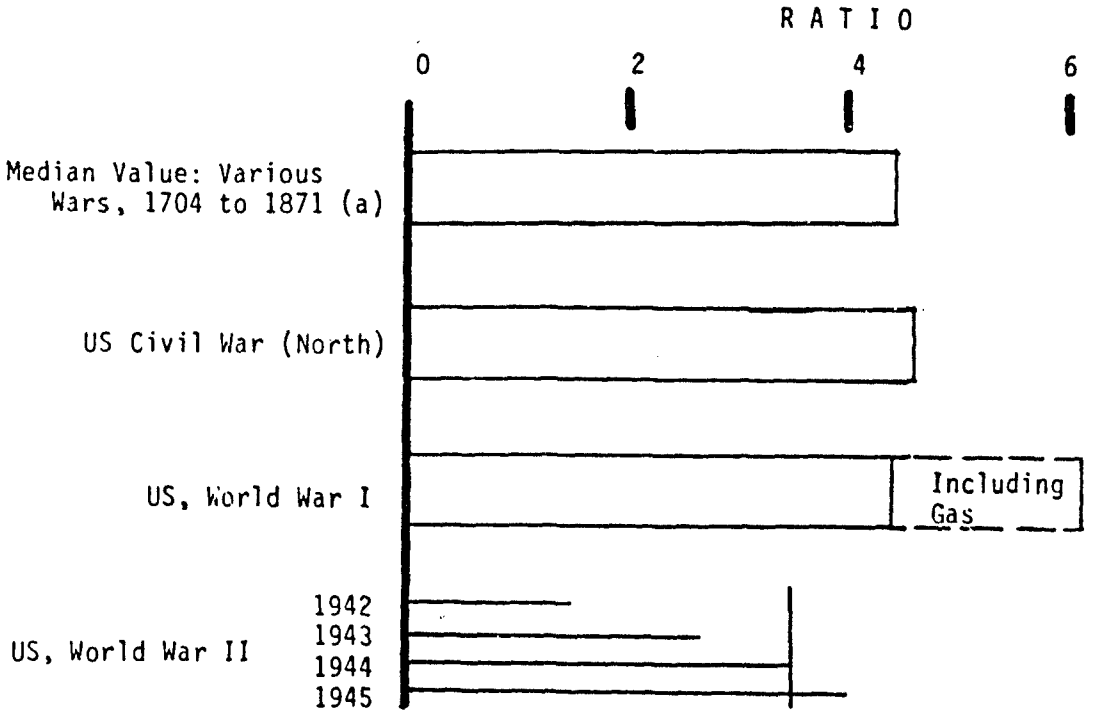


Figure 2: Ratio of Wounded to Killed, Various Wars from 1704 to 1871, and US Army in the Civil War, World War I, and World War II.

Source: Beebe and Debakey, Battle Casualties, p. 34.

already in use, notably the machine gun and high-explosive artillery shell. A precise comparison would require a study which has apparently not yet been performed.

As for its other fear- or horror-inducing characteristics, chlorine was very painful, but probably did not cause more pain than wounds from shell fragments. It is quite possible that it was more immediately painful; men wounded quite severely by shell fragments or gunfire often reported not realizing at first that they had been hit, or not realizing the seriousness of their wounds. The pain of gas was felt with the first breath. It seems likely that -- aside from pain -- the strangling, or drowning, sensation of the constriction of breathing was unusually fear-inducing.

The disfiguring effects of gas were disturbing to other men who witnessed them. The affected men's faces are variously described by survivors as blue, green, or black -- most often as blue. They coughed or vomited green froth or blood, and their tongues hung out. They clutched their throats and gasped for breath. This was the appearance of the very ill or dying. Those who recovered did not suffer permanent disfigurement.

The weapon made no noise, except the hissing of the escaping gas, which might be heard if the opposing trenches were close together.

When first used, the gas appears to have had a significant disruption effect not directly associated with its lethality. Two German sources state that before the gas clouds reached the French trenches, the defending troops were seen to pull back.(16)

The Allies considered the use of poison gas a violation of international law, and expressed outrage at the German use. The Germans justified their use by pointing out that the Hague agreement that dealt with gas warfare "merely prohibited the use of shell the sole purpose of which consisted in the diffusion of suffocating or toxic gases." They charged that the French, who had already used peacetime riot-control tear gas in rifle grenades, had been the first to violate this prohibition, and that releasing gas from cylinders did not violate it.(17)

In any case, little evidence has been found that the Allied troops, in contrast to political and military leaders, were shocked by the weapon's alleged illegality. One British veteran resisted an interviewer's attempts to get him to say that the men were shocked: "We just took the view that in war you can expect anything, you see."(18)

Another veteran did tell an interviewer that he and his companions were bitter about the "unconventional" aspect of the gas, but this statement came only in a late take of an interview being prepared for broadcast, and the context suggests the possibility that he was led by the interviewer to use this word.(19) In addition, Mordacq quotes one of his soldiers as

crying out, less than an hour after the attack, "Colonel, these [deleted] have poisoned us."(20) The traditional Western condemnation of poison in warfare goes back long before the Hague conventions, and this man may have been thinking of it, consciously or unconsciously. A British veteran of the attack of 2 May speaks of anger at the Germans for this "dirty trick," implying a feeling that it was unfair to attack with something the Allies couldn't defend against.(21) Anger about "unconventionality" and the "dirty trick" did not, incidentally, increase fear or trigger panic, but rather heightened determination to stick at all costs, according to men interviewed.

The weapon's seeming invulnerability, which was real enough to troops without any protection, was probably a significant factor in its psychological impact. Defending troops had nothing to protect themselves with and of course had no way to attack the gas cloud. Nor did they have the elementary knowledge of the behavior of gas that would have made them stay upright, rather than burrow in the earth where the concentration was greatest, or stay in their trenches and fire, rather than run with the cloud and inhale a maximum dosage.

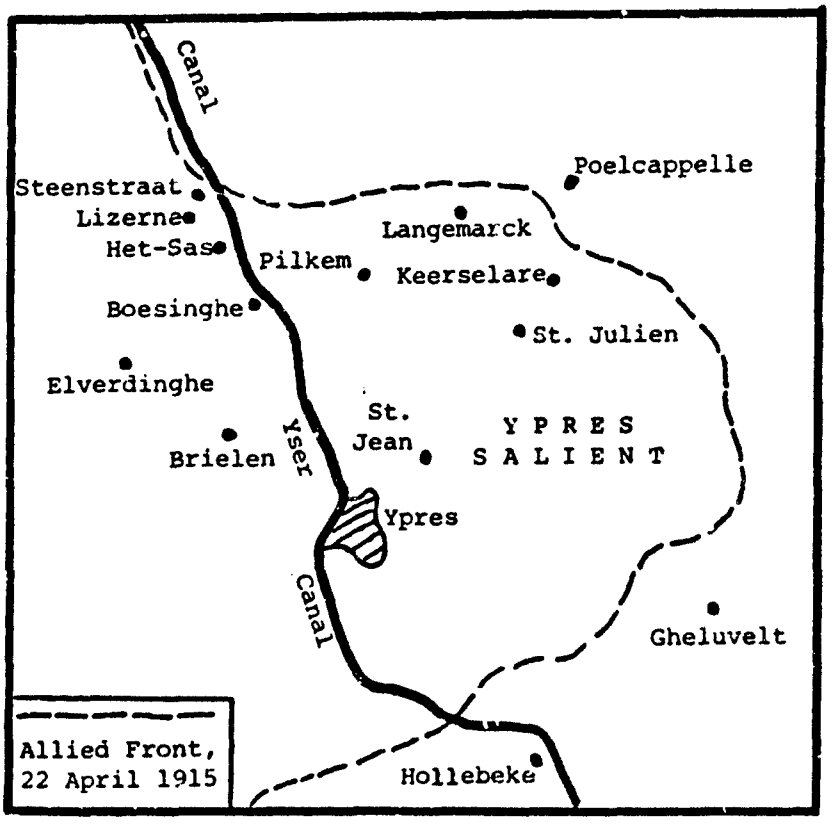
Circumstances of First Use

As indicated above, chlorine cloud attacks were first used in World War I by the Germans against French troops on 22 April 1915, near Ypres, Belgium. Although the fundamental purpose of developing and introducing the gas weapon was to achieve a significant tactical breakthrough and end the stalemate of the trenches, the purpose of the first attack was -- unfortunately for the Germans -- much more limited. As determined by the German high command, it was simply to test the usefulness of lethal gas in warfare. The high command had little confidence in the weapon and refused to use it in an important upcoming offensive on the Eastern Front.(22)

The ultimate objective of the attack at Ypres was "the capture of the Yser Canal, inclusive of Ypres." This would have flattened out the Ypres salient, a knob of Allied-held territory projecting into the German lines (Map 1), but would have achieved no significant strategic objective.

The German commander-in-chief, General Erich von Falkenhayn, gave the mission of the trial employment of gas to the Fourth Army commander, Duke Albrecht of Wurttemberg, and it was he who selected the objective of the Yser Canal and Ypres, having been instructed to choose an objective that was "not too distant." The Duke ordered the XXIII and XXVI Reserve Corps to execute the attack. The gas cylinders were installed in their zones, which lay on the northern side of the Ypres salient, in a line running from Steenstraate to Poelcappelle.

Following release of the gas, the two corps were to advance to the following immediate objectives: The XXIII Reserve Corps



Map 1: Ypres Salient, 22 April 1915

(45th and 46th Reserve Divisions) was to fight its way across the Yser Canal, reaching a line running from a point northwest of Steenstraate through Lizerne to a point southwest of Pilkem. The XXVI Reserve Corps (51st and 52d Reserve Divisions) was to gain the high ground along the highway that ran Boesinghe - Pilkem - Langemarck - Poelcappelle. As already indicated, the ultimate objective was control of the canal southward to include Ypres. Elements of the 43d Reserve Division were in reserve, but the German high command had not placed any large units in army reserve to exploit a breakthrough like the one that actually occurred.

Receiving this first attack with lethal gas would be the French 87th (Territorial) Division and the French 45th (Algerian) Division.

French Territorial troops, like those of the 87th Division, were men who had completed their 3 years of Active Army service, plus 11 years of Reserve obligation, but still remained subject to wartime call-up. These units of older men, their training far behind them, were intended for use in home defense only. However, by April 1915, eight months into the war, many Territorial units had apparently been strengthened by active cadres and by additional training. It can be assumed that the 87th Division was one of the better Territorial divisions, since it was holding the front trenches on a sector of the Ypres salient, but it must have been well below the standard of the French Active Army. The 45th Division, on the other hand, was an Active division, and was furthermore regarded as an elite unit with a fine reputation.(23)

The 87th Division was on the left, with its left on Steenstraate; the 45th on the right, with its right near Poelcappelle. To the left of the 87th were Belgian troops, while to the right of the 45th was the Canadian 1st Division.(24) On 22 April the 87th Division's 173d Brigade was on the line, its 73d Regiment on the left and 74th Regiment on the right, its right west of Langemark.

The Germans had made careful preparations for the use of chlorine. In January 1915, tests on the use of chlorine in warfare had advanced to such a point that von Falkenhayn decided to send 6,000 large chlorine cylinders (apparently all the Germans could readily acquire) for use in the Ypres area. Another 24,000 smaller cylinders were being manufactured. The mission of installing the cylinders and releasing the gas at the time of the attack was entrusted to the

> "newly organized 35th Engineer Regiment; this regiment comprised two battalions of three line companies, one service company, one field meteorological station and one telephone section each. Named after its commanding officer, the regiment was known as "Gas Regiment Peterson."(25)

For the initial attack, 1,600 large and 4,130 small cylinders were used. (German studies had estimated that one large or two

small cylinders would be required for each meter of front.) T-shell (tear gas) was to be fired along with the release of chlorine, to increase the effect of the chlorine.

Transportation and installation of the cylinders began in March, and two gas companies carried out the actual installation in seven nights, 5 April through 11 April. Great care had to be taken to maintain secrecy, especially since the opposing lines were very close together, in some places only 50 meters apart. The metal cylinders were wrapped in blankets or straw whenever they were moved, and when emplaced were carefully concealed as indicated in Figure 1. Every detail seems to have been planned and carried out with great care. One example is the synchronization of the opening of the small cylinders with the 6 to 8 minutes required for the large cylinders to empty, so that an even flow of gas would be maintained throughout the period of release. A table was prepared showing which gas batteries would be eliminated if any of a variety of wind conditions existed at the time of the attack, so as to avoid endangering German troops. The infantry was to move out 15 minutes after the release of the gas began. The German troops had some kind of simple respirators as protection against the gas. One source states, "The soldiers had only primitive protective devices that could be attached in front of their mouths and noses."(26) These were probably similar to the flannel rectangles that the Allied troops used after the first attack.

Despite the care of the preparations, the Germans did not, as indicated above, have adequate reserves on hand to exploit a breakthrough.

The attack achieved complete surprise. Explicit details of the planned attack had been given to the Allies by a German deserter, and had reached the French and British high commands. However, the very depth of detail made the story suspect, and neither this nor other reports of an impending gas attack seem to have been taken seriously by the high command or to have been communicated to officers as high as brigade commander, much less to the French or Canadian troops. The Allied troops had absolutely no protection against gas and no information on how to deal with it.(27)

The Allies had no chlorine stocks for war use and no other lethal gas at this time, and had made no plans to develop or use lethal gas.

Something should be said about the environmental factors involved in this first use of chlorine. Because the gas was to be released from cylinders, success for the attacker depended upon favorable winds. The Germans had been waiting several weeks for such winds. On 21 April the attack was set for 6:45 AM on 22 April. An early morning attack was obviously desirable, so that there would be as much daylight as possible for pressing the advantage hoped for from the gas. However, the wind dropped before the time set, and the attack was postponed until late

afternoon, necessitating delays in all aspects of the infantry assault.

Commentators have noted that, since prevailing winds are from the west in European latitudes, the Germans would usually be at a disadvantage in using cylinder-released gases on the Western Front. This is almost certainly an important reason for the shift to gas shell later in the war.

The first chlorine was released at 6:00 PM (German time) on April 22. The wind was blowing from the north, toward the French trenches, at 4.3 miles per hour.

Defenders' Response

Troops' Response. The chlorine attack and the offensive that followed it came near the end of a relatively quiet and unusually clear and balmy spring day. At about 5:00 PM (Allied time) the Germans fired an extremely intense artillery bombardment; the yellowish cloud then appeared and began moving toward the French lines. According to the German official history, at least a few French soldiers panicked and withdrew even before the cloud reached them.(28) Crown Prince Rupprecht of Bavaria, commanding the German Sixth Army at the time suggests a more general pre-casualty panic: "[Except on th extreme right] everything was taken without a struggle because enemy riflemen fled before the approaching thick clouds...."(29) The smell of the chlorine must have been almost overwhelming, even before the cloud engulfed the men and the full physical effects were felt. A British soldier near Kemmel, six miles from the center of the attack [and thus about 5.5 miles from the closest part of the chlorine cloud] smelled it strongly; a man in his unit said, "Oh, somebody's been using too much bloody powder in the latrines."(30)

If this immediate panic by a few men did occur, it was probably a significant factor in the rout that followed, together with these additional factors: the complete surprise of the weapon's effects; the visual confusion and communications breakdown resulting from the gas cloud; the almost immediate incapacitation of many men; the frightening appearance of the affected men; and the fright-inducing symptoms (strangling, or drowning, sensations) caused by the gas. Many of the men tried to escape or filter the gas by burying their faces in the ground; the Germans found their bodies, blackened by the effects of the gas.(31) Others ran -- "unofficered," as one report puts it -- toward the rear, clutching their throats. One eyewitness account that has been found for this study is an interview with a Canadian, in reserve lines to the rear and right of the 45th (Algerian) Division. He was interviewed as an old man in the 1970s, and is incorrect on some details that can be checked (although correct on others), so his account is not entirely reliable. Nevertheless, his impressions and emotional memories seem worth reporting.

This man and his companions saw the Algerians running toward them, seeming "so out of place, running, staggering toward us" in their colorful blue coats, red breeches, and red hats. His unit tried to rally the Algerians, but the men kept running, pausing only long enough to say what this Canadian remembers as "Allemand -- bom-bom -- alad."(32) He states that he and his companions then turned, on orders, and fired on the retreating Algerians. "We didn't know anything about gas -- didn't know they'd been gassed."(33) Another Canadian, seeing the bright uniforms, and the dark faces of many of the men who streamed by, took them for "Turcos," and was appalled that they were not the "regular French troops" he thought were holding the line. He did not realize that these panicked men were not only regular troops but superior ones.(3

The war diary of the 10th Battalion, 1st Canadian Division, for 22 April, 6:00 PM, reads

> Bn. could not fall in on the St. Jean - Ypres road on account of the terrific shelling...so was led into position by...cutting through the fields and gardens. Proceeding at once to St. Jean, the road was blocked by masses of French troops proceeding towards Ypres in great disorder, there were also masses crossing the fields in a southwesterly direction, many having thrown away anything that could impede their progress. We had difficulty in proceeding along the road owing to this congestion.(35)

There are additional accounts which make clear that this was a disorderly rout. Mordacq, the French 90th Brigade commander, confirms it, while emphasizing the physical distress of many of the men.(36)

Several things may be said about this behavior of the French troops.

First, this was a true panic reaction, not just a withdrawal from a position made untenable by the gas. These men were still running in areas where there was no significant amount of gas. If they had been in the thickest part of the gas, and had been truly incapacitated by it, they could not have run out of it; it was moving faster than a man could run for more than a few minutes. Many of the men described in the accounts quoted seem to have been perfectly capable of standing and firing at the time they were seen in rout.

Second, although there was a widespread panic, by no means all the men in the front-line trenches broke and ran. And the German official history makes it clear that, in the judgment of the German historians, it was the areas where the gas was released most successfully in greatest concentration, and where the infantry followed up the gas promptly, that the great gains were made. For example, on the German far right, facing Steenstraate, "the discharge of the gas was not entirely successful, so that the left wing of the 45th Reserve Division...was able to gain ground only slowly under the heavy

fire of the enemy."(37) Prince Rupprecht puts it more unequivocally: "Out of oversight there was a failure to open the gas cylinders on the extreme right flank."(38) Steenstraate was seized only late in the evening "at the cost of considerable casualties." To push on toward Lizerne, one of their immediate objectives, "was beyond the strength of the greatly exhausted troops." Also, on the far left of the German attack (the French right, where the French units joined the Canadians), "the gas either failed to have its full effect, or the attack of the troops had not followed immediately in the wake of the gas cloud, "which enabled the French and Canadians in that sector to put up a stubborn resistance." (The Germans, who don't seem sure exactly what the strength of the resistance in this sector should be ascribed to, may be giving too little credit to the French defenders, and especially to the Canadians, who took over some of the abandoned French trenches.)(39)

It was in front of the right wing of the XXVI Reserve Corps that the greatest German gains were made. And here the German official history ascribes the gains to the gas. "The moral effect of the gas was tremendous." The assault troops of the 52d Reserve Division "encountered no resistance whatever" and reached their objective, the high ground near Pilkem, just 25 minutes after jumping off.

Thus, at least in the Germans' opinion, the panic occurred where the gas was strongest.

Third, although the 45th Division was regarded as a crack division, almost certainly far superior to the Territorials of the 87th Division, elements of the 87th held stubbornly near Steenstraate, where there was a determined German assault but little or no gas, while elements of the 45th (as well as elements of the 87th) were routed and opened a wide gap in the Allied lines.

Finally, it seems likely that some of the stubborn resistance by defenders was due not primarily to weakness of the gas but rather to effective leadership, discipline, and esprit. The determined defense of the Canadians and French on the French right as been noted. There can be little doubt that many of these men were experiencing sharp pain in the throat and lungs and difficulty in breathing, in view of their closeness to the gas cloud.

Commanders' Response

The response of the field commanders was immediate and militarily appropriate; they promptly and urgently requested reserves -- which were promptly sent -- to repair the gap, and began to plan counterattacks for that same night and early the next day. Mordacq learned of the attack 20 minutes after the gas was released. He immediately rode toward the trenches, and as he approached Boesinghe and realized the gravity of the situation, he detached a courier with orders that all available battalions

in his brigade be sent forward, and with requests that the division let him have help from the 91st Brigade.(40)

Casualties

The widely varying estimates of casualties from this first gas attack have been noted. It is important to remember that the gas attack was just one part of a strong offensive effort, which included a very intense artillery bombardment, plus concentrated machine-gun and rifle fire from advancing German troops. However, the early estimate of 15,000 casualties, which was widely accepted after the war, considerably exceeds the number of men who were in a position to become casualties. And if the SPRI estimates really specify 3,000 dead in addition to 7,000 wounded, then the implied total of 10,000 casualties is also much too high. A figure of 4,500-5,500 total French casualties, based on Mordacq's estimate of 60 percent casualties in his front-line battalions, and on the 87th Division figures of 2,590 total casualties, seems reasonable. It must be noted that these figures would include 1,800 unwounded French prisoners the Germans reported taking.(41) The 4,500-5,500 casualties, it must be stressed, are not gas casualties alone, but casualties from all causes on 22 April. In any case, they represent very high casualty rates.

Panic

In dealing with the question of panic in this report, it was originally intended to ask the question, "Did troops' or commanders' responses indicate panic or fear out of proportion to the casualty-causing effect of the weapon?" Research and thought showed, however, that this was not a meaningful question; there is no historical evidence indicating any standard relationship between casualties and panic. There are numerous examples of units that broke when two or three men ran, in the face of light fire, and of units that held their positions against hopeless odds until they were virtually annihilated.

The question of panic is discussed more fully in the body of the report of this study. What can be said here is that there was, in addition to heavy casualties, widespread panic in the 45th and 87th Divisions. For the 45th Division, panic is something that would not have been expected, even under an unusually intense Western Front attack. It was, as has been noted, a division with a superior record and reputation. The 87th Division, as a Territorial division of older men, might have been considered more likely to panic. However, elements of the 87th that had probably not been hit by gas actually carried out a counterattack during the night of 22/23 April, suggesting that the division was not in reality below standard. In any case, when the gas first hit, both divisions seem to have behaved much the same. The nature of the gas weapon and the surprise with which it was introduced were clearly responsible for the panic.

As has been indicated, there seems to have been no panic among nearby units that were not themselves affected by the gas

at full strength. The Canadians to the right of the French, who, although not hit by the gas were subjected to very severe artillery bombardment and a strong infantry attack, resisted stubbornly and, along with some French troops, managed to fold back the open Allied flank and limit the width of the gap the Germans had opened. The French Territorials on the extreme left of the attacked sector, where the gas was light, held very well.

Tactical Situation After the Attack

The tactical situation at nightfall was this: A wide gap split the Allied line from the Yser Canal near Boesinghe to a point near St. Julien. In the words of the German official history, "A thin line of British troops was barely holding the gap...A continuous front line no longer existed." Since the canal crossings near Ypres were exposed to heavy German fire, it was hard for the Allies to direct troop movements and reinforcements through the town. Again, in the words of the German history, "The situation of the enemy in the Ypres salient had become highly precarious." In fact, if the Germans had had sizable reserves for exploitation, and if they had been able to make the gas attack in the morning rather than late in the day, there was little to keep them from a major breakthrough to the English Channel. As it was, darkness overtook them short of a breakthrough.(42)

Allied reinforcements were brought up during the night and pushed immediately into the gap. Heavy casualties were sustained in re-establishing a front line under intense German artillery fire. Having lost 51 guns to the German assault, the Allies could not counter the fire. However, there were both French and British/Canadian counterattacks during the night. By 10:00 AM on 23 April a firm link had been established between the French and Canadian forces. The new line the Germans had gained by the gas attack did not represent a significant gain. It remained basically unchanged until the Allied Ypres offensive of 31 July 1917, more than two years later.

Attackers' Response

The attitude of German commanders and troops toward the gas weapon before its use was generally unenthusiastic. General Falkenhayn clearly had enough confidence in the weapon to order its use, and the scientists responsible for its development, under the leadership of the distinguished Professor Fritz Haber, head of the Kaiser Wilhelm Institute for Physical Chemistry, were eager to try it. However, according to the official German history of the war, "Practically the entire command, as well as the rank and file, regarded this untested weapon with distrust, if not with absolute disapproval."(43)

The troops in the front-line trenches probably were especially skeptical. A German source, speaking of gas cylinder emplacements in general, says "The installations of the cylinder batteries constituted for the troops in their immediate vicinity a constant source of apprehension."(44) Moreover, according to

one German source, soon after the installation of cylinders began in March, two of the cylinders were hit by Allied artillery shells and exploded, making several nearby men ill; one of them died of lung hemorrhage. Gen. Berthold von Deimling, who commanded the XV Army Corps, described in his memoirs visiting in the hospital men who had become ill after a similar accident, which he says was caused by Allied rifle fire. Fifty men were affected, three of whom died. Deimling wrote of the men he saw, "They had to suffer a great deal. The confidence of the troops in the cruel chemical agents was greatly shaken by these incidents. The soldiers had only primitive protective devices that could be attached in front of their mouths and noses." Deimling himself, whose corps held a sector adjoining that of the XXVI Reserve Corps, stated that the use of gas "went against the grain," but that he accepted it as a necessary aid to victory.(45)

On the other hand the British official history states that the German deserter who gave such detailed information about the impending attack reported German morale much improved, owing to the men having been told that "there is not much in front of them." Although Edmonds does not say that the men were told that the gas had created this desirable situation, the implication is that they were.(46)

In summary, though little can be said with confidence about the attitudes of German troops toward gas before the attack was launched, it is safe to say that while some may have been optimistic about it, many probably had negative feelings, including apprehension for their safety.

Almost nothing has been found that would shed any light on German troops' reaction to the chlorine as it was first being used. With one possible exception, they jumped off promptly and pursued their advantage vigorously. As mentioned above, the German official history suggested the possibility that, on the German left, near Langemarck, "the troops had not followed immediately in the wake of the gas cloud."(47) If this was true, it may have indicated anxiety about the safety of following the gas so closely.

Some of the attacking troops were struck by the blackened appearance of the gas-killed French troops, their faces buried in the dirt in a mistaken attempt to escape the gas.

The German commanders were fully aware of the gap they had created, and also of the Allied reinforcements moving up to close it. They pushed their advantage as well as they could with the reserves they had available to commit, but were not able to keep the gap open. All first-day objectives were achieved -- and in many cases greatly exceeded -- except on the German far right.

Adaptation

During the following month these additional German chlorine cloud attacks took place, all as part of the Ypres offensive:

- o 24 April, 5:00 AM; a "thinly developed cloud" released against the Canadian division in preparation for an attack to seize the ridge north of Wieltje and Frezenburg. Also, about 2:00 AM, gas released against the French near Lizerne.

- o 2 May, 6:00 PM; gas released against British who had taken over French sector between Pilkem and St. Julien; objective called by British Hill 60; German problems with wind and synchronizing release of gas from all cylinders; effect "considerably reduced"; no German gains.

- o 5 May; attack on British troops; Hill 60 taken.

- o 10 May; small amount of gas released against British.

- o 11 May; Menin Road. Attack on British troops.

- o 24 May, early morning; "Whit Monday attack"; massive intense attack against two British infantry divisions and a cavalry division.(48)

In brief, although gas was used repeatedly by the Germans during the Second Battle of Ypres, it was only the initial use on 22 April that produced significant gains. The Germans did not achieve their objective of capturing Ypres and pinching off the Ypres salient. The later gas attacks probably failed because of a combination of these factors:

- o Complete surprise could not be achieved after the first use.

- o The Allied troops began immediately to use primitive respirators, and even something as simple as a handkerchief soaked in urine provided much more protection than the French had had on the first day.

- o Only on 24 May were the Germans able to deliver gas in a cloud as large and concentrated as that of 22 April. It must be remembered that once cylinders had been emptied they could not be reused until they had been recharged, and this could not be done in the trenches. To mount an attack meant locating, filling, transporting, and emplacing large numbers of gas cylinders.

After 24 May there was a lull in German gas attacks until October. Meanwhile, beginning on 3 May, the British began to make plans to develop their own gas capability. During the summer, an organization was set up, a mass gas defense training program was organized, gas officers were assigned to each army, and plans and preparations were made for using a chlorine cloud attack as part of a major British offensive effort. The French also began

developing their own gas capability. Apparently no chlorine was used by either side throughout the summer of 1915.

The first British use of gas was at Loos, in northern France, 25 September 1915. The attack was carefully prepared, but the gas was fully effective only in scattered sections of the front, and in some places shifts in the wind sent the gas back on the British attackers. This first day of the Loos offensive, and the offensive as a wnole, were not especially successful.(49)

The British carried out another chlorine cloud attack in October, and on 19 December the Germans used a more lethal gas, phosgene, along with chlorine, for the first time. The British had been developing a phosgene capability themselves, and had added chemicals to the troops' protective helmets that would neutralize the phosgene. Although the Germans used a higher concentration of more lethal gas, and attacked at night to maximize surprise, total gas casualties were nevertheless held to about 1,000. There were four additional gas cloud attacks against British troops during the war, plus several against the French.

Allied protection had advanced greatly since the first surprise of 22 April 1915. In the attack two days later handkerchiefs filled with moist earth or wet with urine were used, and within a week primitive respirators of cotton wool wrapped in muslin or veiling had been made by volunteers and mailed to the troops. By the attack of 24 May, five types of simple respirators had been issued to British troops. Basically, they were all rectangles of some kind of absorbent material. One veteran told the author that his unit were given "two by fours" -- rectangles of flannelette two inches by four inches that were used to clean rifles -- with tapes attached so that they could be tied on.(50) Another has written that the men in his unit were each issued a body belt (jock strap) that was to be soaked in water and held over the nose and mouth.(51) Some respirators had been soaked in a chemical (washing soda or photographic "hypo") that would neutralize the chlorine, and were to be moistened and tied over the mouth and nose when a gas attack came. In some cases, jars of the neutralizing solution were distributed in the trenches, and untreated respirators were to be dipped into them. In practice, men used whatever was handy -- water bottle, tea cup, or latrine.(52) There seems to be universal agreement that these simple measures helped significantly, and that the men who failed to put on their respirators were the ones most likely to die or be seriously injured.(53) However, the respirators tended to disintegrate after being repeatedly readjusted by men who had to spit or vomit, or involuntarily chewed on as a result of the gas effects.(54) And in a heavy attack, when the men were exposed for more than a few minutes, the respirator would dry out or the chemical would be used up.

Also, by 24 May, the first few smoke helmets had been issued and used. The smoke helmet was a flannel bag that covered the entire head and had a mica or celluloid window. During the summer the British developed the tube or P helmet, which had a breathing

tube, held in the mouth, through which the soldier exhaled, while his incoming breaths were filtered through chemicals that neutralized both chlorine and phosgene. Many of these helmets had been issued by September. (The summer lull in gas attacks gave all Western armies a chance to develop protective measures.) Simple systems of announcing a gas attack, including bells and shell-case gongs, were also developed; this was necessary in dealing with a weapon that often made it fatal to shout an order.(55) After the German night attack of 19 December 1915, with its more lethal phosgene and heavier concentrations of gas, Allied alarm systems improved; the Strombos horn, which worked by compressed air, came into use.(56)

As defensive measures improved, so did German tactics. Throughout the war, the Germans seem to have taken the lead in offensive innovation. By April 1916, the Germans had honed their gas tactics to focus on surprise -- especially important in a weapon that is so effective against an unprotected enemy and so ineffective against a protected one. The Germans would send over several waves of gas at varying intervals, with the heaviest wave often coming last, after the Allied troops had decided that this was a light attack and taken off their helmets. The Germans began using more concentrated gas, and they sometimes mixed smoke with gas, apparently partly as a feint, to make light attacks look heavier.(57) The smoke also provided cover for the advancing infantry; the Allied troops were not able to tell readily that the gas attack was over, nor to see the German infantrymen.(58)

Despite improved tactics and more lethal gas in stronger concentrations, the standard German authority says "After the enemy had once become acquainted with this new weapon, infantry attacks, launched in connection with subsequent gas operations, were no longer successful." Hanslian is referring to attacks subsequent to the first Western Front attack at Ypres, 22 April 1915, and the first chlorine attack on the Eastern Front, at Bolimov, 2 May 1915, in both of which he thinks energetic exploitation by large forces could have brought great tactical success.(59)

From the Allied point of view, the early adoption of crude expedients meant lower casualties and less ground lost in gas attacks. Auld reports that in the heavy attack of 24 May 1915, just a month after the first attack, a regiment with primitive respirators and good gas discipline suffered very light casualties.(59a) Estimated British casualties in the first six attacks of spring 1915 averaged over 1,100. For the five attacks of December 1915 - August 1916, casualties averaged 841, despite the heavier concentrations, the deadlier phosgene, and the improved German tactics.

In July 1916 a new phase of gas warfare was entered with the German introduction of gas shells, fired by artillery. Tear gas shells had been used by both sides since early in the war, and the Germans had consistently fired tear gas along with chlorine and phosgene clouds to heighten the effect of the more toxic

gases and to force defending troops to remove their respirators. However, it was only in July 1916 that a lethal lung-injurant agent was delivered by shell. The gas used was diphosgene, a highly toxic lung injurant which became the principal killing chemical agent used in shells during the war.(60)

Gas shell attacks, not cloud attacks, became the rule. The British also used the Stokes mortar, a trench mortar, to lob gas shells into opposing trenches; they had begun tests of this technique in the summer of 1915. The shell attacks were much less lethal and caused many fewer casualties in each attack than the cloud attacks. British fatalities dropped from 24 percent of casualties to 6 percent of casualties with the shift from cloud to shell attacks.(61) However, the shell attacks were much easier to mount, much less dependent on weather, and posed much less danger to the attacking troops. What seems to have happened is that the Germans -- and the Allies -- abandoned hope of making a tactical breakthrough by using gas as preparation fire, and adapted gas to other objectives. By late 1916 the Germans were using gas shells with great discrimination, not using them in small amounts, but directing intense bombardments on troop concentrations to disrupt Allied offensive preparations, and firing similarly concentrated bombardments to neutralize Allied artillery batteries and transport. The British continued to use cloud attacks throughout the war, and developed mobile cylinders to provide greater flexibility.

By the end of 1916, the British, French, and Germans had fairly satisfactory individual protection, plus protected shelters and dugouts. The final British respirator was the box respirator, which had a clip that closed the nose and a mouthpiece through which the soldier breathed air that had been filtered through a box of neutralizing chemicals. A facepiece with goggles fitted over the whole. It was uncomfortable, but it worked.

Thus effective defensive measures, plus the dangers and inconveniences of launching cloud attacks, had, by late 1916, made the gas weapon primarily a harassing and neutralizing weapon, used as an adjunct to more decisive weapons.(62) The advent of mustard gas in mid-1917 opened a new phase of chemical operations, which is treated in a separate case study. In general, mustard brought many more casualties, slightly more fatalities(63) and an orchestrated use of various gases to achieve specific, limited military objectives.

Reactions and Adaptation of Troops

A strong effort has been made to find first-hand accounts of personal experience with early gas use that provide evidence of psychological reactions to the gas. Twelve personal accounts of the first cloud attacks of April and May 1915 have been found, all British and Canadian. For the first Allied use of gas at Loos, six British and one German accounts have been found. One account of the last gas cloud attack has been included, since it

was the first experience with gas for this man and his unit, and since it is an unusually full account. There is also one account of the first use of gas shell. Other accounts that reflect the psychological impact of gas have also been consulted. (Several accounts of experience with "mustard gas" are presented in a separate case study.) The reaction of troops to gas and their adaptation to gas on the battlefield can be traced in these accounts. (See Table 2 for a summary of these sources.)

Except for a few Canadians who were present in the attack area on 22 April, but who did not get the full impact of the gas that day, all these men had heard about gas before they saw and felt it, and almost all of them had some kind of primitive protection. In this they differed from the French on the first day. Otherwise, they knew nothing and the experience was new. The British troops who were rushed up to fill the gap, and who experienced the gas attacks of the following weeks, had not seen the gassed French troops and had no idea what it was like to inhale gas. One man said, "We did not know much about this new form of warfare and...I'm afraid we treated the matter very lightly."(64) However, all of these men, and most of those in their units, realized immediately what the cloud of grey, green, yellow or white vapor was (the color probably varied with the weather, time of day, and concentration), and promptly put on their respirators.

A number of the men mention or describe the pain and fear of the actual gas experience, although some have what is perhaps a British reticence about lingering on their suffering; one says, for example, merely "After about five, six minutes...I was feeling rather desperate."(65) Another, however, said, "Each successive breath I drew seemed [more] painful and caused a `knife-edge` feeling in my lungs. `Gas,` I thought and got out of my dugout very quickly."(66) Another man who was less affected, but who carried out three trips into the front lines with supplies, said, "My legs felt like ton weights, as if my general system was on a hunger strike."(67)

The most graphic description of the sensations is from the man who said he and his companions had treated the matter lightly:

> No words of mine can ever describe my feelings as we inhaled the first mouthful. We choked, spit, and coughed, my lungs felt as though they were being burnt out, and were going to burst. Red hot needles were being thrust into my eyes.(68)

This same man reports a panic response:

> The first impulse was to run. We had just seen men running to certain death, and [knowing] it, rather than stay and be choked into a slow and agonizing death. It was one of those occasions when you do not know what you are doing. The man who stayed was no braver than the man who ran away. We

*Table 4 : Personal Accounts of First Experience with Lung-Injurant Lethal Gas

Source	Branch	Rank	Date of 1st Experience	Place	Time of Account	Type of Account	Chemical Agent	Delivery method	Attacker or Defender
Abbott	MG Corps	Pvt.	8 Aug 16(?)	Ypres	undated	M	phosgene/Cl	cloud	D
Ashbourne	Inf/CEF	Pvt.	24 Apr 15	Ypres	undated	P (Reid)	Cl	cloud	D
Barley	Chem advisor	Capt.	**	**	c.60 yrs.	I	**	**	D
Colyer	Inf	Subaltern	24 May 15(?)	Ypres	undated	M	Cl	cloud	D
Communications Man	Inf/com.	Enl.man	25 Sept 15	Loos	contemporary	L/P	Cl	cloud	A
Cotton	Inf	Enl.man	24 May 15	Ypres	undated	M	Cl	cloud	D
Currie	Inf/CEF	Col.	22 Apr 15	Ypres	1 yr.	P	Cl	cloud	D
German soldier	?/Ger.	?	25 Sept 15	Loos	undated	M	Cl	cloud	D
Graves	Inf	Officer	25 Sept 15	Loos	c.14 yrs.	M/P	Cl	cloud	A
Hawkins	Inf	Plat.comdr.	2 May 15	Ypres	c.60 yrs.	I	Cl	cloud	D
Kingsley	Inf	Sqdn.ldr.	6 May 15	Ypres	undated	M	Cl	cloud	D
Laws	Arty	Capt.	Jul 16	Somme	60 yrs.	I	phosgene	shell	D
Moir	Inf	Enl.man	25 Sept 15	Loos	contemporary	L	Cl	cloud	A
Myer	Inf	Officer	25 Sept 15	Loos	c.50-60 yrs.	M	Cl	cloud	A
Pratt	Inf	Lt.	22 Apr 15	Ypres	c.60 yrs.	I	Cl	cloud	D
Quinton	Inf	Enl.man	2 May 15 (?)	Ypres	14 yrs.	M	Cl	cloud	D
Reid	Inf	Sgt.	25 Sept 15	Loos	c. 60 yrs.	I	Cl	cloud	D
Scott	Inf/CEF	Lt.	22 Apr 15	Ypres	during WWI	P (Reid)	Cl	cloud	A
Shand	Inf	Pvt.	22/24 Apr 15	Ypres	undated	P (Reid)	Cl	cloud	D
Stafford	Inf	Lt. Col.	25 Sept 15	Loos	contemporary	J	Cl	cloud	A
Trinity	Inf/CEF	Enl.man	22 Apr 15	Ypres	c. 6 yrs.	M/P	Cl	cloud	D
Underwood	Inf/CEF	Enl.man	22 Apr 15	Ypres	c. 60 yrs.	I	Cl	cloud	D
Worrall	Dragoons	Enl.man	24 May 15	Ypres	68 yrs.	I	Cl	cloud	D

* For explanation of column headings see p.50.

** Describes reactions on learning of 22 Apr 15 attack, and defensive preparations for and outcome of 19 Dec 15 phosgene attack.

*Table 4: Personal Accounts of First Experience with Lung-Injurant Lethal Gas

Source	Physical sensations	Fear or stupor	Panic	Anger	Desire for Action	Incapa-citation	Appear-ance	Protection	Esprit	Leader-ship	Good Per-formance	Disap-pointment	Gas blown back	No mention of gas
Abbott								x			x			
Ashbourne								x			x			
Barley		x						x			x			
Colyer			x	x	x	x		x			x			
Communications Man							x	x						
Cotton						x	x	x			x			
Currie			x								x			
German soldier														
Graves							x	x				x	x	
Hawkins	x			x			x	x		x	x			
Kingsley	x	x						x (none)	x		x			
Laws								x						
Moir														x
Myer												x		
Pratt														
Quinton	x	x	x		x		x	x			x			
Reid								x					x	
Scott	x					x		x						
Shand							x							
Stafford												x	x	
Trinity	x		x			x								
Underwood			x	x				x	x		x			
Worrall	x		x				x	x					x	

* For explanation of column headings see p.50.

Table 4

Personal Accounts of First Experience with Lung-Injurant Lethal Gas

Explanation:

Following are explanations of column headings that are not self-explanatory.

Time of account: Years after event that account was recorded.

Type of Account: I = INTERVIEW

J = JOURNAL

L = LETTER

M = MEMOIR

P = ACCOUNT APPEARS IN PUBLISHED WORK

Appearance: Comments or descriptions indicating horror at the appearance of gas casualties.

Protection: Comments on protection, including descriptions of improvised early devices, comments stressing the importance of protective devices, and criticisms of protective devices.

Good Performance: Narratives showing, or comments indicating, good military performance despite gas attacks.

Disappointment: Disappointment in the effects of the gas experieced by troops on the attacking side.

> crouched there, terrified -- stupefied. We lay with our noses in the mud, fighting for breath, forgetful of the bursting shells. I felt myself choking, I could not stand it much longer, I would have to get up and run.(69)

As the writer indicates, he had just seen British troops in rout. They were tearing at their throats with their hands, "raving mad with terror," running through a hail of German artillery shells. Thus, if his account is accurate, at least some British troops panicked and ran in this attack, which was probably that of 2 May. Another veteran passes on reports that troops in his area "left their trenches" during a gas attack.(70)

One bit of behavior by British medical officers during the very heavy attack of 24 May seems worth reporting, although it is difficult to evaluate. Although German sources mention only cloud chlorine and shell-delivered tear gas (T-Stoff) as being used in the attack, some British officers not only identified gas of four different colors released from ordinary tear-gas shells, but three different types of gas delivered by high-explosive shell. A report concluded that the evidence suggested hydrogen cyanide, cyanogen chloride, and possibly formaldehyde had been fired. All were identified by smell. It is possible that these gases were indeed fired experimentally by the Germans on 24 May, but it seems more likely that the British, under the stress of this extremely heavy attack, believed that they perceived gases that were not actually used.(71)

The reasonable but inappropriate response of burying the face in mud -- mentioned in the quotation just above -- should be noted. This is also what many of the French troops are reported to have done on 22 April. It was apparently what they had been trained to do for smoke, which tends to rise, but it is a counterproductive defense against chlorine, which is heavier than air. The men simply lacked the information to act effectively.

Another reaction mentioned was anger, in each case accompanied by a statement that the anger strengthened determination to hold the position or "account for some Germans."(72) Also expressed was an eagerness to do something, to move out of the trenches, whether forward or back, and a frustration at having to stay put and endure the gas.(73)

The reaction most commonly mentioned in the personal accounts is distress or horror at the appearance of the gassed men. "Their colour was black, green and blue, tongues hanging out and eyes staring....some were coughing up green froth from their lungs."(74) "It is very distressing to see these men who ten minutes ago were so serene and cheerful, now writhing about in varying degrees of torment and despair."(75)

> And he was carried past me in the ditch behind me, on a stretcher, blue in the face, dying, and he actually died about five minutes later. I've never seen a chap like that. But they were all blue. All the men who died of this gas

were blue in the face. And it was the most beastly thing to see.(76)

> Black in the face, their tunics and shirt fronts torn open at the necks in their last desperate fight for breath....the most awful death I have ever seen....One poor devil was tearing at his throat with his hands. I doubt if he knew, or felt, that he had only one hand, and that the other was just a stump where the hand should have been. This stump he worked around his throat as if the hand were still there, and the blood from it was streaming over his bluish-black face and neck.(77)

A number of positive measures, or things that helped, are mentioned in these accounts. One man found, during the course of his first attack, that breathing slowly and regularly eased his discomfort.(78) He also experienced the pleasure of realizing, after holding his position and enduring the attack, that the worst was over, that the cloud was passing. The first breath of relatively clear air was a great relief.(79) One of the accounts mentions an officer who recognized the chlorine and immediately urged the men to urinate on their handkerchiefs and breathe through them.(80)

It should be stressed that in all these accounts men under gas attack for the first time (and in most cases also simultaneously under intense conventional attack) continued to carry out their military assignments to the best of their physical ability.(81) In two cases there was a breaking point, but in one it came when the company machine gun was blown out of the trench and the company commander killed, not because of more gas than the men could endure. The other case was not a combat situation.(82)

The report of J.S. Haldane, the distinguished scientist sent by the British government to investigate effects of the first attacks and identify the agent used, contains evidence of troops' carrying out tasks on orders. He quotes a deposition taken from a Canadian captain, who was gassed in the 24 April attack:

> He saw, first of all, a white smoke rising from the German trenches to a height of about three feet. Then in front of the white smoke appeared a greenish cloud, which drifted along the ground to our trenches, not rising more than about seven feet from the ground when it reached our first trenches. Men in these trenches were obliged to leave, and a number of them were killed by the effects of the gas. He made a counterattack about 15 minutes after the gas came over, and saw 24 men lying dead from the effects of the gas on a small stretch of road leading from the advanced trenches to the supports. He was himself much affected by the gas still present, and felt as if he could not breathe. [Emphasis added.](83)

The reasons for this continued military performance undoubtedly include inertia, the conditioning of training, and the lack of anywhere better to go. However, several of the accounts spontaneously mention strong esprit de corps or the comradely attitude of the men, or cite an example of effective leadership.(84)

In addition to the personal accounts, one example may be given from the many in the official Canadian war records:

> On the morning of 24 April the Company on the left No. 1 and part of the centre company No. 2 received the full blast of the poisonous gas which came as a surprise to them, and which seems to have been always successful in clearing trenches before. Not a man left his post and though they were in a very bad way, at least 4 died of the fumes at their posts in the trenches, they stopped the German attack. Though the men were sick and heavily shelled all day the Germans could not drive them from their trench.(85)

After the first attack was over, several responses appeared. One was recognition of the great importance of the respirator. Troops who had experienced gas attacks urged new arrivals to look to their respirators; they had seen the life-or-death difference between wearing and not wearing one.(86) Several men expressed a confidence in their top leadership that kept them from being terrorized by the fear of another attack: "Our powers to be, they weren't asleep, they could soon tell us what it was." "We'd got gases, and as soon as he started using gases, we used gas." "[We had a] great feeling of confidence."(87)

There was, however, an involuntary carryover of the panic. One memoir describes the effect of the chloride of lime used to disinfect and deodorize latrines: "A sudden whiff of this chloride of lime, and our hearts began to thump, and we broke out into a cold sweat. Which proves how much we feared it. (This was of course before we had gas masks.)"(88)

The writer Robert Graves has described a similar reaction after a gas experience the following year: "Since 1916, the fear of gas had obsessed me: any unusual smell, even a sudden strong scent of flowers in a garden, was enough to send me trembling."(89) Graves goes on to describe similar reactions to artillery shelling -- "The noise of a car back-firing would send me flat on my face, or running for cover." Another memoirist, H. Allen, has stated that "Gas shock was as frequent as shellshock,"(90) but the examples he gives of nervousness at the sound of gas alarms, and of many false gas alarms, do not in themselves support this statement. Denis Winter, in the book on life in the trenches from which the statement was quoted, says that artillery and gas were the two great fears. He gives many examples from many persoral accounts, and specific and detailed symptoms, for shellshock, or artillery panic, while the passage from Allen's memoir is the only evidence he cites on gas fear. There is no doubt that the experience of being gassed did leave

some victims with a latent terror that could be reactivated later by stimuli associated with the attack, but it seems doubtful that the fear was as great as the fear of artillery.

First Use by Original Defenders: Troops' Reaction

Five months after the first German gas attack, the first Allied gas attack took place when the British used chlorine cloud in their offensive at Loos on 25 September 1915. According to the architect of the British gas program, C. H. Foulkes, the carefully planned attack was a significant, qualified success, hampered by last-minute changes in the wind. Foulkes credited the gas for much of the limited success the Loos offensive achieved.(91) There is no reason to doubt that Foulkes was correct, but apparently the experience seemed quite different to the infantry who participated in the attack.

One communications man, whose letter is quoted by Foulkes, saw dead gassed Germans "three or four deep" in the first German trenches, but he also stressed the devastating machine-gun fire from the German third-line trenches, and the heavy losses his regiment took.(92) One man, who appears to have been with the 1st Division, which, according to Foulkes, advanced behind a gas wave and was very successful, does not mention gas at all in his graphic, detailed account of the first day's attack.(93) Of the six personal accounts of this battle that were found, three mention gas blowing back on the British troops.(94) One of those gassed expressed dissatisfaction with the P helmet then in use. One man spoke of the gas only as an obstacle to British visibility during the attack and as a target that attracted German fire.(95) One anonymous account by a German soldier at Loos claims that the Germans in this man's sector had heard noises that gave away the British gas preparations and were themselves prepared with emergency cloth respirators similar to the early Allied ones, and with boxes filled with tar and straw which, when lighted, lifted the gas over their trenches and enabled them to mow down "the British infantry carelessly advancing with trailing arms."(96)

Robert Graves was at Loos, and his account bears out the anonymous German one in several respects:

> The Germans, who had been expecting gas, immediately put on their gas-helmets: semi-rigid ones, better than ours. Bundles of oily cotton-waste were strewn along the German parapet and set alight as a barrier to the gas. Then their batteries opened on our lines. The confusion in the front trench must have been horrible; direct hits broke several of the gas-cylinders, the trench filled with gas, the gas-company stampeded.(97)

Graves describes the British preparations for the attack, the scepticism of some of the young infantry officers, the many errors (in most cases the gas troops apparently did not have wrenches that fit the cylinder valves), and the indecision and

wrong decisions about releasing the gas under existing wind conditions.(98)

In general, on the basis of these few examples, the reaction of British troops to their first use of lethal gas was one of disappointment and, in some cases, a degree of bitterness at the gassing of friendly troops and the difficulties the gas created. No compunctions about using gas were expressed by these men, with two exceptions, one of which is doubtful. The communications man cited by Foulkes wrote "At 5:45 on Saturday morning we turned the gas on the devils -- it was an awful sight...," but he seems to be referring to the gas itself, as it traveled toward the German trenches, not to its effects. However, Graves quotes a fellow-officer as saying, "It's damnable. It's not soldiering to use stuff like that, even though the Germans did start it. It's dirty, and it'll bring us bad luck."(99)

First Use of Gas Shells

The Germans began using gas shells in the summer of 1916. There was no massive introduction of the shells, which were not intended to soften the lines for an infantry breakthrough but rather to harass troops and neutralize artillery batteries and transport operations. Because the shells did not generally deliver gas in as great concentrations or on as wide a front as cloud attacks, there was no significant tactical surprise associated with their introduction. And since phosgene, which was used in the shells, has relatively little odor, and its lethal effects are often delayed, Allied troops first noticed only shells that didn't explode normally, and thought they were duds. A veteran of one of the earliest attacks said that the men in his unit thought nothing of the shells until they noticed that their pet dog was sick. Once they put on their gas masks (the PHG flannel helmet), "we weren't too bad." However, the harassment effect of the shells seems to have been considerable. The Germans would fire perhaps half a dozen shells, then nothing for an hour, and then "another dose." The gas helmet could not be worn constantly, and for artillerymen there was a special problem: "It was very difficult to lay a gun with these things. You couldn't see, and you couldn't observe very well through them." This man said that his unit took "a lot of casualties," in its first gas shell attack.(100)

Assimilation

Although lethal gas again became an unconventional and forbidden weapon after World War I, it is the judgment of this author that it came in the course of that war to be regarded as a weapon very much like any other, with accepted tactical uses and recognized limitations. Standard measures for protection against it were developed. It is impossible to give a specific date by which this assimilation had taken place, but it can be said with confidence that it had happened by the end of October 1916, or about 18 months after gas was first introduced.

By this time, both sides had considerable supplies of several lung-injurant lethal chemicals and the means to deliver them. Both sides had reasonably effective individual protective devices, gas discipline procedures, training in protection, gas-warning systems, and procedures for protecting shelters and dugouts. Describing preparations for one of the last German cloud attacks, in October 1916, a physician serving with one of the German gas regiments said, "The engineers went about their work with self-assurance and a gradually acquired sense of security, as if it were the work of their normal trade in peacetime."(101)

A British Army chemical officer, interviewed many years later, said that he felt gas could have been decisive both in April 1915 and in December 1915, when phosgene was introduced, but that after that "it became on both sides another weapon -- what I would term another weapon."(102)

By November 1916, both sides had adopted delivery methods best suited to their needs. The Germans had virtually abandoned the cylinder-produced mass cloud attack, probably largely because it was hard to control and risked blowbacks on German troops, especially on the Western Front, where the prevailing winds were against the Germans. It was also a cumbersome method, involving laborious installation, and long waiting periods for suitable wind. The French carried out only 20 cylinder cloud attacks during the war. The British, however, continued to use the cylinder cloud method throughout the war, eventually developing a mobile-cylinder method. The Germans preferred the less lethal but highly flexible artillery-shell method.(103) From late 1916, gas was delivered for specific harassing, neutralizing, or attrition purposes. It was an arrow in the quiver of commanders that might be selected and employed in some circumstances, and which commanders and troops had to be constantly aware of and alert against.

The assimilation process did not, of course, become complete on a specific day. As late as 6 February 1917, General Erich Ludendorff, by that time joint German supreme commander with General Paul von Hindenburg, sent out to all commands a memorandum that said this:

> Our cloud gas has become an effective weapon, and most of the current enemy defense measures are still inadequate....Occasional casualties on our side do not alter the value of the new weapon. Serious German gas poisonings, sometimes fatal, are due in the most part to accidents or to failure to apply protective measures in time. In any event, they are decreasing in relation to the casualties of our enemies...Among the troops there are still misgivings about our gas attacks. [Emphasis added] I ask you to work against this so that the effective gas weapon will be applied as often as tactical considerations, weather, and terrain permit.(104)

What actually happened was this: there were only two more German cylinder-produced gas attacks against the French, the last on 26 September 1917. The last such attack on the British had come on 8 August 1916, and the last on the Russians in December 1916. It is a reasonable guess, on the basis of the document just quoted, that Ludendorff would have liked to continue to use gas in the form of massive clouds but eventually decided not to, largely because of accident-caused casualties to German troops and resulting resistance by troops to the use of gas.

Although gas had largely been assimilated by late 1916, new gases and delivery methods continued to be introduced, and tactics continued to develop. For example, in spring 1917 the British introduced the Livens gas projector, which lobbed cylinders of gas into enemy positions, creating a cloud on the target, and producing such intense concentrations that gas masks could not provide breathable air.(105) All belligerents adopted the projector, and British fatalities from German projector attacks averaged 18%, in contrast to 6% from gas shell attacks.(106) Projectors were far less mobile than artillery shells, however, and for that reason there were many fewer such attacks and many fewer casualties overall.

The most important new chemical agent was the one called mustard gas, introduced by the Germans in July 1917. It is different enough, and is associated with enough changes in chemical warfare, to merit a separate case study.

Summary of Impact of First Use on Troops

The human, or psychological, impact of the first use of gas on attacking troops can be quickly summarized, since little information has been found on it. There is no indication that they were enthusiastic about the weapon, although there is one report that their morale was good because they had been told that the attack would be unusually easy. There are some reports that they were dubious, apprehensive, or lacked confidence in the weapon, because of earlier accidents with the cylinders in the trenches that had caused injuries and deaths. There is a suggestion that in one sector the attacking troops may not have followed the gas closely enough, and if this is true, apprehension about the danger to them of the gas may have been responsible. In later uses of gas, it seems clear that there was apprehension about the danger to friendly troops. No evidence one way or the other has been found as to any ethical compunctions attacking troops may have had about the gas. One general did indicate, after the war, that using gas "went against the grain."

When British troops used gas for the first time -- much less successfully than the Germans -- they also seem not to have been enthusiastic. Some of them were disappointed by the limited effectiveness of the gas, frustrated by the obstacle the gas posed to visibility, annoyed by the way the gas seemed to attract German fire, and dismayed by being caught by the gas themselves

or learning that friendly troops had been gassed. Gas was not an appealing weapon to the men who first used it.

There is considerably more information about how defending troops reacted. During the first 20 minutes after gas was introduced, sizable portions of two French divisions panicked and ran. The first men apparently panicked as the wall of gas approached and they were hit with the overwhelming smell of chlorine. As is characteristic of panic, once a few had broken, and a few more followed, the whole front quickly caught the contagion. A few officers stayed long enough to report to their headquarters what was happening, but the lines had become untenable and all troops either pulled back quickly, or were killed by the gas, or were captured as the German infantry swept into the trenches.

Troops on the flanks of the first attack held well. One or two of the few personal accounts available for that day suggest that men on the flanks and behind the lines felt anger both at the Germans and at the troops that broke and fled. The anger seems to have been associated with a heightened determination not to break, but to do what was required, no matter what the cost.

Many more personal accounts are available for the following days of early gas attacks. They indicate that, in the case of gas, even the most primitive protective devices and some advance warning of what to expect made it much easier for troops to survive and to cope effectively with the psychological impact of the weapon. The accounts, and the historical records of what happened, indicate that, although there were isolated instances of panic and rout, most troops carried out their assigned tasks to the best of their physical ability and with success. The Germans gained no more ground in April/May 1915 as a primary result of gas attacks, although the Allied troops continued to yield territory slowly, largely as a result of the heavy inroads the Germans had made into their lines on the first day.

Some of the men reported feeling anger at the Germans for the "dirty trick" of using gas. Some expressed frustration at having to stay in the trenches and endure the gas; they felt the impulse to run away, or to dash toward the German trenches in attack. Some told themselves to be calm, breathe slowly, look to their troops (if they were officers), being sure they were using respirators and staying upright in the trenches. A few mentioned examples of leadership by officers or comradely behavior by the men that made the experience more endurable.

A good many of the men reported being struck by the appearance of the gassed men, which inspired horror.

It is a likely supposition, borne out by a few personal accounts, that veterans of the first attacks had a continued fear of gas that showed itself in physical symptoms of anxiety and panic in the presence of stimuli that recalled the attack. Along with this reaction went a strong feeling for the importance of the respirator, and anxiety when gas alarms were sounded.

There is no mention of gas malingering in any of the early accounts, and no mention of it has been found in official records or secondary accounts for this period (1915-1916). There are mentions, however, during that period, of men being quick to take advantage of a slight gunshot wound, and mentions of sought or self-inflicted wounds. It is therefore likely that there was also gas malingering, at least after the introduction of phosgene, whose less obvious odor and delayed effect must have encouraged would-be malingerers to claim they had been gassed.

In general, however, at this period of the war, morale and esprit de corps were good, and the troops shared a fundamental confidence in their top leadership. These attitudes are reflected in the personal accounts examined for this study.

Notes to Case Study on Lung-Injurant Gas

1. Claims that the attack of 22 April 1915 did not represent a significant new departure, notably by German writers during and after World War I and more recently by the historian Ulrich Trumpener (see Bibliography), have been noted, but not accepted; the evidence seems to this writer to be clearly against them.

It is often stated that the Germans first used gas on the Eastern Front in January 1915, but that the extremely cold weather kept the gas from being effective. However, the gas used on this occasion was a lacrimator, xylylbromide, similar to agents the French had already used, and cannot be considered a lethal gas under ordinary conditions of use. It was delivered by 15 cm. high-explosive shell; this shell, containing xylylbromide, was called T-shell. Very cold weather did make its first use ineffective. Reichsarchiv, The World War (translated extract), p.1.

2. Hessel, Hessel, and Martin, Chemistry in Warfare, pp. 164-165.

3. Hanslian, Chemical Warfare, pp. 2, 6.

4. Reichsarchiv, Der Weltkrieg, Vol. 8, p. 40.

5. Mordacq, Le Drame de l'Yser, p. 62.

6. Report on Operations of 1st Canadian Division, 22 April to 4 May, 1st Div Hq. files (RG9IIIC3, vol. 4011, Folder 15, File 1). Canadian Archives.

7. Compte-Rendu des operations du groupement d'Elverdinghe. French Archives.

8. Les Armees francaises dans la grande guerre, Vol. 2, p. 699.

9. As reported, for example, in Quinton memoir, p. 52.

10. Worrall interview; Quinton memoir.

11. Groehler, Der lautlos Tod, p. 45; see also Trumpener, "The Road to Ypres," p. 460n.

12. Mordacq, Le Drame de l'Yser.

13. Foulkes, "Gas!," chart facing p. 332.

14. US Army Medical Corps, Vol. 14, p. 273.

15. Love, War Casualties, p. 76. US troops were fighting near the end of the war when mustard was the chief casualty-causing chemical agent.

16. Reichsarchiv, Der Weltkrieg, Vol. 8, p. 40; Crown Prince Rupprecht of Bavaria, Mein Kriegstagebuch, Vol. 1, p. 237.

17. Reichsarchiv, The World War (translated extract), p. 2.

18. Pratt interview.

19. Underwood interview, Take 6. This guess is based on the fact that Underwood did not mention unconventionality in an earlier account recorded on the tape, and that the word "unconventional" does not seem to fit his vocabulary and speaking style.

20. P. 65.

21. Hawkins interview.

22. Unless otherwise stated, this account is based on Reichsarchiv, The World War (translated extract).

23. The French Army from Within; Davis, The French War Machine, p. 87; Croplet, Cinq siecles d'infanterie francaise; Porch, The March to the Marne, p. 204; Challener, The French Theory of the Nation in Arms, pp. 44, 51-52, 82, 143; Memorandum, Paul Beaven, Army Historical Branch, British Ministry of Defence, to author, 25 August 1983.

24. Mordacq.

25. Hanslian, quoting Seesselberg, Trench Warfare, 1914-1918, pp. 407-411.

26. Groehler, p. 32. The account of German preparations is based on Groehler, Hanslian, and Reichsarchiv, The World War.

27. Mordacq expresses bitterness that he was not informed of the intelligence reports. Some field-grade officers did know about the reports but didn't believe them or didn't realize the Germans were preparing to use lethal gas. See, for example, Currie, "The Red Watch", p. 216.

28. Reichsarchiv, Der Weltkrieg, Vol. 8, p. 40.

29. Mein Kriegstagebuch, Vol. 1, p. 237. Rupprecht was not directly involved with the attack, and must have based his statement on reports.

30. Pratt interview.

31. Groehler, p. 44.

32. Phonetically transcribed from tape by author. Another Canadian reported the cry was "Alumen non bon.' Trinity War Book, p. 92.

33. Underwood interview, Take 5.

34. Currie, pp. 214-215.

35. Canadian War Records, Vol. I, Doc. 111.

36. Pp. 64-65.

37. Reichsarchiv, The World War, p. 4. Unless otherwise indicated, German statements below are from the same source.

38. Mein Kriegstagebuch, Vol. 1, p. 237.

39. Canadian War Records, Vol. I, Doc. 118. The left company of the 13th Canadian Battalion reoccupied about 150 yards of French trenches, rallied some of the French troops, and held this open-flanked position for one hour.

40. Canadian War Records, Vol. I, Doc. 117; Mordacq, p. 65; Reichsarchiv, The World War, pp. 5-7. The German source notes French and British counterattacks and air reconnaissance reports of reinforcements moving toward the front.

41. Reichsarchiv, The World War, p. 5.

42. Description of tactical situation from Reichsarchiv, The World War, p. 5.

43. Reichsarchiv, The World War, pp. 2-3.

44. Hanslian, p. 15.

45. Groenler, pp. 31-33; Deimling, Aus der alten in die neue Zeit.

46. Edmonds, France and Belgium, 1915, Vol. 1, p. 163.

47. Reichsarchiv, The World War, p. 4.

48. Dates of the attacks are taken from Edmonds and, in the case of the attack on the French on 24 April, from the French official history (Les Armees francaises dans la grande guerre). Hanslian gives different dates in several cases, and the Reichsarchiv history does not deal with attacks after 9 May.

49. Hessel, Hessel, and Martin, pp. 88-90; Foulkes, Loos chapter; Reichsarchiv, Der Weltkrieg, Vol. 9, pp. 53-55; Reid interview; Moir letter; Myer memoir.

50. Worrall interview.

51. Quinton memoir.

52. Auld; Foulkes, p. 307.

53. Worrall interview; Underwood interview; Hawkins interview.

54. Cotton memoir; Worrall interview.

55. Auld, p. 25; Foulkes, p. 52.

56. Auld.

57. Auld, p. 90.

58. Hanslian, p. 13.

59. Hanslian, pp. 12-13.

59a. The regiment was the 1st Royal Irish Fusiliers. Its good discipline and low casualties are confirmed by a report by its medical officer dated 24 May. Appendix to Report on Gas Attack, 23rd-24th May 1915. WO 32/5169. British Public Records Office.

60. Prentiss, p. 159. Like mustard, diphosgene is a liquid at ordinary temperatures, but all chemical agents used in warfare are customarily referred to as gases.

61. Foulkes, casualty chart.

62. The dangers were considerable. Crown Prince Rupprecht reports that in a "mishap" of 29 April 1916, in which German gas blew back on German troops, 1 officer and 306 men were killed and another 4 officers and 550 men were gas-injured but recovered. Mein Kriegstagebuch, Vol. 3, pp. 84-87.

63. HERO has estimated, on the basis of Prentiss (p. 180) and Foulkes (chart facing p. 332) that for about each 2,400 lbs. of mustard used in World War I, one fatality resulted, while an average of 3,833 lbs. of lung-injurant was required to cause a fatality.

64. Quinton memoir, p. 49.

65. Hawkins interview, Take 2.

66. Cotton memoir.

67. Anonymous Canadian veteran, Trinity War Book.

68. Quinton memoir, p. 50.

69. Ibid.

70. Colyer memoir. Probably the 24 May attack.

71. Great Britain. Report on Gas Attack, 23rd-24th May, 1915. WO 32/5169. Public Record Office.

72. Underwood interview; Hawkins interview; Colyer memoir.

73. Quinton memoir; Colyer memoir.

74. Cotton memoir.

75. Colyer memoir.

76. Hawkins interview.

77. Quinton memoir.

78. Colyer memoir.

79. Ibid.; Hawkins interview.

80. Underwood interview.

81. Barley memoir; Underwood interview; Quinton memoir; Hawkins interview; Kingsley memoir (describing both defending British troops and German troops who were trying to attack with their own gas blowing back on them); and others.

82. Underwood interview; Abbot memoir. Breaking point, as used here, does not denote the disintegration or rout of the unit, but simply that it stopped carrying out its assigned mission. In the noncombat case, the unit finally gave up its effort to find the sector of the line it was to report to.

83. Haldane Report, 27 April 1915. Thomas file, US National Archives.

84. Underwood interview; Kingsley memoir; Hawkins interview. Of course, men who participated in unauthorized withdrawals are much less likely to write memoirs or volunteer for interviews, an assumption that must be kept in mind when analyzing these sources.

85. Report by commander, Canadian 8th Battalion, Canadian War Records, Vol. 1, pp. 239-240. It should be noted that the German official history describes the 24 April gas as a "thinly developed cloud," so it seems likely that it was not as concentrated as that of 22 April, although clearly concentrated enough to cause fatalities. Reichsarchiv, The World War, p.7.

86. Worrall interview; Hawkins interview; Quinton memoir; (panic flashbacks "before we had gas masks.")

87. Worrall interview. Hawkins and Pratt expressed a similar confidence in the leadership.

88. Quinton memoir.

89. Good-bye to All That, pp. 267-268.

90. H. Allen, Toward the Flame (Harper, 1934), quoted in Winter, Death's Men, p. 121.

91. Foulkes, pp. 76-84.

92. Foulkes, p. 72.

93. Moir letter.

94. Reid interview; Stafford journal; Worrall interview.

95. Myer memoir.

96. Imperial War Museum (hereinafter IWM), Miscellaneous Document 469. No further information is available about this man.

97. Good-bye to All That, p. 152.

98. Ibid., pp. 144-165.

99. Op. cit., P. 146.

100. Laws interview.

101. Schroth, p. 15.

102. Barley interview.

103. Hanslian, p. 29; Dorothy K. Clark, Effectiveness of Chemical Weapons in World War I, p. 59; Foulkes, pp. 314-316.

104. Memorandum, signed Ludendorff. Bayr. Kriegsarchiv, IAK Bayr. Armeekorps Gen. Kdo (1914-1918), Vol. 51, File 5, Gasschietz, Gassoffizier, Allgemeine.

105. Volkart, pp. 33-34; Prentiss, pp. 352-357.

106. Foulkes, casualty chart.

Mustard Gas

Introduction

The chief point about the preparation of a case study on mustard gas that needs explanation is the matter of separating it from other toxic gases introduced in World War I and treating it in a case study of its own. The fact is that there were a large number of new chemical agents and delivery systems introduced during that war, many of which were as distinctly different from others as the proximity fuze or ICMs (improved conventional munitions), for example, were from other munitions in use at the time of their respective introductions. These World War I chemical agents and delivery systems included at least the following: chlorine gas, the cylinder-produced cloud method of delivery, the Stokes mortar, phosgene, the Livens projector, gas shells, diphosgene, chlorpicrin, and mustard. There were, in addition, several dozen more agents that were not different enough in their characteristics or military effects to warrant separate consideration.

Mustard has been selected for separate treatment for the following reasons:

- o Mustard is a vesicant, or blistering agent, attacking the whole body through the skin. The other chemical agents listed above are lung-injurant agents that attack primarily the respiratory tract, are not harmful to parts of the body protected by skin, and can thus be protected against by a mask that covers the face and filters incoming air.

- o Mustard is persistent, remaining for hours or days in an area, and retaining its toxicity.

- o Mustard is not a gas. It is a liquid at temperatures above 57 degrees F. and -- when not mixed with other substances that keep it liquid -- is a crystalline solid below that temperature. (It is nevertheless properly called a gas in a military context, because all poisonous chemical agents used in warfare are officially termed gases as a matter of convenience.)

- o Mustard was used for military purposes sharply different from those of other gases.

- o Once it was introduced, mustard accounted for <u>far more casualties</u> than any other gas, and for <u>far fewer fatalities</u> in relation to casualties.

- o This distinctly different chemical agent was considered so effective that it came out of the war with the generally acknowledged title "King of the Battle Gases."

Once it was decided that mustard was different enough to be treated in a separate case study, there was no problem with other

criteria for selection. There is a great deal of data in English, French, and German on the introduction and use of mustard, and the weapon was deliberately used, at least in World War I, entirely against military personnel. Unfortunately, few first-hand personal accounts of early experience with mustard have been found, but this paucity is something that could not be ascertained until a careful search had been made. The very absence of personal accounts gives some indication of the reaction to the introduction of the agent.

The Weapon

Description

So-called mustard gas is the chemical compound dichlorethyl sulfide, with the formula $S\begin{smallmatrix}\diagup CH_2\text{-}CH_2Cl \\ \diagdown CH_2\text{-}CH_2Cl\end{smallmatrix}$. It is an oily, colorless (brown in its crude form) liquid at ordinary temperatures, with a boiling point of 217 degrees C. (422.6 degrees F.) at 750 mm. pressure. As a gas, it is five times as heavy as air. The liquid evaporates slowly, and the vapor is toxic, although much less so than the liquid.(1) Mustard is stable under ordinary conditions, but it undergoes hydrolysis in the presence of water. Because of its stability and density, it was extremely persistent under combat conditions, clinging for days to earth and foliage in dry weather, especially in trenches and hollows.

Mustard is practically odorless in low concentrations, including concentrations strong enough to be harmful. In strong concentrations it has an odor variously described as like mustard, garlic, or horseradish -- hence its common name.(2) Rothschild says that mustard is virtually odorless when used in pure form, but when impure has the mustard or garlic odor. The US Medical Department volume says that it can be detected at about 1 part in 3,000,000.(3) In any case, after the first few breaths, the olfactory nerve no longer responds to the odor.

There are no other immediate effects that the person exposed notices; the chemical passes through the outer layers of the skin without causing pain. It readily penetrates clothing and boots. Symptoms appear in two to six hours. Exposure for a few minutes to a concentration of one part to 30,000 parts of air causes fatalities.(4) The Medical Department history states that the lethal concentration is 0.05 mg. per liter (7 ppm.)(5)

Mustard, as indicated in the introductory section, is a vesicant; that is, it blisters tissue. The eyes, skin, and respiratory tract are most severely affected, with injuries ranging from redness and irritations in cases of light concentrations to destruction of skin and mucous membrane. The first symptoms are nausea, vomiting, and inflammation of the eyes and skin. Temporary blindness, which required several weeks for recovery, was a common result in World War I. The casualties who became fatalities usually died of pneumonia after two days to

four weeks. Only about 2 percent to 5 percent of those injured by mustard did die, but 25 percent of all US casualties were mustard gas casualties, so the total numbers are high. The areas of the skin most frequently burned by mustard were the genitals and face.(6) One source suggests that the low percentage of deaths to casualties was due to the frequency with which severe burns resulted from exposure, rather than to any low lethality of mustard. Mustard is several times more toxic than the same concentrations of phosgene.(7) However, it must be remembered that phosgene was not delivered in highly lethal concentrations, once cloud attacks ceased and shell attacks became the rule, about a year before mustard was introduced. The British lethality-to-casualty rate for gas for that year previous to mustard was 6 percent.(8)

Dichlorethyl sulfide was not a newly developed chemical. It had been synthesized by scientists in the 1850s, and its toxic properties were fully described at that time. Both British and German scientists carried out early studies of the chemical, and the Germans developed a means of production, which they used in 1917. The British had explored the possibilities of using mustard before 1917, and had decided against doing so, mainly because of the difficulties and dangers involved in manufacturing it.(9)

Mustard was delivered by shells, fired from regular artillery guns or mortars. By the time it was introduced, this was the usual method for delivering gas. In addition, land mines were later used by both sides. The US land mines were simply one-gallon tin cans of the kind used to hold varnish or syrup, exploded by a slow fuze or electrical device and spreading mustard over a considerable area.(10)

Mustard is neutralized by chlorine or chlorinating agents, which convert it into harmless higher chlorides. The Germans used chloride of lime (mixed with water) to decontaminate mustard-affected areas.(11)

Purpose

Mustard, like chlorine two years earlier, was introduced in an effort to break a stalemate -- in the case of mustard, the stalemate between offensive gas efforts and defensive gas measures. By mid-1917, if a gas was to have any substantial effect, it had to bypass the protective gas mask. As matters stood, the only gas casualties occurred when troops were careless or inadequately trained in using the gas mask, when complete surprise could be achieved, or in the few cases when the British, by use of the Livens projector, were able to saturate the air with gas. The chief purpose for which mustard was introduced was to get past the gas mask. It lent itself to certain very specific military purposes, such as isolating the battlefield by denying areas to the enemy, but it is not certain whether the tactics of using mustard in these ways were foreseen when its introduction was first planned.

Differences from Other Weapons in Use at the Time

Although, as has been indicated, mustard is actually several times more toxic than phosgene, its lethality was not greater than that of high explosive weapons, and was clearly not a significant factor in its psychological impact on troops, as compared with the impact of other weapons. It was difficult, because most mustard casualties were relatively minor, to make officers -- including gas officers -- and troops realize the seriousness of mustard. As late as September 1918, Canadian Corps headquarters found it necessary to send a message to all its commands stating, "It should be realized by all troops that Yellow Cross Gas [so called from the yellow cross on the German mustard shell] is often strongly lethal," and citing the case of 13 out of 15 men who died after a mustard shell burst inside their shelter.(12) In a book published in 1918, S. J. M. Auld, chief gas officer for the British Third Army, said that mustard was "not a killing gas like Green Cross [highly toxic lung-injurants, including phosgene and chlorpicrin]."(13) In the post-World-War-II period, mustard was classified by at least one authority as an incapacitating, rather than a lethal, weapon.(14) Certainly, whatever the theoretical or statistical lethality of mustard, it was not perceived by troops as being more lethal than earlier weapons.

It is thus very difficult to come to conclusions about the operational lethality of mustard. However, using Prentiss's statement that it took 60 pounds of mustard -- on the average -- to cause a casualty in World War I, in contrast to 230 lbs. of lung-injurant gas, together with Foulkes's figures showing that British gas fatalities in the shell gas period before mustard were 6 percent of casualties and those in the mustard period were 2.5 percent of casualties, it appears that about 2,400 lbs. of mustard caused one fatality while it took about 3,833 lbs. of lung-injurant gas to cause one fatality.(15) These calculations suggest that mustard was indeed more lethal than earlier gases of World War I. However, using the Foulkes figures for shell gas probably distorts the picture, since the earlier cloud attacks had a much higher lethality-to-casualty ratio. To pursue this matter further would require research beyond the scope of the present study.

Mustard burns could be disfiguring. Tissue destroyed by mustard was permanently destroyed. However, most of those who were injured did recover, and on the average took less time to recover than those wounded by gunshot. In any case, the disfiguring effects, which were probably less than those from comparably severe gunshot wounds, appeared long after exposure, and were not known to the first troops affected by mustard.

Following are characteristics of mustard which did differ from those of earlier weapons, and which might be expected to have special impact on attacked troops:

o Mustard is insidious, giving little or no warning of its presence and not causing symptoms until hours or even days after the attack. Thus, there could be little impact on troops of the first use at the time of the first attack. However, once the effects of mustard were known, it might be expected that troops would become apprehensive of future attacks, perhaps suspecting the presence of mustard even when it was not being used.

o There appeared to be no adequate defense against mustard. A gas mask protected the eyes, face, and lungs, as long as it was kept in place, but there was no protection for the rest of the body; attempts to find an effective protective ointment were unsuccessful. As late as June 1918, the chief of staff of the US 2d Division wrote

> The gas discipline of the men is excellent, and every man had and used his mask. The casualties were largely due to body burns, caused by clothing saturated with mustard gas. These we consider unavoidable casualties, when it is recognized that the troops occupied wooded and thickly grassed positions which had to be held.(16)

These burns were not fatal unless they became infected.

o The body areas most affected by mustard were the lungs, eyes, and genitals. The eyes could be protected by gas mask, but troops -- especially artillerymen -- often removed the face piece of the mask in order to see better, retaining the mouthpiece and nose clip that protected their lungs, but exposing their eyes to mustard. There is, not surprisingly, some evidence that troops fear wounds to the eyes and genitals (along with the abdomen and brain) considerably more than wounds to other parts of the body, such as the face, extremities, limbs, and upper torso.(17) The proportion of those wounded by mustard who suffered eye injuries and burns to the scrotum is striking. Following are reports from two US Army evacuation hospitals (Table 5).

Evacuation Hospital No. 7

Total number of cases examined, 250.

Those presenting symptoms of—	Number	Percent
Respiratory tract	197	80
Eyes	148	60
Nose bleed	6	2.4
Vomited	93	38
Burns of the—		
Face	16	6.4
Neck	7	3
Chest	5	2

Burns of the—	Number	Percent
Belly	0	0
Back	11	4
Axilla	2	0.8
Scrotum	55	22
Arms	6	2.4
Hands	2	0.8
Thighs	9	3.6
Feet	1	
Buttocks	1	

Evacuation Hospital No. 8

Total number of cases examined, 152.

Those presenting symptoms of—	Number	Percent
Respiratory tract	126	83
Eyes	143	94
Nose bleed	8	5
Vomited	63	41
Burns of the—		
Face	72	47
Neck	35	23
Chest	13	8
Belly	8	5.3

Burns of the—	Number	Percent
Back	25	17
Axilla	11	7.3
Scrotum	84	56
Arms	13	8.6
Hands	0	0
Thighs	13	8.6
Feet	0	0
Buttocks	9	6
Legs	8	5.3

From this table it will be noticed that 77 per cent of the cases had eye infections, 81 per cent respiratory symptoms, 40 per cent burns of the scrotum and 40 per cent had vomited.

Table 5: Mustard Gas Injuries in Two Evacuation Hospitals.

Source: US Army Medical Department, The Medical Department in the World War, Vol. 14, p. 69.

o Mustard, since it caused what were in effect burns, was extremely painful, though not for hours after exposure. One nurse wrote, "Gas [mustard] burns must be agonizing because usually the other cases do not complain even with the worst wounds but gas cases are invariably beyond endurance and they cannot help crying out."(18)

In addition to their direct effects on troops, mustard's characteristics had certain tactical implications. Because it was persistent, mustard could not be used as part of a preliminary bombardment for an assault; attacking troops could not move through it. But it could be, and was, used to deny a given area to enemy troops, and was used in the offense to isolate the battlefield, hampering defenders in attempts to commit reserves. On the defense, the area-denying effect was very useful. However, mustard could not stop an attack in progress, because its effects were so much delayed. One significant effect of mustard was the removal of large numbers of enemy troops from the front. Even though they would be well enough to return in a few weeks or months, they were lost for the time being -- as, for example, Allied troops were lost during the great German offensive of March 1918.

Since the Germans had a monopoly on mustard for a year after its introduction, up to the last months of the war, it was largely they who took advantage of its militarily useful characteristics.

Circumstances of First Use

Mustard gas was first used by the Germans against British troops in July 1917. The date was probably the night of 12/13 July.(19) The place was the Ypres area of Belgium, where poison gas, in the form of chlorine clouds, had first been used two years earlier.

The Germans were on the defensive, tactically, as British Field Marshal Sir Douglas Haig had launched an offensive which he hoped might capture the German submarine bases of Ostend and Zeebrugge, drive the Germans from the Flemish coast, and thus open a flank of the seemingly impenetrable German lines. The offensive had opened well for the British, with the taking of Messines Ridge by massive mining that culminated in an explosion heard clearly in England (7 June). There was then a lull, however, and the Germans took full advantage of it. They established field fortifications in depth, and had counterattack divisions ready. The British sector nearest the coast was heavily counterattacked on 10 July and the two line battalions that were east of the Yser River were isolated and virtually destroyed (see case study "Air Attack on Ground Troops").

The Allies opened an offensive on 11 July, began a massive artillery bombardment on 18 July, and sent the infantry over the top on 31 July. Meantime, on 12/13 July, the Germans had begun saturating the town of Ypres with mustard, in addition to other

gases and artillery bombardment, continuing heavy mustard attacks until mid-September.(20) British and Canadian artillery batteries were favored mustard targets. On the night of 28/29 July, just before the Allied infantry offensive, both flanks of the British front -- the towns of Nieuport and Armentieres -- were simultaneously drenched with mustard. British casualties were 3,019, including 53 killed.(21)

Complete surprise was achieved in the use of mustard. The British had considered, but rejected, the use of this agent, and, once they realized that some new chemical had been used, did not at first know what it was. (The French, who were heavily hit by mustard in August and September 1917 at Verdun, were similarly unprepared.)

Defenders' Response(22)

Since the effects of mustard are delayed by two to six hours, there was no immediate response by troops or commanders. This was a weapon, which, by its nature, could not produce panic when first used. From two detailed accounts by veterans of early mustard attacks, neither of whom had any previous knowledge of mustard, the following description of troops' first response to first use can be constructed:

Many of the men realized that gas shells were falling because of the "popping" sound, quite different from the violent detonation of a regular artillery shell. They also noticed a "pungent smell," like mustard, garlic, or horseradish. They were equipped with box respirators, which they promptly put on. Those who didn't put on their respirators felt some slight irritation of the nose and throat, and concluded this was not a very severe gas attack. Officers removed their respirators from time to time to shout orders, especially if this was not the first attack of 12/13 July but was two weeks later, when the affected men had the mission of advancing and taking objectives. Artillerymen found their respirator goggles fogged by droplets of mustard, or simply by condensation of their body heat, and dropped the facepieces of their respirators so that they could see to lay their guns; they knew they were protecting their lungs as long as they kept their noseclips on and breathed through the breathing tube, and they had no warning of what the mustard was doing to their eyes. Most men, checking the air after an hour or two and finding no odor and no obvious irritating effect, thought the gas was gone and removed their respirators completely. None of them realized the gas would still be there the next morning and made more active by the heat of the sun. Some who had been exposed to mustard found shelter in gas-proofed dugouts and slept for hours with men who had not been exposed, not realizing that the mustard was on their clothing and would contaminate the whole dugout and attack everyone in it.

Another factor that must have led to men taking off their respirators was the fact that the Germans were firing a second new gas, known as Blue Cross, which acted as a "mask breaker."

Blue Cross shells contained sternutator (sneeze-causing) agents (diphenylchlorasine in the first shells) which were effective in getting through respirator filters and causing respiratory irritation, sneezing, and vomiting that forced troops to remove their respirators and left them vulnerable to mustard (and to lethal lung-injurants like phosgene).(23)

The men who had removed their respirators began to have watering eyes, then sore eyes, then extremely painful eyes, then eyes swollen shut, and blindness. One man's description conveys a graphic feeling of disorientation and helplessness:

> ...I was totally blind. I began to stagger and stumble, aimlessly and helplessly, falling over the broken and churned-up ground, and into shellholes. In this plight someone clutched my arms, whether friend or foe I didn't know, and [I] was relieved to hear him say, "I am Major M.A. Hold on to my belt and follow me." Others in same condition were collected on the way and joined up in single file behind.(24)

This man had a slow, hazardous trip back, including crossing a canal on broken duckboards. He lost consciousness, was sent to England, and spent six weeks there in a hospital, plus seven days' leave, before being reassigned, apparently completely recovered. He does not describe any gas injuries except the blindness. He discusses what he thinks were the tactical effects of the mustard -- helping to stop the British offensive short of its objectives. He does not express anger or bitterness. He seems to have taken his gassing as a stroke of good luck, although not one he would have sought.

> Afterward, I learned that we were taken to a Casualty Clearing Station and sorted out....I was marked "severe,"... which meant I was for "Blighty" [England]. That was what every wounded soldier hoped for! Two of the Platoon Commanders in my Company had been killed. The total number of casualties I never knew.(25)

Casualties for the first mustard attack of 12/13 July are given as 2,143 British, including 86 killed, and 347 French, including 1 killed. For the period of intense gas attack, in which several gases, but predominantly mustard, were used, from 14 July through 4 August, British gas casualties totaled 14,726, including 500 killed.(26)

Both the personal accounts of first experience with mustard that have been examined reflect good morale, confidence in leadership, and no special horror of mustard, even when, in one case, an interviewer spoke of it to the veteran being interviewed as "one of the new and most horrible weapons of the First World War." It seems to have been accepted by these men as just another fact of war.(27)

As for the tactical effects of the introduction of mustard gas, it certainly hampered the British preparations for a major offensive -- the second phase of the Third Battle of Ypres. The Germans suspected that it might have caused delay in the offensive. They held high ground that allowed them a clear view of Allied preparations, and the heavy initial mustard attack of 12/13 July was apparently intended to spoil an Allied assault which the Germans believed was set for 13, 14, or 15 July. However, British sources do not indicate such an assault date, and the most thorough German treatment of the subject acknowledges that "it is nowhere recorded" that the British attack was to start on one of those dates.(28) It is more likely that the long British delay was caused by waiting for French participation and by the changes in plans and preparations resulting from a change of commanders Haig made after the Messines ridge was taken and before the second stage began. Haig's offensive did fail in its objective of freeing the Channel U-boat ports and outflanking the German line (although it made a contribution to the Allied cause by easing pressure on the mutiny-shaken French army). Probably the veteran whose memoir is cited above was right when he wrote, "Unfortunately, the right arm [of the intended double envelopment] failed to achieve its objective [, just] as ours did, partly for the same reason of mustard gas, but more because of the mud of Passchendaele."(29) To the mud must be added the slowness of the British commanders in making their preparations.

Attackers' Response

Little has been found on the German troops' and commanders' attitudes toward mustard before it was used, or their responses afterward. It is unlikely that there was any special reaction beforehand. The mustard shells looked just like any others, except for their distinctive markings, and enough new gas shells had been introduced to make it unlikely that another would arouse any great curiosity. Because of the persistence of mustard, and its ability to penetrate clothing and boots, special efforts did have to be made to protect friendly troops. Chloride of lime solution was kept ready for use, and mustard released by accident or enemy action had to be promptly decontaminated.

German unit records and histories for the period clearly imply a very positive response by the troops to the use of mustard. One artillery regimental history says that the massive contamination shellings with Yellow Cross "gave the defending troops a feeling of relief," because Allied counterbattery fire often diminished or ceased altogether afterward.(30) Another source says that the heavy Yellow Cross shellings had the "remarkable" effect that "the enemy was well behaved for one to two days."(31) The history of the 16th Dragoons states: "All of Ypres and especially the battery positions there were for the first time systematically contaminated with Blue and Yellow gas. Result: Two days of utter quiet at Ypres."(32) These statements are included here because their references to relief and quiet seem to reflect psychological responses of troops as well as a

reporting of military events.

The tactical purpose of the introduction of mustard gas and its intensive use during July and August 1917 in the Ypres area was defensive -- to harass, delay, and weaken a major Allied offensive. A goal like this is relative, and since many other variables affected the degree of success of the Allied offensive, no clear-cut answer can be given on the achievements of the mustard-gas shellings. It can be said, however, that the Germans made good use of the properties of mustard to support their defensive goals, and its employment assisted those goals, probably significantly.

Adaptation

German Adaptation

After the first attack on 12/13 July 1917, the Germans carried out Yellow Cross (mustard) shellings almost every night for three weeks, through 4 August. As indicated above, the British suffered 14,726 casualties from mustard, including 500 killed, during this period.(33) A relatively recent German study states that even more mustard was fired between 4 August and mid-September.(34) The German tactics for the use of mustard seem to have been well developed before the agent was introduced. The Germans called mustard tactics "toxic fire," and their aim was to create "yellow zones" -- areas so contaminated with mustard that they could not be used by the enemy.(35) This was primarily a technique for defense.

By the summer of 1917, German chemical warfare tactics for both offense and defense had been rather fully worked out. Having analyzed the situation and recognized that the Allied troops had individual protection against all gases, they decided there were only four ways to get effective results from gas:

- Surprise; sudden delivery of gases in such high concentration that enemy troops had no chance to adjust their respirators before being overcome.
- Prolonged bombardment; bombardment so long lasting that the enemy could not stand to wear his respirator any longer and took it off.
- Deception; delivering gas in such a way that the enemy did not know he had been attacked, and therefore failed to use his respirator.
- A new gas that evaded the respirator.(36)

The Germans systematically and fairly successfully worked to achieve all these ways around antigas protection. Mustard gas met the requirements of the second, third, and fourth methods.

As indicated above, Blue Cross had the ability to force troops to remove their respirators. Thus, by using what they called "varicolored fires" of Blue Cross (sneezing and vomiting gas) and Green Cross (lethal lung-injurant gas), the Germans could achieve an effective offensive gas weapon. This technique was used successfully on the Eastern Front on 1 September 1917. The use of Yellow Cross (mustard) in combination with Blue Cross at Ypres was a variation of varicolored fire useful for the defense. The "yellow zone" technique of denying areas to an attacking enemy by mustard gas saturation, which was effective at Ypres, was also used at Verdun against French attacks in August and September 1917.(37)

In summary, German analysis and planning had effectively integrated mustard gas into German tactics before it was introduced. Further analysis and planning adapted mustard gas to offensive efforts preparatory to the great German offensives of 1918. For example, for days before the spring offensives, heavy concentrations of Yellow Cross were fired far into the zone over which the attack was to move, creating yellow zones. These "acted in the manner of advance bastions, so to speak....Crossroads, towns, or villages, battery positions, and woods or standing crops constituted desirable targets." The bombardment stopped two or three days before the attack, so that, in the relatively warm weather of spring, the mustard would have dispersed before the German troops reached the areas. Meanwhile, artillery batteries were neutralized and troop concentrations disrupted.(38)

Another 1918 innovation was high explosive/gas shell, which, unlike the "popping" gas shells of 1917, was three-fourths high explosive, and thus did not announce to enemy troops that it was a gas shell. In addition to the surprise achieved, the shell was an effectively deadly artillery shell with "a splinter effect only little below that of a real high explosive shell."(39) The Yellow Cross version of this shell was also much more effective in spraying droplets of mustard onto enemy troops' bodies and clothing, and into the air breathed by anyone who was caught without his respirator. Since mustard liquid is much more toxic than mustard vapor, a striking increase in the seriousness of respiratory damage from mustard was noticed by Allied medical personnel.(40)

In summary, although further adaptations of technology and tactics were made in the six to eight months following the introduction of mustard gas, the Germans had already integrated it successfully into their tactics before introducing it. It was primarily useful as a defensive weapon, employed to neutralize artillery batteries and to deny areas to the enemy.(41)

Allied Adaptation

Three days after the first use of mustard, and before the new agent had been identified, a message went out from General Headquarters of the British Expeditionary Force to all subordinate headquarters:

A new type of gas, smelling slightly of garlic or mustard, has recently been used in shell by the enemy on the Fifth Army front. Owing to the fact that the smell from this gas is not very noticeable, and that the immediate effect on troops exposed to it is only a slight irritation of the nose and throat, a considerable number of casualties have been incurred by men failing to realise that gas shell were being employed. This fact might, however, have been inferred from the nature of the bombardment, which included a very large proportion of shell with a small explosive effect.

All ranks should, therefore, be warned that any shell which causes only a slight explosion usually contains gas, and that precautions must be taken at once, even if no actual gas can be smelt or recognised.

Although no immediate lachrymatory effect is experienced, this gas seriously affects the eyes.

Box Respirators should, therefore, be properly adjusted at once. The face-piece must not be allowed to hang down with the mouthpiece in the mouth and the noseclip adjusted, leaving the eyes unprotected. Precautions should be taken to prevent men removing their Respirators without orders (S.S. 534 S.60 (iv.))....(42)

Despite this prompt analysis and communication of the nature of the new weapon, commanders and gas officers did not have very much success in getting troops to follow these orders consistently. In fact, throughout the remainder of the war, there was a constant and only partially successsful effort to have the men promptly adjust their respirators and leave them on as long as there was mustard contamination in the area.

A report from a British First Army gas adviser, dated 19 July, gave more details about the first attack (12/13 July) and about the effects of the gas.(43) Of the casualties in the first attack, 45 percent were slight and could return to duty in two weeks or less, 12 percent were serious, and 2 percent had died by that time, a fatality-to-casualty rate slightly under that for mustard in the war as a whole. The box respirator that the British troops were using had been tested with the contents of an unexploded mustard shell and found to give complete protection. The casualties had resulted from men not putting on the respirator promptly, or taking it off too soon, or dropping the face-piece and exposing the eyes. As another gas adviser report, dated 17 July, pointed out, the problem was that the immediate effects were "trifling," and had been ignored. Men had gone to sleep after the bombardment ended and waked up with severe eye pain. Because the severe pulmonary symptoms that could lead to death from pneumonia were so rare, these advisers thought they might be caused by another gas being fired at the same time. It now seems clear, however, that they were rare because most men kept their mouthpieces and noseclips on, exposing only their eyes.

As indicated above, artillery batteries were favored targets for mustard gas shellings, and mustard was especially suited for

this mission. A bombardment with high explosive shell might damage one or two guns and kill and wound several men, but the rest could go on firing, and in a few hours the damage might be repaired and personnel replacements go into action. With mustard shell, all the men in the battery would be affected. If they did not remove their facepieces and goggles, they would be seriously hampered in firing their weapons. If they did, they were likely to be out of action for days or weeks. In either case, the whole environment of the battery would be contaminated with mustard for hours or days, the men would be painfully burned if they sat or lay on the ground, and any replacements would be injured also. Thus the battery was effectively neutralized. The German regimental accounts quoted above show how successful these counterbattery fires seemed to troops on the side firing them.

The experience of Canadian artillery units during heavy mustard bombardments of August 1917, when the Allies were attacking in the Third Battle of Ypres, suggests the problems of adapting to mustard. This discussion is based on a group of reports from Canadian 1st Division Artillery headquarters, brigade commanders, and individual battery commanders on a mustard shelling of 17/18 August. This was a month after the first attacks, and these officers were well aware of what mustard was and of the precautions that should be taken against it. The division artillery commander states that there was excellent gas discipline throughout the two brigades involved, and cites as evidence the fact that there had been no gas casualties during a gas bombardment a few days earlier, before the second phase of the Allied assault began on 16 August. As he points out, Allied troops were not then advancing, and the artillery was not firing in support of them. Under these circumstances they were meticulous about wearing their respirators.(44)

However, it was different on the night of 17/18 August:

> There can be no doubt that on the night in question many men, especially the No.'s 2, 3 and 5 [of the gun crews], removed the face-piece of the Box Respirator in order to be able to see to carry out their duties. I believe these men did so with a full knowledge of the probable consequences, but were determined to do what they thought was required of them at all costs, and that it was not done either from carelessness or ignorance.
>
> The Small Box Respirator, while affording a perfect protection from gas, is not suited for use with poorly illuminated sights. The illumination is so indifferent that even without goggles it is difficult to read the graduations, while with goggles the very film applied to prevent fogging practically renders it impossible to see the markings. The shape, too, of the mask is such as to very much limit the angle of vision, and it is necessary to bring an object immediately in front of the eyes to see it at all. This is a very important detail that requires remedying.(45)

The 1st Brigade Artillery report reinforces this picture:

Men were working at very high pressure serving the guns and bringing in ammunition. The light in the pits was poor and the No's 3, 2, and 5 are nearly certain to have taken off their gas masks to see to do their work properly, preferring to suffer from gas, than to letting down the infantry, through slackening their rate of fire. It is nearly impossible to see well enough at night in gunpits to serve guns adequately and quickly.(46)

Likewise, the 2d Brigade Artillery reported this:

The gunners have been trained and so disciplined that an "S.O.S." calls for any sacrifice to give an accurate and intense rate of fire. Consequently I have no doubt that No's 2, 3, and 5 in several cases removed their respirators.(47)

In the 1st Brigade, about 80 to 85 percent of the men in the 1st, 2d, and 6th Batteries were evacuated, apparently most of them for mustard injuries.(48)

An adequate defensive adaptation to mustard would have included a more comfortable mask that could have been tolerated for longer periods of time; goggles that provided much better visibility; better illumination of gunsights; and protective clothing that could not be penetrated by mustard and still allowed free movement. Research for this study did not discover whether or not significant visibility improvements were made. However, the British small box respirator was used by British troops throughout the war and was also used by US troops. Complaints that it was uncomfortable continued. French and German masks were somewhat different, and in some ways better, but they had their own disadvantages. The final German mask, for example, was very tiring for the neck muscles, since the entire weight of the mask was carried by the head. The French Tissot masks had a feature that prevented fogging by drawing incoming air across the eyepieces, and was used by some artillerymen, but it was too clumsy and hard to adjust to be used effectively by front-line troops.(49)

The problem of protective clothing was never solved during World War I. Troops were warned not to sit or lie on contaminated ground and not to enter dugouts or shelters while wearing clothing that might be contaminated, but as indicated in the US medical report cited above (under "Differences from Other Weapons in Use at the Time"), in the reality of combat it was often not possible to heed the warnings.

Defensive training for mustard never seems to have been adequate. One reason was probably the fact that, because such a high proportion of the casualties were relatively minor, it was very hard for commanders, and even gas specialists, to grasp the seriousness of mustard. As mentioned earlier, Major Auld, Third Army gas adviser, in his book on chemical warfare published in 1918, devotes only a few pages to mustard. While he acknowledges

that it is "a nasty proposition," he says it is "not deadly poisonous" -- "not a killing gas like Green Cross." In effect, this leading expert on gas warfare treated the most effective gas weapon of World War I as a minor matter.(50)

Also, mustard was introduced late in the war, after gas procedures were well established. Inertia probably played a role in the lack of attention given it. One result was that some US gas training manuals, based on British practice of 1917, virtually ignored what, in practice, was to be the major gas weapon American soldiers would meet.(51) Training for British and Americans alike was centered on the lecture; the injunction that in a gas attack there were only two kinds of soldier, "the quick and the dead"; and the minutes in the gas chamber with respirator on. There does not seem to have been enough training in recognizing different kinds of gases, and certainly not enough indoctrination in the persistence of mustard and the importance of keeping the entire respirator on for long periods. One US Marine veteran tells of a number of men being gassed with mustard after a young lieutenant told them they could remove their masks.(52)

In brief, despite the efforts of some concerned officers, mustard was never taken seriously enough, too little attention was paid to it in gas training, the difficult problem of protecting the skin of the entire body was never solved, and a respirator that provided good visibility and that troops were willing and able to tolerate for long periods of time was never produced.

Allied Use and German Troop Response

Germany alone had mustard gas for the first year after its introduction. The British had explored the possibilities of using mustard before 1917 and had decided against doing so, mainly because of the difficulties and dangers involved in manufacturing it.(53) After the German introduction, both the French and the British began development and production. By spring of 1918 the French were manufacturing "Yperite" -- their mustard -- and they introduced it that summer. The British probably first used mustard on 26 September 1918, less than two months before the war ended.(54)

A German report of 4 August 1918, describing the first mustard experience of one group of German troops during the period 20-30 July, suggests that the Germans experienced the same problems the Allies had, even though they had had an additional year to prepare for defense against mustard. The men suffered severe eye inflammation and temporary blindness, and burns to the rest of the body, especially the sexual organs. Some of them complained that the gas mask did not protect against this new gas, but careful investigation showed that in all these cases the men had removed their masks during a long interval when there was no shelling, then put them back on when there was new shelling, and then become ill from the delayed effects of mustard they had

been exposed to while their masks were off.(55) Some Allied troops had also believed the mask was inadequate for mustard, for the same reason.(56)

Another German Army report of August 1918 shows the Germans seeking to adapt Allied mustard tactics to their own use. The authors of this report noted that the Allies (presumably French) had been firing mustard shell primarily between midnight and 4:00 AM, and that (mustard) gas fired at that time has its strongest effect in the morning, when the sun warms it. This necessitates using the gas mask for hours. Also, it is impossible to find shellholes and decontaminate them at night. Therefore the following directive for German gas procedure was recommended by German First Army and endorsed by higher headquarters:

> Yellow-cross shelling is best carried on between 0100 and 0400. At first, the enemy will be compelled to put on gas masks. If the gas can no longer be identified by odor after a few hours, the enemy soldier will probably remove his mask and then later become ill after sunrise from the effects of the haze. Apart from battery positions, the recognized main line of resistance and especially the groups of shelters [and] machine gun emplacements . . . should be covered with Yellow Cross to the extent that weather permits; construction of new trenches, especially if they are in new sectors, could be significantly disrupted by Yellow Cross shelling.
>
> Every enemy attempt to eliminate the after-effects of our nightly gas shelling early in the morning is to be prevented by fire strikes with rifles, machine guns, trench mortars, and artillery.(57)

One German soldier who had his first experience with mustard in the first British mustard attack was Adolf Hitler. His account is given below. it is clear that this was a new experience for which these German soldiers were unprepared, even though the Germans had been using mustard for so long. Hitler's account of his own symptoms sounds authentic, but it seems doubtful that others in his unit "passed out," some "forever," from the effects of mustard. If they were wearing their respirators they should not have passed out, and even if they were not, it seems unlikely that they passed out forever so soon after breathing mustard. Most fatalities came days or weeks later from pneumonia.

> In the night of October 13, the English gas attack on the southern front before Ypres burst loose; they used yellow-cross gas, whose effects were still unknown to us as far as personal experience was concerned. In this same night I myself was to become acquainted with it. On a hill south of Wervick, we came on the evening of October 13 into several hours of drumfire with gas shells which continued all night more or less violently. As early as midnight, a number of us passed out, a few of our comrades forever. Toward morning I, too, was seized with pain which grew worse with every quarter hour, and at seven in the morning I

stumbled and tottered back with burning eyes, taking with me my last report of the War.

A few hours later, my eyes had turned into glowing coals; it had grown dark around me.(58)

Summary of Impact on Troops

Although mustard was an extremely effective weapon, although its introduction ushered in a new phase of chemical warfare in World War I, and although the troops and commanders first attacked by it had no warning of its use and no knowledge that their enemy possessed it, there was no panic by troops when it was introduced. This was undoubtedly because of the delayed effects of the weapon, which were not felt until two to six hours after exposure. In addition, the first symptoms were relatively mild, and it was more hours, or days, before the most serious effects were experienced.

Even though mustard caused very painful injuries and attacked parts of the body that are especially sensitive psychologically, there does not seem to have been any special horror of it. That is, it does not seem to have been as much feared as high-explosive artillery shell, and was certainly no more feared.

Throughout the remaining year of the war it was difficult to impress upon officers and men the importance of taking protective measures against mustard.

Troops using mustard for the first time were pleased by the relief it brought them from enemy artillery fire. This is the only response from user troops that has been found.

When the Allies first used mustard the following year, the defending German troops had much the same response as the Allied troops had had earlier: they took off their gas masks too soon, not realizing the persistence of the gas, and some thought that their masks were not effective against the new gas, even though in reality they were.

Notes to Case Study on Mustard Gas

1. US Army, The Medical Department, p. 301. Other information in this paragraph is from Hessel, Hessel, and Martin, p. 169.

2. Hessel, Hessel, and Martin, p. 169; Rothschild, p. 37; US Army, The Medical Department, p. 54.

3. P. 302.

4. Hessel, Hessel, and Martin, p. 170.

5. P. 301.

6. US Army, The Medical Department, pp. 69, 276-279. A detailed discussion of the physiology of mustard's effect on living tissue is given by Prentiss, p. 186.

7. Hessel, Hessel, and Martin, p. 95.

8. Foulkes, chart facing p. 332. This ratio is in contrast to a fatality/casualty ratio of 24 percent for the earlier cloud gas attacks, and a similar ratio of about 25 percent for gunshot weapons. Foulkes, ibid.; Love, War Casualties, p. 76.

9. Hessel, Hessel, and Martin, p. 94.

10. Brophy, Miles, and Cochrane, The Chemical Warfare Service, p. 65.

11. Prentiss, p. 185.

12. 1st Div. Hq. files (RG9III C3, vol. 4009, File 9, Folder 11). Canadian National Archives.

13. Gas and Flame, p. 172.

14. Rothschild, p. 36. Rothschild seems to have based this classification on the facts that mustard accounted for 25 percent of all US casualties in World War I, but that only 2 percent of these casualties were fatalities. His lethality concentration figures show that phosgene, which he classifies as lethal, requires a higher concentration than mustard for lethal effects.

15. Prentiss, p. 180; Foulkes, chart facing p. 332.

16. US Army Medical Department, p. 70.

17. Casey and Larimore, pp. 20-21, citing John Dollard's work on the Spanish Civil War.

18. S. Millard, I Saw Them Die (1936), quoted in Winter, p. 123.

19. This is the date given by German sources, including the comprehensive study by W. Volkart, Die Gasschlacht in Flandern in Herbst 1917, p. 47. The British official history of the war gives 10 July, but the context suggests that little mustard was used until 12/13 July. Edmonds, France and Belgium, 1917, Vol. 2, pp. 119, 137n-138n.

20. Volkart, p. 59.

21. Hanslian, p. 65. The narrative account of the British offensive and first use of mustard is based on Cyril Falls, The Great War, pp. 298-303, and Edmonds, France and Belgium, 1917, Vol. 2.

22. Allied troops are treated here as "defenders," since they were being attacked by mustard gas. Actually, tactically, they were on the offensive.

23. Volkart, p. 47; Prentiss, chart following p. 262, p. 123. British and Canadian sources examined do not, however, mention this factor.

24. Bate memoir, p. 17.

25. Ibid.

26. Hanslian, p. 65, citing Fries and West.

27. This account is based on Bate memoir; Buxton interview; and Message, BEF Gen. Hq., 16 July 1917, from 15th Battalion files, Canadian Archives (RG9IIIC3, Vol. 4076, Folder 2, File 12.)

28. Volkart, p. 48.

29. Bate memoir, p. 18.

30. Geschichte des Reserve-Feldartillerie-Regiments Nr. 49, cited in Volkart, p. 50.

31. Das III. active Bataillon des Niedersaechsischen Fussartillerie-Regiments Nr. 10, Oldenburg, Berlin, 1934, cited in Volkart, p. 50.

32. Das 2. Hannoversche Dragonner-Regiment Nr. 16 im Weltkriege 1914-1918, Berlin 1929. Only the Yellow Cross (mustard) would have actually caused "contamination," as the Blue Cross persisted for only five to ten minutes. (Prentiss, chart following p. 262).

33. Hanslian, p. 65.

34. Volkart, p. 59.

35. Hanslian, pp. 63-64.

36. Ibid., pp. 50-51.

37. Ibid., pp. 58-59, 66.

38. Ibid., pp. 67-68.

39. Ibid., p. 61.

40. Paul Viovenal and Paul Martin, La Guerre des gaz (Paris, 1919).

41. The pre-use tactical integration of mustard is implied by Hanslian, and the facts of first use strongly suggest it. However, Volkart, who has made a careful study of gas use in the Flanders campaign of summer and fall 1917 (Third Battle of Ypres), says the Germans then used gas "from case to case, where it seemed especially worthwhile, particularly against massed artillery, but not yet . . . on the basis of predetermined plans which the High Command had organized and ordered."(p. 64) So the effective use that was made of the specific characteristics of mustard may have been partly accidental. In any case, the use and the results suggest good tactical integration of the new chemical weapon.

42. BEF Gen. Hq. message cited above.

43. First Army chemical adviser reports, Canadian Corps chemical adviser files (RG9 III C1, Vol. 3978, Folder 10, File 6), Canadian archives.

44. Letter, 1st Canadian Division Artillery to 1st Canadian Division, 1st Div. HQ files (RG 9 III C3, vol. 4009, Folder 10, File 2), Canadian Archives.

45. Ibid.

46. Report, 1st Brigade C.F.A., ibid.

47. Report, 2d Brigade C.F.A., ibid.

48. Report, M.O., 1st Brigade, C.F.A., ibid.

49. Prentiss, pp. 537-540.

50. Auld, p. 172.

51. See American Expeditionary Force, Gas Manual. However, some US manuals did devote considerable attention to mustard. See AEF, G-5, Memorandum on Gas Poisoning in Warfare, with Note on Its Pathology and Treatment, No. 28, November 1917, reprint 1918.

52. C.F. Rincker folder, 2d Battalion, 5th Marine Regiment, World War I Veterans Survey, US Army Military History Institute, Carlisle, Pa. This discussion is based also on Staff interview; IWM interview 000041/04; US 16th Infantry Regiment history, Veterans Survey, Carlisle, p. 6.

53. Hessel, Hessel, and Martin, p. 94.

54. Hessel, Hessel, and Martin, p. 94. This source gives 14 October for the first British use; Hitler gives 13 October in Mein Kampf. The date used here is from Foulkes, p. 326.

55. Report, 19th Replacement Division to I Bavarian Army Corps, in files of Ib GenKdo I. bay. AK, Vol. 51, Kriegsarchiv, Munich.

56. Bate memoir; Buxton interview.

57. First Army command report, endorsed by Chief of Staff, Field Army, 7 August 1918, in files of Ib GenKdo I. bay. AK, Bd.. 51 (gas officer file), Kriegsarchiv, Munich.

58. Mein Kampf, trans. Ralph Manheim (Boston: Houghton Mifflin, 1971) pp. 201-202.

Tanks

Introduction

The tank was a distinctly new weapon when it was introduced by the British on 15 September 1916. There is a good deal of data available on its introduction and its impact on the troops involved. Because the attacking troops were British, sources in English on the reactions of those troops who used the weapon are much more readily available to US researchers than is material on reactions of the German troops who were attacked by the tanks. However, enough German material has been found to make possible an adequate case study. It is, of course, useful to have unusually full information on the user troops, including both the special troops who employed the new weapon (the tankers) and the infantry who were supported by -- and who supported -- the weapon.

A special problem in dealing with the introduction of the tank is the fact that it had, in effect, two dates of introduction: 15 September 1916, when a few tanks were first used, and 20 November 1917, when tanks were first used in mass. The military impact of the mass use was so different from that of earlier use that the tank used in this way may almost be said to have constituted a new weapons sytem. In carrying out the case study, it was first planned that the 1917 use would be treated as the introduction of the tank, but this was not really accurate. Furthermore, it was discovered in preliminary research that the initial 1916 introduction had had a strong impact on troops of both sides. Therefore it was decided to treat the 1916 introduction as first use, and to treat the 1917 introduction of tanks in mass rather fully under the heading "Adaptation."

The Weapon

Description and Purpose

The tank is an armored fighting vehicle. This definition implies its three key characteristics. It is armored; that is, it is encased in armor sheathing that protects both the men inside it and its locomotive apparatus from hostile fire. It fights; that is, it incorporates intrinsic firepower capability. And it is a vehicle -- it moves. The tank's protection is bullet- and splinter-proof plate, and it was armed in World War I with machine guns and cannon. Its locomotion is powered by an internal combustion engine, facilitated by the fact that it is a track-laying vehicle; that is, it is carried on caterpillar tracks.

The tank was developed by the British during World War I as part of the great effort by both sides in that war to solve the "riddle of the trenches." With both the Allies and the Central Powers fortified behind formidable defensive systems of trenches, barbed wire, and machine guns, both sides sought to restore mobility, to find some way to break through and beyond the trench barrier. Chemical weapons were one such effort, developed and

first used by the Germans. However, the principal German effort was tactical. The tank was the chief British technological attempt.

The first British tanks, designated Mark I, were of two types, one weighing 31 tons and mounting two 6-pounder guns and four machine guns (designated the male), and the other weighing 30 tons and mounting 6 machine guns (designated the female). The dimensions of both were 26 feet 5 inches long, 13 feet 9 inches wide, and 8 feet 1 inch high. They were powered by a 105-horsepower Daimler water-cooled engine, had steel tracks on a rigid-type suspension, and had armor from 0.2 inches to 0.4 inches thick. They could span trenches up to 11 1/2 feet wide, climb a 22-degree slope, and surmount obstacles 4 1/2 feet high.(1)

Differences from Other Weapons in Use at the Time

The tank's lethality was initially relatively low. The historian Cyril Falls says this: "The tank was not primarily destructive. It was primarily demoralizing. The number of men killed or wounded by tanks in the course of the war was minute in proportion to the total. The moral effect was tremendous."(2)

The reasons for this psychological effect seem fairly clear. In the experience of the men who first faced the tank, there had never been anything on the battlefield like it -- a combatant on the ground along with the soldier, but immensely bigger and heavier, and apparently invulnerable. It seemed that nothing the soldier could do to these monsters would affect them. Marshal von Hindenburg wrote this comment on the psychological effect of the tank, stressing the role of its seeming invulnerability:

> The physical effect of fire from machine guns and light ordnance with which the steel Colossus was provided were far less destructive than the moral effect of its comparative invulnerability. The infantryman felt he could do practically nothing against its armored sides. As soon as the machine broke through our trench lines, the defender felt himself threatened in the rear and left his post. I had no doubt, however, that our men would soon get on level terms even with this new hostile weapon.(3)

The limited research on fear in combat suggests that by far the most common and strongest reason for fearing one weapon more than another is its greater ability to cause casualties. However, weapons do not seem to be feared in direct relationship to their casualty-causing ability, and the invulnerability of some weapons does appear to make them more feared than others with the same casualty-causing ability.(4) In any case, a new weapon, experienced for the first time, whose casualty-causing capability is not known, and which appears invulnerable to any defensive measures the soldier may take, might be expected to be extremely frightening.

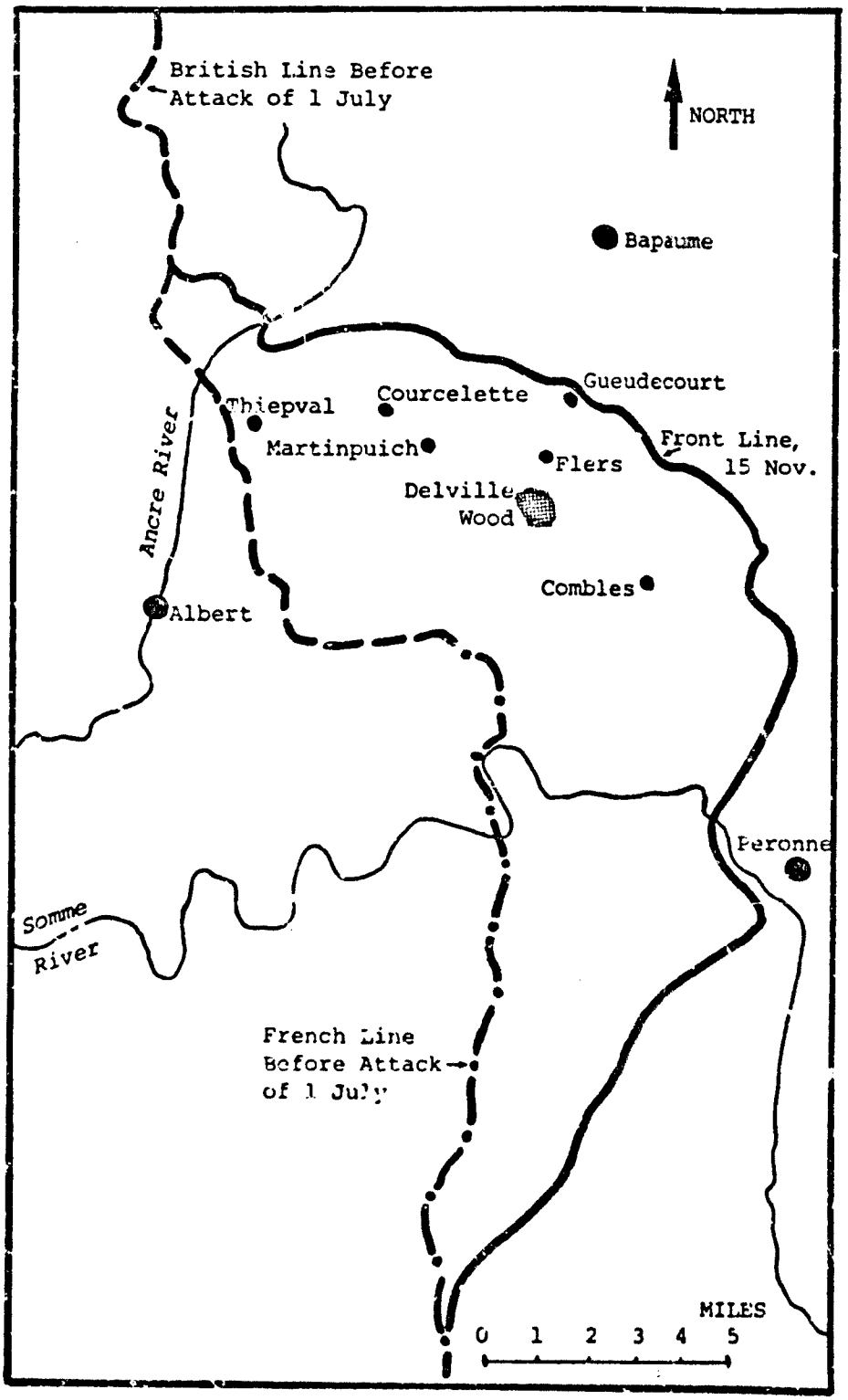
It should be noted that there were other reasons, in addition to psychological impact, for the tank's high military effectiveness in relation to its casualty-causing capability. Its ability to overcome rough terrain, hostile fire, and obstacles, carrying soldiers with it, enabled it to bypass opposition and to open gaps, whether or not casualties were caused.

Circumstances of First Use

Tanks were first used in the late days of the faltering Allied (primarily British) Somme offensive, on 15 September 1916. (Map 2) Col. (later Gen.) Sir Ernest Swinton, the British officer who conceived the idea of the tank after seeing US caterpillar tractors used for moving heavy artillery behind the lines, and who had played a key role in the tank's development, had warned against using the weapon until there were enough on hand to use them in a mass attack, but his advice was not followed. The military context for the actual first use was this:

The great Somme offensive had opened on 1 July with high hopes. That first day, of the approximately 100,000 men who advanced on the British front, over 57,000 became casualties, and more than 19,000 of these were killed or died of wounds. No breakthrough was achieved. The British, with some French help, continued to push slowly forward during July and August, winning encouraging local successes here and there, but basically producing only a large bulge in the line. Field Marshal Sir Douglas Haig remained sanguine, believing that a little more effort in the right place would bring a decisive victory. Haig's big mid-September push was to be carried out on a 10-mile front from Combles to the Ancre Valley beyond Thiepval. (See Map 2.) The British would attack with twelve divisions, facing six and a half German divisions. As always, the objective was to break through the German defenses and open a gap that could be widened to make room for a war of movement behind the German lines. To give his assault every possible strength, Haig decided that the few available tanks would be thrown in in the sector of the 41st Division. Although it was hoped that the tanks would contribute significantly to a breakthrough, their use was also to some extent experimental -- to find out how they would perform in battle.(5)

In preparation for the tank attack, efforts had been made to establish tank-infantry coordination, but they seem to have been as faltering as they were inexperienced. Accounts differ as to how many tanks were then in France and how many were used in the Battle of Flers, as this part of the Somme effort was called. There was a maximum of 59 tanks in France and a maximum of 49 allotted to the attack. However, not many were made available for training with the infantry. One veteran, who was a brigade staff officer, has reported that his whole brigade was allotted one tank, one of the first to arrive in France, to train with in preparation for the offensive.(6) This officer remembers that the infantry troops were trained to follow a specific tank in a column of a section or a platoon (15 or 30 men).



MAP 2: THE SOMME AREA

As time for the offensive grew near, details of men from each infantry unit were taken to see a tank, given a lecture and demonstration, and told to spread the word in their units. One former corporal remembered that

> The first full day hereabouts most of our officers disappeared. They had been given a map reference and told to meet at a certain LOOP to view some "TANKS," with which they ought to become familiar. . . . Because the authorities were a shade doubtful what would happen if a tank got into difficulties a party of men was to accompany each tank -- one more task for the poor infantry.(7)

For the 15 September attack, individual tanks were given individual routes of advance. For example, eight were to advance west of Flers and six to the east of the village, with the village of Gueudecourt their objective. They were to leave their starting point with their own infantry sections at half an hour before zero hour (dawn was jump-off time for the infantry assault) so that they could, theoretically, reach the German trenches a few minutes before the first wave of infantry. The tanks were to attack all strongpoints on their routes, and to help the infantry units that were being held up, as the opportunity arose.(8)

The infantry assault, in which the tanks were to play a small, but, it was hoped, significant role, was preceded by two or three days of extremely intense artillery bombardment, as was still the general practice. This alerted the Germans that an attack was imminent and also cratered the terrain into an obstacle course for tanks.

As already indicated, accounts differ as to the number of tanks that were used and how they fared. The following tabulation is given by tank officer Clough Williams-Ellis in the official history of the Tank Corps:

> 49 Tanks were employed.
> 32 reached their starting-points.
> 9 pushed ahead of the infantry and caused considerable loss to the enemy.
> 9 others did not catch up the infantry but did good work in "clearing up."
> 5 became ditched.
> 9 broke down from mechanical trouble.(9)

It will be noted that, according to these figures, 17 tanks that were designated for the attack did not even reach their starting points, presumably because of mechanical failures or German shell damage.

The Germans were not surprised by the attack, but they were taken completely by surprise by the tanks. They had no such weapons of their own and apparently had not conceived of this approach to the problem of the trench deadlock. It appears that

neither the field commanders nor the troops in the trenches had any warning of the imminent use, or even the existence, of tanks.

Environmental factors which should be mentioned, in addition to the shell-cratered terrain, were the fair, dry weather and contrastingly "sticky" ground, wet from earlier rains.(10)

Defenders' Response

There was some panic among defenders, and some resourceful coping. The German official history says

> About 25 tanks in all reached or crossed the front German line, generally firing as they drove along. At some places their appearance evoked panic and panicky fright. However, at two places which were especially hard hit, at the Foureaux woods and north of Combles...men of the 4th Bavarian and 185th Infantry Divisions held off all attacks...with their flanking machine gun fire.(11)

A footnote adds "At the Foureaux woods, one German infantryman climbed onto a tank, opened a hole, fired, and wounded one of the crew."(12)

Instances of panic and large-scale surrenders were reported by British soldiers. One medical corpsman wrote

> These tanks are the thing. They literally put the wind up the Hun and when I was doing some collecting of wounded on the 15th I saw some in action. The Hun at first came out and held up their hands, but they soon had to drop them. You see it is difficult for them to take prisoners!(13)

A letter from a tanker includes these references to the 15 September battle:

> Guess you have read what a success our tanks have been ....It makes one smile to see Germans running over the trenches surrendering. They don't half look scared.(14)

An airman who saw the tanks in action from above apparently based his comments about German reaction on reports he had heard: "Judging from what some of the prisoners captured say, the tanks caused them no small amount of alarm."(15)

The best-known incident of mass surrender on 15 September was that of 300 Germans whose trench was enfiladed by the machine gun of a tank resting astride it. The tank then moved along the trench, and the Germans in it surrendered to the British infantry whose advance had been held up by fire from this trench. These surrenders did not necessarily indicate panic, but rather, perhaps, a realistic response to the situation. However, had the Germans experienced tanks before, it is quite possible that 300 infantrymen would have found a way to overcome one tank.

As for the tactical outcome of the use of the new weapon, in the words of historian Falls, "The advance, though good, was not sensational."(16) The average gain for 15 September was a mile and a half, with a good deal more in the center of the front, at Flers, where the tanks were most effective. Apparently a breakthrough was close. The German official history says

> Only a few tanks reached Martinpuich and Flers. There they directed horrible fire at resistance nests, machine guns, and batteries, and into dugouts. Some gained ground to the northwest beyond Flers, and two even reached the area of Guedecourt. There, at noon, the German resistance was as good as gone. But since the British Army did not push forward strongly, and since the tanks passing beyond Flers were put out of commission one by one by German fire, the crisis could be overcome by approaching reinforcements. In any event, this first British tank attack had greatly shaken the structure [Gefuege] of the First Army troops. [Emphasis added.](17)

Attackers' Response

The tank appears to have had one of the warmest initial receptions ever accorded a weapon by its users and those it was intended to help. To judge from the reports included in the histories and accounts by early tankers, the immediate reaction of the accompanying infantry, air observers, and the British press was one of pleasure, relief, enthusiasm, pride, affection, and amusement. This impression is borne out by a number of independent first-hand accounts, especially for the period before the tank was actually used at Flers. Once the tank went into battle, there was some disillusionment, especially among the infantry.

In the following discussion, the reactions of the tankers -- the men inside the tanks -- will be treated first, and then the reactions of the infantry who accompanied the tanks.

Tankers' Reactions

Early tanker veterans stress the cramped quarters and, especially, the great noise inside the tanks -- noise from the engine, the tracks, and the tumbling about of oil drums and other paraphernalia. The noise of the tank was so great that the men could hardly hear the massive artillery bombardment outside.(19) It was difficult to communicate within the tank. If the driver wanted to turn left, for example, he had to signal the secondary gearsman, sitting behind, by striking the engine casing with a spanner (wrench). Simply learning to drive the tank had been the most difficult part of training, according to one tanker. It was different from an automobile in several ways, and maneuvering on rough ground and steep grades in the early tanks without tipping over required considerable skill.(19)

As for the first battle, the young subaltern who commanded tank D-9 at Flers later remembered being taken with the other tank commanders, all volunteers, on the day before the assault, to see the front line and the terrain over which they would attack. He said "It was terrifying. There were shell holes there you could put houses in." The shell holes were often lip to lip, sometimes running into one another, most of them "full of slime." There had been lots of rain. They decided among themselves that they would never get to Flers. "But we'd volunteered for the job, and we had to go."(20)

One thing that buoyed many of the tankers was the reaction of the infantry to the new weapon. The following account illustrates both the infantrymen's hopeful enthusiasm and the tankers' combined pride and annoyance:

> It was a hot September day, and we were approaching our assembly point on the Somme battlefield, and we had about three miles to go. And we were doing about three miles an hour. And the noise of the tank and the heat of the engine and the noise of the tracks -- we had the doors open because it would be cooler for us. And as we opened the doors, it seemed as though the British Army were very interested in us, and they came up, walking by the side of us, [looking] in the open sponson doors, and I was sat down as a secondary gearsman at that time. And I had to answer their questions. They were asking what this thing was, what was it going to do, and what did we expect to do, did we expect to go over trenches with it? How many guns had it got, and what was it capable of? What speed was it capable of? What was the thickness of the armor plate and...would it stop a 5-inch shell, or a 4-inch shell? We kept on answering these questions, and then the fellow would go on, looking quite pleased with himself, as though, "Well, there's something come here to help us on....No sooner you get over [the top] than you [get] a rain of machine guns, and here's a boy coming along that's apparently going to stop all this. He's going to win the war for us." And one after another came up, and in all I suppose we answered questions to 50 or 100 of them before we got to our assembly point at Green Dump. And eventually we got rather browned off with all the questions, and we closed the doors, and let them go on.(21)

As the tanks approached their starting points, the feelings of many of the tankers changed to frustration and disappointment. One man has described how out of three tanks, only one -- not his -- got across a British support trench and moved on toward the German lines. His account conveys his own frustration combined with a suggestion of pride and esprit, as he describes watching other tanks move forward and says he thinks it was the third man in his section who was first into Flers.(22)

Once under fire, "There weren't any comforts but there was a certain satisfaction in being surrounded with armor that you hadn't got when you were on your feet outside."(23) However, even though machine gun bullets could not pierce the armor, the impact oxidized the steel on the inside, and sparks, or little white-hot flecks of metal, would be detached and whistle around inside the tank, distracting, stinging, and raising fears of blindness if the eye should be struck. "Quite sufficient to put you off your stroke," as one tanker said.(24)

Casualties among tankers were insignificant, according to J.F.C. Fuller.(25) After the long first day of tank battle, most of the survivors probably felt what one tanker wrote to his sister: "We were in action 14 hours and jolly glad to get back again."(26)

Infantry Reactions

First infantry reactions to the tank seem to have been compounded of hope that it might somehow change the pattern of terrible infantry casualties, plus awe, amusement, and delight at the strangely appealing, animal-like appearance of the new weapon. Many infantrymen saw the tank as a clumsy, benevolent, and effective monster that could roll over the barbed wire and silence the machine gun emplacements that had been such formidable and deadly obstacles. Although the infantrymen well knew that there was a crew inside, the impulse to personalize the tank was irresistible. The following account was reportedly given in a London hospital by a wounded New Zealander who had followed the tank that led the way into Flers:

> The Tank refused to wait for our barrage fire to lift, and lolloped along through it all as if such a little shower of shells were beneath contempt. We were amazed.
>
> We saw not a single member of her crew -- not even a head or hand once.
>
> Just on the outskirts of the village the "Tank" approached a German stronghold -- a barn crowded with machine-guns, which were playing havoc among our men.
>
> "What's this?" the travelling fortress seemed to ask. Then she pounded away with her guns for five minutes and then heaved forward.
>
> First the wall crashed down, and then the barn was crushed out of existence. She just walked over it in her own peculiar, impertinent way.
>
> She smashed everything that came in her way, and we of the infantry, scarcely believing our own eyes, just followed and did the rest.
>
> She walloped straight along to the Flers High Street, over shell-craters, bringing down ruins and trees, and turning no corners, but taking the shortest cuts.(27)

Williams-Ellis gives this account, attributed to a wounded London Territorial:

"Old Mother Hubbard" they called her and lots of other funny names as well. She looked like a pantomime animal or a walking ship with iron sides moving along, very slow, apparently all on her own, and with none of her crew visible. There she was, groanin' and gruntin' along, pokin' her nose here and there, stopping now and then as if she was not sure of the road, and then going on -- very slow, but over everything.

It was her slowness [that scared us] as much as anything, and the way she shook her wicked old head and stopped to cough. It was a circus -- my word! I only saw her for about ten minutes. She came humping out of the fog at one end of the line and humped into it again at the other. The last I saw of her was when she was nosing down a shell crater like a great big hippopotamus with a crowd of Tommies cheering behind.(28)

Because the details of what a tank was were still secret, and the first accounts given in letters from the front had to pass censors, the writers had to communicate the essence of the tank, as they saw it, rather than a literal description. This necessity gave wide opportunities for fantasy and humor. The following story is given by Sir Albert Stern, who played an important administrative role in the tank's development. He states that it was "a letter from a soldier to his sweetheart, which appeared in the newspapers at the time." The fantastic description catches the spirit of infantry reaction:

> They can do up prisoners in bundles like straw-binders, and, in addition, have an adaptation of a printing machine, which enables them to catch the Huns, fold, count, and deliver them in quires, every thirteenth man being thrown out a little further than the others. The Tanks can truss refractory prisoners like fowls prepared for cooking, while their equipment renders it possible for them to charge into a crowd of Huns, and by shooting out spokes like porcupine quills, carry off an opponent on each. Though "stuck-up," the prisoners are, needless to say, by no means proud of their position.
>
> They can chew up barbed wire and turn it into munitions. As they run they slash their tails and clear away trees, houses, howitzers, and anything else in the vicinity. They turn over on their backs and catch live shells in their caterpillar feet, and they can easily be adapted as submarines; in fact most of them crossed the Channel in this guise. They loop the loop, travel forwards, sideways and backwards, not only with equal speed, but at the same time. They spin round like a top, only far more quickly, dig themselves in, bury themselves, scoop out a tunnel, and come out again ten miles away in half an hour.(29)

The Allied war correspondents expressed reactions of humor and elation very close to those of the infantry. In the British press the tank was called "Diplodocus Galumphant" and a "polychromatic toad," and stories were told of its smashing trees

"like matchwood," crushing a machine gun "under its ribs," and stamping down a dugout "as if it were a wasp's nest."(30)

The writer H.G. Wells also wrote a contemporary description of the tank. Wells had predicted the creation of war machines similar to tanks in his earlier writings, and Sir Albert Stern gave him a conducted tour of the tank training area at Birmingham. His description of the tank, which did not pass censorship at the time, is in agreement with the spirit of the infantrymen's reactions. This reaction, incidentally, seems markedly different from what might have been expected, given the nature of the tank and later attitudes toward this weapon, which have focused on its massive, inexorable power, whether as friend or foe. The first tanks were seen, rather, by those on their side, almost as clever toys or lovable, oversized stuffed animals. Because Wells's description reflects this attitude so well, and with so much detail, sizable excerpts from it are given here:

> The young of even the most humble beasts have something piquant and engaging about them, and so I suppose it is in the way of things that the land ironclad, which opens a new and more dreadful and destructive phase in the human folly of warfare, should appear first as if it were a joke. Never has any such thing so completely masked its wickedness under an appearance of genial silliness. The Tank is a creature to which one naturally flings a pet name; the five or six I was shown wandering, rooting, and climbing over obstacles, round a large field near X---, were as amusing and disarming as a litter of lively young pigs.
>
> In a little while there will probably be pictures of these things available for the public; in the meanwhile, I may perhaps give them a word of description. They are like large slugs; with an underside a little like the flattened rockers of a rocking horse; slugs between 20 and 40 feet long. They are like flat-sided slugs, slugs with spirit, who raise an inquiring snout, like the snout of a dogfish, into the air. They crawl upon their bellies in a way that would be tedious to describe to the inquiring specialist. They go over the ground with the sliding speed of active snails....They are not steely monsters; they are painted the drab and unassuming colours that are fashionable in modern warfare, so that the armour seems rather like the integument of a rhinoceros. At the sides of the head project armoured cheeks, and from above these stick out guns that look very like stalked eyes. That is the general appearance of the contemporary Tank.
>
> It slides on the ground....It swings round about its axis. It comes to an obstacle -- a low wall, let us say, or a heap of bricks -- and sets to work to climb with its snout. It rears over the obstacle, it raises its straining belly, it overhangs more and more, and at last topples forward; it sways upon the heap, and then goes plunging downwards... If it comes to a house or a tree or a wall, or such like obstruction, it rams against it so as to bring all its weight to bear upon it -- it weighs <u>some</u> tons -- and

then climbs over the debris. I saw it, and incredulous soldiers of experience watched it at the same time, cross trenches and wallow amazingly through muddy exaggerations of shell holes....

About the field other Tanks are doing their stunts. One is struggling in an apoplectic way in the mud pit with a cheek half buried. It noses its way out and on with an air of animal relief.

They are like jokes by Heath Robinson. One forgets that these things have already saved the lives of many hundreds of our soldiers and smashed and defeated thousands of Germans.

Said one soldier to me: "In the old attacks you used to see the British dead lying outside the machine-gun emplacements like birds outside a butt with a good shot inside. Now, these things walk through."(31)

The picture of universal infantry enthusiasm for the first tanks that emerges from these accounts is not entirely accurate. The infantrymen who give them are anonymous, and they are all reported by tankers.(32) There is no reason to doubt their authenticity, but they do not tell the whole story. On the basis of documented first-hand accounts by infantrymen, it appears that the tank's reception was mixed, and that in many cases initial enthusiasm and great hope were followed by disillusion or, at best, some disappointment. Some resentment of the tankers' perceived arrogance and some envy of their armor protection also appear.

An infantry officer who saw one of the first tanks to arive in France and who was briefed on the tank's capabilities said "Everybody was staggered to see this extraordinary monster crawling over the ground," and "thought it was a terrific thing." After the first battle the officers of his brigade were disillusioned -- "rather lost our faith" -- when all three tanks allotted to the brigade broke down before they reached the German front line. In this soldier's experience, the tanks in their first use "failed completely," and it was "a terrible disappointment." He knew, however, that to the north of his brigade "a tank had a great success, at a place called Flers."(33)

A former corporal remembered that just before the battle he heard a tremendous noise, "like a convoy of broken-down lorries with no silencers," and wondered why someone didn't stop it before it gave away the attack. "Then we remembered the new machines of war which were going to do wonders. Before we had time to admire our new friend zero hour had arrived...."

After this man started forward with his unit, "The tank seen earlier wallowed along, not fast enough for the keen troops, so it was left behind us with its gallant section to guard it." In the battle this man's battalion, the 21/King's Royal Rifle Corps, took heavy casualties. Late in the day the survivors encountered a tank whose officer "said how delighted he was with the work done by his tank."

> He was in a merry mood and said he would look around and report to any troops he saw that our battalion had come this far. Another tank was waddling along in the distance. I learned later that the two sections of infantry guarding them had almost been wiped out because the new weapon had drawn much fire.(34)

Another infantryman, who was held back as cadre when his unit went into battle on 15 September told how his companions were introduced to the tanks and also gave his reaction to the battle:

> They had been taken to see the first tanks and some of the descriptions were quite amusing. Now they had all gone forward to Delville Wood and on the 15th September 1916 the attack was made, with tanks, for Flers, which was captured, and the Battalion got as far as Gueudecourt. Our losses were fairly heavy, and it was something of a shock to watch the Companies returning with so many faces missing.(35)

Another infantryman, assigned to bring supplies up to front-line troops, gives a more completely enthusiastic account, with a description of the tank that conveys its power and also has a suggestion of the humor present in the early tank accounts:

> The attack had been held up at [a fortified sugar refinery near the village of Courcelette], and a party of us had to rush up with more ammunition, bullets and grenades, to the 21st Battalion, lying in shell holes in front of the refinery. As we reached them we saw a landship, named the L.S. Creme de Menthe, pass ahead, and go right up to the walls of the refinery, its guns blazing. It seemed to lean against one of the walls, which collapsed, and the monster roared into the fort, while we could see the Germans streaming out behind it, offering an excellent target to the riflemen in the shellholes.(36)

Finally, one infantry veteran, a man named Staddon, who was a young subaltern in 1916, tells a story that debunks the most famous legend of the first use of tanks. According to the legend, a tank drove right through German resistance into Flers, followed by a group of laughing, cheering British infantrymen, and was seen from above by a British reconnaissance pilot. The message the airman reportedly sent back -- "A Tank is walking up the High Street of Flers with the British Army cheering behind" -- was featured by the British press.(37) According to Staddon, who was at Flers, the observer in the aircraft "put 2 and 2 together and made 5." In actuality, the tank commander had just asked Staddon directions for getting to Gueudecourt. The tanker closed his "little door near the port gun" and moved on, although he didn't seem to know where the British flanks were or to be interested in learning. At this point, 32 unarmed Germans emerged from a dugout or cellar and surrendered. There were no other British or Germans around. Staddon formed the Germans into a platoon and sent them back with one of his corporals.

According to Staddon, it was his platoon that entered Flers first, before the tank, after heavy casualties on the way and great difficulty in getting through half-cut barbed wire.

> That a tank was proceeding up the high street of Flers with a group of laughing Tommies behind it was not true. Those laughing Tommies were a group of Germans with chattering teeth. I'd never seen chattering teeth before, but I did then. The tank, in the meantime, had gone farther up the road. Of course, he'd got a nice steel waistcoat. I hadn't.(38)

Whether or not Staddon's story is entirely true, it provides additional evidence for the existence of one kind of infantry reaction which may be summarized thus: The tankers were not-very-bright glamor-boys who had it easy behind their armor, and it was the infantry who, as usual, did the hard and dirty work and took the casualties.

Adaptation

Tanks continued to be used by the British (and the French, beginning in April) in relatively small numbers during the following year. They had no spectacular successes, and finally bogged down in the mud of Third Ypres. There was considerable disillusionment in the Allied high command, and it seemed that the tank program might be cancelled. At the same time, the Germans' confidence in their ability to master the tanks grew, and they made little effort to produce tanks of their own. Although the British introduction of tanks in such small numbers meant that they were not effective during the first year, this very lack of success apparently lulled the Germans, so that when tanks were first introduced in mass at Cambrai in November 1917, true surprise was achieved, and the massed tanks had the impact of a new weapons system.

Second Use

Following their introduction at Flers on 15 September 1916, the tanks were next used in the same battle ten days later, in attacks on 25 and 26 September. After the tank casualties of the initial attack, only 13 tanks were operational and available for the 25 September attack. Of these, nine got stuck in shellholes -- the weather had become increasingly wet since the initial attack -- while two reached Thiepval and were helpful to the infantry there before also getting stuck. One tank did what Fuller called a "star turn," cooperating with infantry to take 1,500 yards of well-wired German trench, plus 370 prisoners, at a cost of five British casualties.(39)

By the time the tanks were used for the third and last time in 1916, at Ancre -- also in the Somme area -- in November, more heavy rain had fallen, the battle site was a "morass of mud," and

only 7 of the 20 tanks originally designated could be used. They were employed in batches of two and three. Nevertheless, two tanks that became ditched after reaching the German front line used their guns there to good effect, with 400 Germans surrendering and being taken in charge by the two tank crews.(40) These small incidents of extraordinary success probably kept the tank a strong positive force for British infantry morale, despite the insignificant tactical results.

They may also have continued to evoke fear from German troops, but even as early as 1916, according to a British tank veteran, the Germans had found ways to deal with tanks:

> [The Germans] were, in my opinion, superb. They were full of ingenuity. They started on the original Mark IV [Mark I?] tanks -- that was on the Somme in '16. They had exhausts and the exhaust was covered by an angle iron, like that. One to each cylinder, you see, half a dozen. The old German would lie on the track as it went up and he'd put egg bombs down the exhaust. [That,] to my mind, required courage of a very high order.(41)

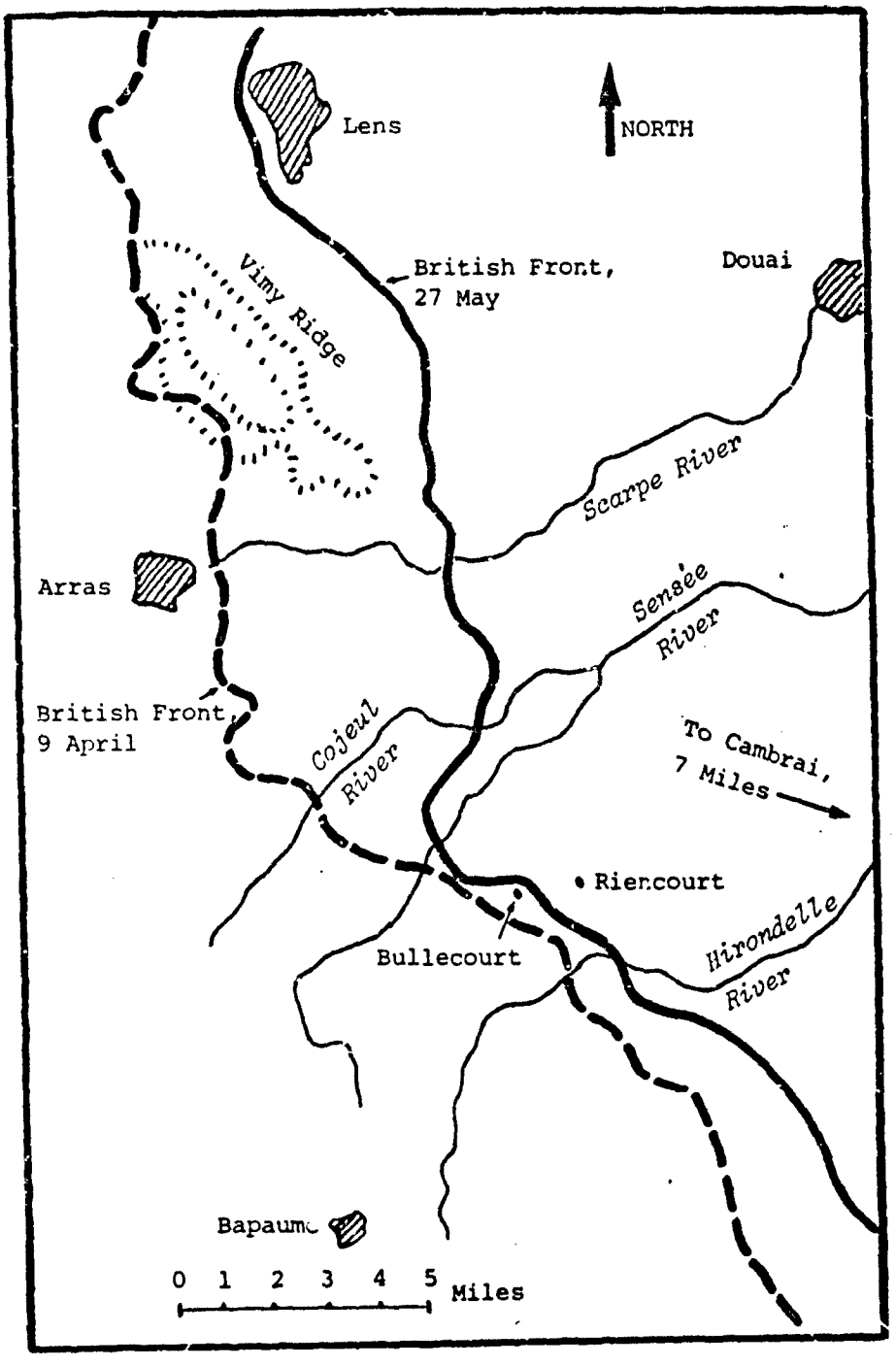
The British countered this improvisation by putting wire netting over the exhaust,(42) but this veteran portrays a German enemy who was, in general, not daunted by the new weapon.

1917 before Cambrai

Three battles in which tanks were used in 1917 before Cambrai will be briefly discussed. These are the British offensive centered on Arras in April, the French offensive on the Aisne (Nivelle's offensive) that same month, and the muddy later part of the Third Battle of Ypres, called Passchendaele, in the fall. There is some data on psychological reactions and adaptation on all these battles, and, for Arras, data from both British and German sources is available.

The British offensive at Arras was intended to assist, and strike a coordinated blow with, French General Robert Nivelle's much-touted spring offensive. In the event, Nivelle's offensive failed, with widespread French troop mutinies one result, and the Arras offensive, after a good start on 9 April, accomplished little (Map 3). The Allies were, in some places, attacking the extremely strong fortifications of the Hindenburg Line, since the Germans had shrewdly withdrawn their forces to that position before the offensive, thus giving themselves a shorter and much more defensible line and throwing their enemies off balance.

A veteran British tanker has described his experience on the first day of the Arras offensive, when his tank was among those assigned to help the Canadians take Vimy Ridge. He stressed the lack of adequate communication -- within the tank crew, between tanks, and between tank and infantry, and also pointed out that by this time the Germans had armor-piercing bullets which,



MAP 3: ARRAS OFFENSIVE, APRIL-MAY 1917

although "not very harmful, used to buzz around the insides like mosquitoes," and "made it a b uncomfortable."(43)

This man, Brigadier R. C. Cooney, then a tank commander, described jumping off in falling snow at 4:00 AM, leading the infantry over the British front line, and then across the German front line:

> We chugged on and eventually the infantry caught us up and by this time everything was getting a bit disjointed. The barrage had practically finished and it was just a question of struggling on to the objective. And we bogged down; some of them got up to the top of the ridge. They all bogged down at the top where they were cockshies for the German gunners. . . . That was the end of it. . . . It was . . . of no value at all -- that's what I would say. The tanks; the conditions were hopeless.(44)

Of this action, Cyril Falls says, "The tanks, though a few were invaluable, suffered all too many casualties from ditching and breakdown."(45)

A German divisional history describes an action involving tanks that took place two days later near Riencourt. The British attack was initially successful, a success which the German narrator ascribes entirely to the tanks. Then, however, German reserves were brought up, the British attack was stopped by artillery fire, and the British troops who had broken through the German lines and occupied German trenches were systematically rolled up by German infantry using hand grenades, coming in from both flanks. The Germans captured 28 officers, 1,142 men, and 80 machine guns.

> That...was the grand and significant result of this day: It deprived the tanks of their terror for a long time. They showed themselves much less invulnerable than was assumed until then. Of the 12 tanks which attacked the division front, only 3 were able to save themselves through turning around.
>
> Thus, this day which had started so gravely ended with a success which a division seldom experiences when it is in a defensive position. Yes, it remains a singular feat that a division on the defensive took 80 machine guns as booty....The men and the leadership felt they had accomplished something extraordinary....Leadership and men were hardly ever again in such an elated and joyful mood as on 11 April 1917.
>
> The defeat of the English at Riencourt was the first ray of light in the battle of Arras....The proof of the vulnerability of the tank removed a nightmare from the minds of all military commanders. General von Maur was decorated with the Pour le Merite and the whole division was honored thereby.(46)

A careful reading of this source suggests two things: first,

that the seeming invulnerability of the tank was an important factor in the fear and panic it evoked; and second, that the elation in discovering that the tank could, after all, be overcome, was so great that the fearsome earlier tank image was almost turned into an asset for the Germans.

Tank veteran Cooney was in another action on the Arras front, south of Arras at Bullecourt, on 3 May 1917, an action of which Falls says, "It was a ghastly failure, some thought the blackest day of the war." Cooney says, "Except for the fact that that was the Hindenburg Line, which had been specially enlarged to stop tanks, it would have been quite a good show."(47) However, the tanks were stopped, and a way to get them across the Hindenburg Line trenches would have to be devised if they were to be useful there.

The German 27th Division history also deals with the action at Bullecourt:

> On 3 May the enemy started a furious drumfire on our lines. Then, barely 10 minutes later, strong masses of enemy infantry rushed forward against the entire division front. Simultaneously, 8 tanks appeared at Bullecourt. After 11 April the tanks could no longer terrorize the infantry. Soon 5 tanks were lying in front of our lines, put out of action by machine gun and artillery fire. Three escaped destruction by turning tail. [Emphasis added.](49)

Meanwhile, on the French front French tanks were used for the first time on the first day of Nivelle's offensive, 16 April. Nivelle did not get his hoped-for quick breakthrough, progress was slow, and, as Falls put it, there was "a holocaust of tanks for which there had been no parallel in the British attack."(50)

One German account indicates that the French tanks did have some limited effectiveness:

> On 16 April 1917 the division was attacked by 64 tanks. Thirty-two were disabled, partly by artillery and partly by machine guns. The tanks did not have the decisive effectiveness on the infantry's morale that the enemy had expected. However, they were undoubtedly the reason for the capture of the first position and the artillery defense position. Also, after they broke through, they harassed some batteries by knocking out men with machine guns and also delayed the arrival of reserves.(51)

Overall, records of the I Bavarian Army Corps for the Aisne battle indicate that not all German infantry units had the kind of exhilarating experience with tanks that the 27th Division did in the Arras battle:

> The appearance of tanks still proved to have a great effect on the morale of the infantry, especially when they came firing along our lines early in the morning, when it was

still half dark. in these cases, it is hard for our artillery, some distance away, to hit them....Infantry guns with armor-piercing shells and close-combat batteries are an excellent means of defense.... The French deliberately tried to draw the fire of the close-combat guns so that they could then knock them out. ...They also tried, with tanks that had broken through, to attack batteries from the rear and knock out machine guns, so as to create insecurity and confusion about the approaching enemy infantry attack. The British may use this same technique. The confidence of the infantry must be increased by continued instruction in our defensive measures and their excellent effectiveness. Infantry have nothing to fear from tanks if they keep quiet and let the artillery, etc., take over fighting them. On the other hand, it should be the infantry's duty to fight immediately against every tank that appears [at close range?] -- the type of combat must be up to them.[Emphasis added.](52)

It was in the mud of the Third Battle of Ypres that the British tanks came close to being figuratively as well as literally buried; the tanks became so often and inextricably bogged down in the marshy, shell-torn terrain that the British War Office sharply cut back orders for future tanks. The final disastrous episode came on 9 October, when eight tanks tried to attack strongpoints on the Poelcapelle road. (See Map 1, lung-injurant gas study.) All became mired in mud or disabled by shellfire before they reached their objectives, most of their crews were killed or wounded, and wrecks of the tanks remained, blocking this vital road and preventing supplies from being brought up to troops at the front. The tanks had to be blown up, and it took a week of dangerous work to clear the road.(53)

After this incident, no more tanks were used on the Ypres front in 1917:

> The Tank Corps withdrew from the salient in a state of gloom. They had achieved so little at so great a cost. Every infantryman trudging over the duckboards could see the scores of derelict tanks lying helplessly in the slime. Everybody was remarking, "Tanks are no good; look at them stuck in the mud all over the place."(54)

Tank Corps Esprit

Despite the repeated failures, the Tank Corps had developed, and continued to build, a fine esprit de corps and some special traditions that should be mentioned as part of the adaptation process.

Several factors contributed to the Tank Corps esprit. First, there were its naval associations, which set it apart from other ground combat arms. Having been developed by the Admiralty, the tank had port and starboard sides and was called a landship. Its secrecy, and then its newness, also set it apart. Most of its members were citizen soldiers, not Regular Army men, and most of

the top officers, who were Regular Army, were drawn from the Engineers. The younger officers who volunteered for the "Heavy Branch Machine Gun Corps" -- the original cover name for the Tank Corps -- were likely to be ambitious, adventurous men intrigued by this mysterious new organization.(55)

Tank Corps training was rigorous. Even a private had to be a trained driver and mechanic, qualified with the Lewis and Hotchkiss machine guns and the 6-pounder cannon, and to have gone through signal, revolver, compass, and reconnaissance courses, as well as basic infantry training.(56)

Tank Corps training consciously sought to create an elite corps. The training manual stated: "The object of all training is to create a 'Corps d'Elite.'....It cannot be emphasized too often that all training ....must aim at the cultivation of the offensive spirit in all ranks."(57)

Unusual emphasis was placed on leadership. It was a cardinal principle of the Tank Corps, "which must never be departed from," that commanders themselves trained the troops they were to lead into battle.(58) Early in the corps's history, there was some feeling that the naval tradition dictated that each tank commander must stay with his tank until it was destroyed. In any case, there developed a spirit of dedication and self-sacrifice called the "Robertson tradition," which, while it cost many good tank officers, added to the feeling of group pride the tankers seem to have shared.

Robertson, a captain, was a section commander who, in early October 1917, personally marked out with tape a route of advance for his section through the soggy, broken terrain of the Ypres area. He then personally, on foot, and under heavy German fire led his tanks to and across a narrow bridge which their crews could easily have missed and which provided the only approach to their objectives. Robertson was killed; he was posthumously awarded the Victoria Cross. Many section commanders, especially in his own A Battalion, followed Robertson's example, choosing to lead their tanks on foot rather than remaining with the headquarters of the accompanying infantry battalion or advancing in one of their own tanks. Leading on foot, though extremely dangerous, was not the useless gesture it seems now, for with no other means of communication between tanks, the sight of the leader, and his orders given personally as he moved from tank to tank, gave a cohesion to the attack that could have been gained in no other way.

Cambrai

Despite the miring of the tanks at Ypres, tank advocates were able to persuade the British high command to try them once more in circumstances that held some hope of real success.(59) This time there was to be dry, uncratered ground; tanks used in mass; careful preparation for overcoming German obstacles; close tank infantry coordination; and an attempt at complete surprise.

The attack was to be carried out by 378 tanks (in contrast to 48 at Arras).(60) The assault would be toward Cambrai, not far from Arras. Again the British troops would be attacking the Hindenburg Line -- three lines of trenches too wide for tanks to span, with wide, multiple bands of barbed wire.

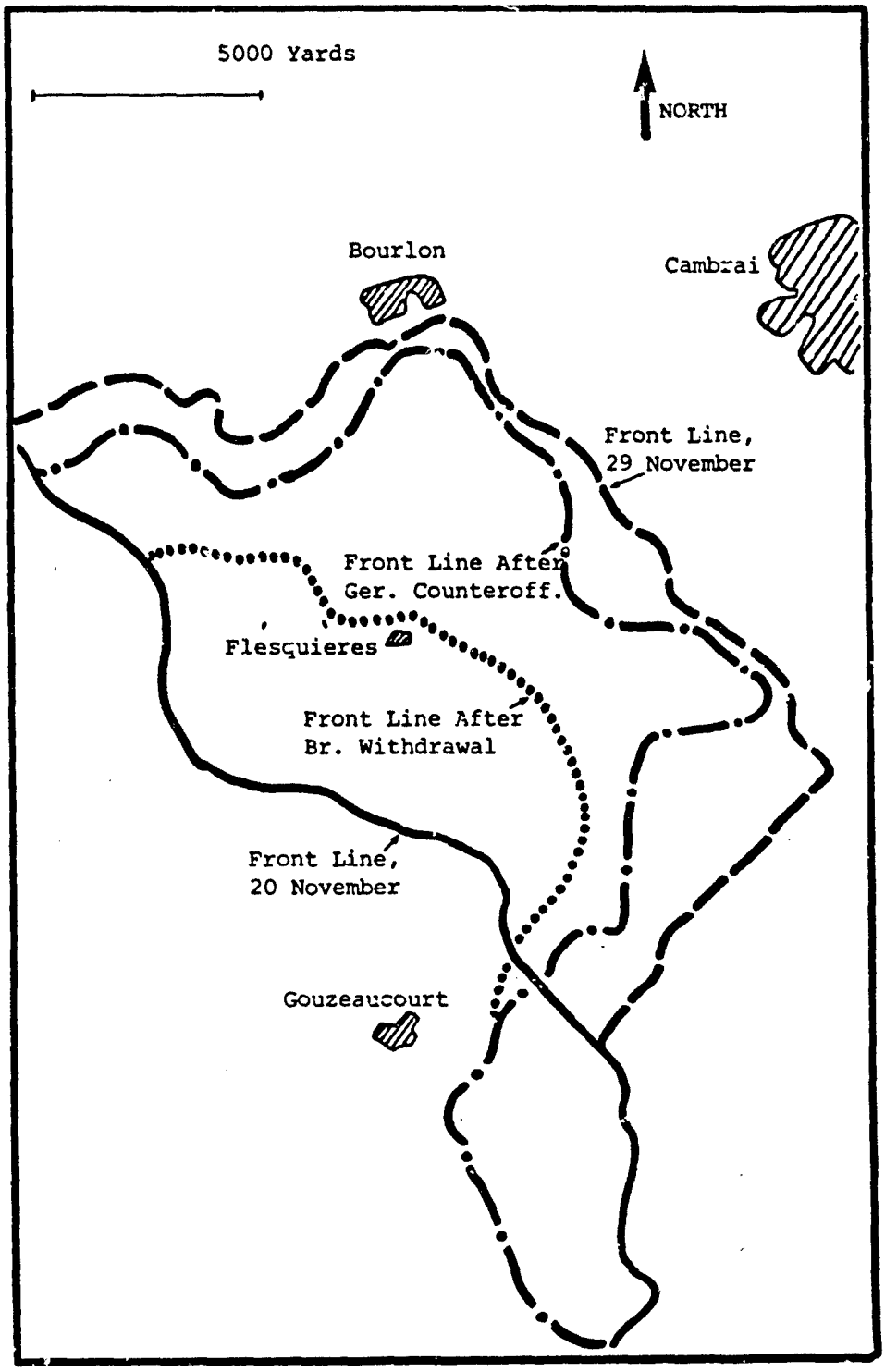
To traverse the trenches a simple, but carefully prepared, technical device was to be used: huge fascines, or bundles of brushwood, each weighing a ton and a half, were to be carried by the tanks, each tank laying down its own fascine to provide its bridge across a trench. The tanks would work in threes: The lead tank was to drive onto the enemy wire guarding the first broad trench and drive along it, flattening the wire and firing into the trench. The second tank, thus covered, would drop its fascine into the trench, cross over it, turn left and fire its way along the trench. The third tank would cross the first trench on the already-placed fascine, drop its own fascine in the second trench, and cross. Then the first tank could cross the first two trenches and deposit its fascine in the third trench. The infantry would cross immediately behind the tanks. Their confidence in the tanks had been built anew by having the tanks, during training, demolish all the defenses that they, the infantry, could contrive.(61)

There was to be no massive pre-assault artillery bombardment lasting several days, alerting the enemy to a coming attack, and ruining the terrain for tanks. The artillery would not even register before zero hour, when over 1,000 guns of various calibers would open fire on the German outpost line and then lift their fire ahead of the tanks and infantry in successive intervals of 250 yards.(62) In the spirit of the young Tank Corps, Brig. Gen. Hugh Elles, its commander, chose to be on board his tank, the Hilda, leading the attack with Tank Corps colors flying.

Everything went as planned in the initial stages of the attack. Complete surprise was achieved. The fascines worked. The tanks broke through the Hindenburg Line. More than three miles were gained on the first day, an unprecedented advance.

However, all the available tanks had been committed; there were none for exploitation. There were cavalry divisions for exploitation, but these were committed late, took heavy casualties, and accomplished nothing. The whole timetable for the assault was held up by an effective German battery at Flesquieres ridge (see Map 4) that picked off tanks as they came up the hill. Despite their gains the British never reached Cambrai. The Germans counterattacked successfully on 29 November, and the British pulled back to more defensible lines. Nothing tactically significant had been gained, although the effectiveness of the tank under favorable conditions had been demonstrated.(63)

It is not difficult to see how the British could have emerged from Cambrai with new confidence in the tank's



MAP 4: CAMBRAI, 1917

effectiveness, while the Germans emerged with equal confidence that they could handle the tank and that there was no need to worry unduly about Allied tanks or to rush production of their own.(64)

Troop Reactions at Cambrai

The area attacked at Cambrai was held by the German Second Army, part of the army group commanded by Crown Prince Rupprecht of Bavaria. According to the official history, "Troops suffering from combat fatigue and in need of training were standing sectors of considerable breadth."(65) The official history indicates that these troops were not considered capable of holding successfully against a major attack, but that all prior experience indicated that "the obstacles -- up to 100 meters in depth -- of the deeply echeloned position offered adequate defense." It was precisely because the defenses were especially strong in that area that it was held by relatively few troops of relatively low combat effectiveness.(66)

The available German sources do not mention panic, although the massed tank attack was a complete surprise to troops in the trenches and commanders up to the army group level. Crown Prince Rupprecht said, "The speed with which the tanks, favored by the dryness of the ground, moved forward seemed incredible....The sudden appearance of the tanks must have had a demoralizing effect on the troops, and there was a shortage of artillery to combat them."(67).

A German regimental history describes the "powerless rage" of the German defenders, who had been preparing to give the enemy infantry a "warm reception," but saw their bullets and hand grenades "bounce off the tanks without any effect."(68) However, reserves were quickly brought forward, and resourcefulness was shown by individual officers and men. In his day-book entry, Crown Prince Rupprecht mentions the effectiveness of the first-day "emergency measure of using antiaircraft guns firing from trucks -- one alone of these destroyed seven tanks," and says that "all Fourth and Sixth Army guns mounted in this fashion are to be sent to Second Army without delay."(69) The battery that destroyed so many tanks as they mounted Flesquieres ridge has already been mentioned.

Although the German sources do not mention panic, rout, or mass surrenders, British sources do report mass surrenders of German troops. A machine-gun section commander remembered that his men had trouble getting their mules across a huge, captured German trench, "but luckily there were quite a lot of Germans there, who were more or less looking for someone to surrender to, and they helped us to get our mules across."(70) This same man says, "There were a certain number of Germans in every direction. The ones near us were really just trying to surrender, but further on down the slopes we could see quite a number of Germans running about trying to escape from the tanks. They had left the trenches and they had left their dugouts -- probably rightly --

because had they stayed there they would have got the Mills bombs from the Jocks [hand grenades from Scottish infantry]." He added,

> The extraordinary thing was that for about three minutes I had to stop firing altogether. A great number of Boche came straight towards our guns with their hands up, and it would have been absolute sheer massacre to have killed them."(71)

This man also commented on what he took to be the poor quality of the German troops he saw at Cambrai, describing them as small, unshaven, dirty, and, in many cases, wearing glasses.(72)

In contrast to the British personification of the tanks as humorous and clumsy, the Germans, not surprisingly, saw them as monsters. These terms are found in one regimental history: "big black-and-gray monsters," "black monsters that spit small-caliber grenades and sprayed machine-gun bullets," "terrible war machines," and "horrible black monsters."(73)

The British tankers and troops were generally happy with the events of the day. One tank officer remembered years later the heat, stench, and noise of the tank interior, the "cakewalk" of the advance across the Hindenburg line, the satisfaction of reaching the objective on time, and then the frustration and disappointment of waiting in vain for cavalry or infantry reinforcements.(74)

One infantry officer wrote

> There were tanks everywhere. One could count a score going across at once in our sector, and there were hundreds more besides. We let them get a little bit in front of us and then advanced at a walk, with rifles slung and everyone smoking merrily.
>
> The Boches had got belts of wire 25 ft. thick, but the tanks strolled over them as if they were crops, and we wandered behind in their tracks.(75)

A British airman, seeing the scene from above, also noted the relaxed air of the infantry: "I see, behind each tank, a trudging group of infantry, casually smoking, looking up at us. Other knots of infantry stroll along a little in the rear, between the tanks."(76)

Of course, the whole day was not so pleasant for the British. In addition to the tanker's frustration at the absence of reinforcements to keep the attack moving, the airman, the machine-gun officer, and the tanker all saw or experienced tanks going up in flame and infantry shattered by artillery shell.

After Cambrai

The British and French pushed ahead with tank production after Cambrai; the Germans did not. A few German tanks were used

in the offensive of March 1918, and there was some tank-against-tank combat during the remainder of the war, but German tanks were not numerous enough to play a significant role. The tactics developed at Cambrai were basically those that continued to be followed by the Allies. Tanks led off the final Allied offensives and were important to their success.

General Ludendorff said this about reasons for German defeats in August 1918:

> Mass attacks by tanks and artificial fog remained hereafter our most dangerous enemies. This danger increased in proportion as the morale of our troops deteriorated and as our divisions grew weaker and more exhausted.(77)

Ludendorff is also quoted as saying, "I hope that the tank panic, which at one time was overcome and now has revived again, will be once more overcome. It returned in all its force on August 8th."(78)

Summary of Troop Reaction

The first reaction of some German defenders to the tank was panic, associated with anger and a feeling of helplessness in the face of the seeming invulnerability of the tank. This was also a first reaction to the later use of tanks in mass. The size of the tanks and the absence of any visible humans operating them made defenders see them as "monsters." Some defenders expressed anger at the tank's inability (perceived as refusal) to take prisoners, regarding the tank as an unconventional weapon that violated the accepted rules of war.

At both Flers (first use) and Cambrai (first use in mass), the Germans were able to regain much of the ground they initially lost to the tanks, and at Arras, the Aisne, and Third Ypres (all occurring between Flers and Cambrai in time) they scored notable successes against tanks. The quick recovery from panic, the resourcefulness the troops showed against the tanks, and the effectiveness of the standard procedures the higher commanders established led the German high command to underestimate the military potential of the tank and not to push development and production of German tanks. German sources nevertheless show that repeated efforts to prevent panic and build the troops' confidence were necessary.

In summary, the size, mechanization ("monster" appearance and behavior), and seeming invulnerability of the tank evoked initial panic, but the attacked troops and commanders so quickly learned ways to deal with the tank that even the astute German General Staff underestimated the great military potential of this innovation.

The British troops who first experienced tanks also saw them as huge creatures, and also sometimes used the word "monster" to describe them. However, the personal characteristics they

projected on the tanks were, not surprisingly, entirely different from those the Germans saw. To the British infantrymen, the tanks were powerful, but also clumsy, amusing, and lovable. The troops delighted in the tanks' ability to smash or span obstacles and crush weapons that had cost many infantry lives in the past. After the tanks went into battle, however, and during the first year of their use, there was much disillusion and disappointment with them, primarily because they broke down so easily. There also seems to have been some jealousy of the perceived ease and safety of the tanker's position within his "steel waistcoat."

The infantry's confidence in the tank had to be rebuilt after Third Ypres. Apparently this task was successfully accomplished, and in the first advance at Cambrai, as noted above, relaxed infantrymen reportedly strolled, smoking cigarettes, behind the tanks.

The British tankers found their vehicles cramped, extremely noisy, and hard to drive. The difficulty of communicating within and between tanks was frustrating and frightening, as was the marked tendency of the tanks to break down. However, the tankers were buoyed by the infantry's initial enthusiasm and by the excitement of being part of a new, elite corps from which much was expected. Naval terminology and traditions probably gave the Tank Corps a special eclat in a nation whose Navy had an especially high status. The versatility and rigorous training demanded of tankers fostered their esprit de corps, and an image of panache and of self-sacrificing dedication in the leadership was established early.

Thus, despite the failures that caused the Germans to underestimate it, the newly introduced tank quickly acquired an extraordinarily positive image in the minds of the men who operated it and those who fought alongside it.

Notes to Case Study on Tanks

1. Specifications from Charles E. Brown and Robert Joseph Icks, "Tank," Encyclopaedia Britannica, 1966.

2. The Great War, p. 315.

3. Horne and Austin, Vol. 5, p. 392.

4. Casey and Larimore, pp. 15-20.

5. Williams-Ellis says "The battle had been essentially experimental." The Tank Corps, p. 29.

6. Neame interview.

7. Dennis memoir, pp. 70-71.

8. Fuller, Tanks in the Great War, p. 56.

9. The Tank Corps, p. 29.

10. Falls, p. 205.

11. Kriegsarchiv, Der Weltkrieg, Vol. 11, p. 68.

12. Ibid.

13. Robertson letter. Other sources reported that the Germans complained that the tanks behaved contrary to the rules of war in not accepting surrenders. Sueter, Evolution of the Tank, p. 142. In the letter quoted here, and some other first-hand accounts, original punctuation has been changed slightly for easier reading.

14. White letter.

15. Routh journal.

16. The Great War, p. 205.

17. Kriegsarchiv, Der Weltkrieg, Vol. 11, p. 69.

18. Reiffer interview.

19. Cooney interview.

20. Hutton interview.

21. Reiffer interview.

22. Hutton interview.

23. Cooney interview, p. 43. This tank veteran was not at Flers, but his comments seem relevant.

24. Cooney interview, p. 43.

25. Tanks in the Great War, p. 56.

26. White letter.

27. Sueter, Evolution of the Tank, p. 120.

28. The Tank Corps, pp. 29-30.

29. Stern, Tanks, pp. 98-99.

30. Williams-Ellis, The Tank Corps, p. 30.

31. Stern, Tanks, pp. 100-102.

32. The Reiffer account, cited above under "Tankers' Reactions," is in a different category from the published accounts, since it records a tanker's first-hand experience with infantry enthusiasm.

33. Neame interview, pp. 69, 70, 80.

34. Dennis memoir, pp. 75-77.

35. Plint memoir.

36. McIntyre Hood interview transcription, Department of Documents, IWM.

37. Williams-Ellis, The Tank Corps, p. 28.

38. Staddon interview.

39. Fuller, Tanks in the Great War, p. 57. Fuller extensively quotes a XV Corps report that describes this incident, so its authenticity seems established. However, it is suspiciously similar, in tactics and number of prisoners taken, to the trench-taking episode of 15 September, also reported by Fuller, who is not always accurate in these reports of events in which he was not personally involved. It seems possible that there was really only one such incident, on 25 September, but there has been no opportunity to pin down the facts.

40. Fuller, Tanks in the Great War, p. 57-58.

41. Cooney interview, p. 42.

42. Ibid.

43. Cooney interview, pp. 39-40.

44. Ibid., p. 42.

45. The Great War, p. 273.

46. Adolf Deutelmoser, Die 27. Inf.-Div. im Weltkrieg 1914-1918 (Stuttgart, 1925), p. 58.

47. The Great War, p. 274.

48. Cooney interview, p. 44.

49. Deutelmoser, p. 59. Probably none of these tanks was Cooney's, which he says was hit by an artillery shell, "a pure chance hit," when the tank was not near any infantry or any German positions. His tank had lost contact with its infantry, which apparently had panicked and routed. Cooney interview, p. 44.

50. The Great War, p. 278.

51. Kriegsarchiv, Munich, I Bavarian Army Corps,5th Bavarian Reserve Division 27.4.17, Experiences from the Battle of the Aisne.

52. Kriegsarchiv, Munich, III 3, I Bavarian Army Corps, Special Section Armee-Abt-C, Folder on experiences in spring 1917.

53. Mitchell, pp. 123-126.

54. Ibid., p. 127.

55. Mitchell, pp. 288-289; Cooney interview.

56. Mitchell, p. 289.

57. Great Britain War Office, Tank Corps, Instructions for the Training of the Tank Corps in France, p. 8.

58. Ibid., p. 7.

59. Churchill says the success of a few tanks, properly used, in a minor operation at Passchendaele made this persuasion possible. The World Crisis, Vol. 4, p. 58.

60. Williams-Ellis, pp. 104-105; Fuller, Tanks in the Great War, p. 144.

61. Williams-Ellis, pp. 103-104.

62. Fuller, Tanks in the Great War, p. 145.

63. Falls, pp. 316-322; Williams-Ellis, pp. 106-109; Fuller, Tanks in the Great War, pp. 145-147.

64. Von Eimannsberger, pp. 22-23.

65. Reichsarchiv, Der Weltkrieg, Vol. 13, p. 124.

66. Ibid.; Rupprecht, Mein Kriegstagebuch, Vol. 2, p. 19.

67. Rupprecht, loc. cit.

68. Dahlmann, p. 355. German armor-piercing guns also had trouble with the tanks at Cambrai. These were the second-generation Mark IV tanks.

69. Pp. 19 ff. Entry for 21 November.

70. Wimberley interview.

71. Ibid.

72. Ibid.

73. Pries, pp. 238-241.

74. Leigh-Jones interview.

75. Quoted in Sueter, Evolution of the Tank, p. 125.

76. Lee, No Parachute, p. 162.

77. Ludendorff, My War Memories, 1914-1918, p. 692, quoted in Sueter, Evolution of the Tank, p. 145.

78. Sueter, loc. cit.

Flamethrowers

Introduction

Flamethrowers were first introduced by the Germans in World War I. Preliminary research for the current study found general agreement, among sources consulted, that they were not effective in that war and were not widely used. For example, US Maj. Gen. Amos Fries called the flamethrower "one of the greatest failures among the many promising devices tried out on a large scale in the war."(1) And Maj. S.J.M. Auld, the British chemical warfare specialist, wrote, "There is now [no] German innovation which has fallen more into disrepute, and which has had less success when once the first surprise was over."(2)

The impression that the flamethrower was originally ineffective, requiring the development of napalm in World War II to make it militarily useful, made it seem a questionable choice for a case study. Consideration was given to treating the World War II introduction as a case study, but there again the early uses seemed ineffectual, and there was no clear first use in significant numbers.

The weapon is of special interest in a study of the psychological effects of weapons, however, because of the obvious terror effects of fire. There was also a substantial amount of information readily available on the construction and operation of the first flamethrowers. Then, as the German sources were explored, it became clear that, at least to the Germans, this was not an ineffectual failure but a useful weapon whose operation required skill and courage, and whose troops constituted an elite corps.

Since the flamethrower clearly met the basic criteria for selection -- a distinctly new weapon (in World War I), used against military personnel, and with considerable data available -- the HERO staff decided to make it the subject of a case study.

The Weapon

Description and Purpose

The aim of those who developed the flamethrower was to use the psychological effect and the penetration capability of fire for military purposes. The problem the developers had to solve was that of conveying fire -- a notoriously uncontrollable element -- to a target and directing it on that target.

According to German sources, the Japanese had used burning liquids against the Russians in the 1904-1905 war, a fact the German high command had noted but not pursued.(3) In or about 1914, a Berlin engineer named Fiedler, and also the commander of a German Army engineer company, Bernhard Reddemann, independently began experiments aimed at developing a military flamethrower.

Reddemann was a firefighter in civilian life, and his first experiments were carried out with the help of professional firefighters from the Posen (Poznan) fire department; apparently sprays of water from a steam fire engine were used to simulate liquid fire. At the end of 1914, the two men learned of each other's efforts, and joined forces. The devices they developed were relatively simple, and enough were ready for use by February 1915.(4)

The flamethrowers were, according to a British source, invariably called Flammenwerfer by British as well as German troops. The Germans had two kinds -- small (portable) ones, which could be carried by one man on his back, and large ones, which had to be emplaced in trenches. The small German flamethrower consisted of a steel cylinder about 2 feet high and 15 inches in diameter, plus a length of flexible hose ending in a nozzle. The cylinder was divided into two compartments, which could be connected by opening a tap. The upper compartment was a compressor, and the lower an oil reservoir. The compressor compartment was filled with nitrogen or deoxygenated air to a pressure of 23 atmospheres. (Air could not be used, of course, because of the danger of an explosion.) The nitrogen was brought into the trenches in cylinders, and the flamethrowers were filled there. The oil in the reservoir compartment varied, but always consisted of a light component (such as gasoline) and a heavy component (such as a tarry product of wood distillation or a heavy petroleum oil). The light component kept the flame lighted, while the heavy component clung to surfaces and burned longer.(5) The munition delivered to the target was thus not actually flame but fire -- that is, a burning liquid.

When the weapon was to be fired, a valve between the compartments was opened, so that the compressed nitrogen forced the oil mixture through the hose. The pressure of the oil on the nozzle triggered a friction lighter, which ignited a fuze composed of paraffin wax and a heavy wick. The fuze continued burning throughout the discharge, igniting the oil as it flowed out.

The small flamethrower had a range of 25 to 30 yards, while the large one had a range of 30 to 45 yards and could cover a front of 55 yards with flames. Since these large weapons were too heavy and cumbersome to be carried forward in battle, mines or saps had to be dug to within range of the enemy trenches, and the flamethrowers emplaced there, all as secretly as possible.(6)

The fire of the flamethrower was directed by the operator, and this was not an easy task, because of the force of the stream, especially with the large projectors. Many German flamethrower troops were former civilian firefighters (7), probably both because of their familiarity with fire safety and their experience in handling and directing heavy fire hoses.

No first-hand accounts of how the flamethrower appeared to troops using it have been found in either German or Allied sources. The weapon must have inspired some apprehension in users. It employed fire, a substance which has sometimes been considered contrary to the rules of war because its effects are so difficult to control. Despite historical precedents going back to the ancient "Greek fire," the flamethrower was, for those dealing with it, basically a new weapon, previously untried, when the Germans first took it into combat in February 1915. It posed a serious tactical problem -- how men could get it within range of the target -- a quite short distance for early flamethrowers -- while physically encumbered with the flamethrower, without being spotted and shot down by the enemy.

As for how the weapon appeared to defenders, in the case of the flamethrower, an unusually good source is available. A few days after the first German flame attack on British troops, an officer from British Army headquarters interviewed men wounded in the attack, which had come about dawn on 30 July 1915.(8) From these men's reports, it appears that they were hit by large flamethrowers which had been emplaced by mining near the British lines. They described the flame as like a mine explosion or an ammunition dump going off, but without the noise -- a silent explosion. Then came jets of flame, which one saw as 15 feet high and another as 30 to 40 yards long. One lieutenant said this:

> It seemed that the fire came from the jets, and I got a few drops on my hand. At first [it] came out black, then red, and ran along the ground and into trenches [someone has inserted the word doubtful in parentheses after this statement]. Smell rather funny, more like burning oil than anything. Flames flowed down into trench as far as I could see, but not near me. ... Element of surprise very great. Flames lasted 4 minutes. Came out of jets; looked as if they waggled round, as if on joints.(9)

The appearance of the flame was very frightening to the men. One officer said that the loss of the trenches was entirely due "to the fire, and its moral effect."(10)

Differences From Other Weapons Then in Use

Under ordinary circumstances of trench or open warfare, the relative lethality of the World War I flamethrower was very low. However, to the individual soldier who was within its limited range and exposed himself to it, or to troops caught by it in enclosed shelters, it was extremely lethal. The wounds it inflicted were very painful, probably more immediately painful, as well as more painful during hospital treatment, than those from high-explosive shells. The healed wounds were disfiguring. The appearance of the charred bodies of the dead and the wounds of survivors was certain to be stressful to other soldiers.

As for the weapon's vulnerability or lack of it, although the first jets of flame must have seemed invulnerable, generally effective measures for dealing with flamethrowers were developed so quickly and were so simple -- orders to stay in the protection of the trenches and be alert to pick off the advancing flamethrower troops were given to British troops within a day or two -- that seeming invulnerability cannot be considered a characteristic of the weapon. On the contrary, the flamethrower operators were extremely vulnerable, and special efforts were made by the Germans to protect them and provide them with psychological rewards.

The weapon was virtually silent, and this may be one case in which, when the weapon was first experienced, silence was more horrifying than noise. This surmise is based on the fact that two of the nine survivors of the first attack on the British mentioned the quiet, apparently spontaneously. An uncanny picture of a huge but silent explosion is conveyed by these reports.

Flame weapons have not been included, so far as can be ascertained, in any international conventions forbidding classes of weapons regarded as inhumane. However, there was, at least prior to World War II, some traditional onus on the use of fire as a weapon in war, an onus stemming from the impossibility of limiting its effects to military targets when it is used on a large scale. Some, at least on the Allied side, did consider the flamethrower an immoral weapon. The leading British gas officer, S.J.M. Auld, writing during the war, said "When the German Army entered on its policy of frightfulness there was none of its new and unprincipled methods which had more immediate and striking success than the use of liquid fire." [Emphasis added.](11)

Circumstances of First Use

Flamethrowers were used first by the Germans against French troops in the Bois de Malancourt, near Verdun, on 26 February 1915.(12) Little information has been found on this attack, and the specific military objective for which it was used is not known. The Western Front was generally quiet in February, with no major offensives under way. It seems likely that the use of the flamethrower then was intended primarily to test the effectiveness of the new weapon. Its co-developer, Bernhard Reddemann, wrote after the war that there was some reluctance to put the weapon on the battlefield, and that it was the interest of the German Crown Prince that led to its first use, and that it was he who directed that it be used at Malancourt.

The attack was carried out by the Abteilung Reddemann, which had been formed in January 1915 and comprised 48 selected engineers and 12 large flamethrowers. As indicated earlier, these flamethrowers were too heavy to be carried forward in the open and had to be emplaced in the position from which they would be fired -- within about 40 yards of the enemy positions -- by mining. For the Malancourt attack, the large flamethrowers were "set up in trenches and saps [at] intervals of about 50 meters."(13)

Nothing is known about the reaction of attacking or defending troops to this first use of flamethrowers. The German sources state only that "success was even greater than anticipated."(14)

It appears certain that the attacker achieved surprise, that the defending troops had no training in dealing with the new weapon, and that no serious effort was made by the attacker to exploit whatever gains were made. Apparently the use was largely experimental, and no significant breakthrough was sought. Since the attack was described as successful, and subsequent German work on flamethrowers bears this out, and since there was panic among defenders in subsequent early uses of flamethrowers, it is probably safe to assume that there was panic among the French defenders at Malancourt.

More material on defending troops' and commanders' reactions is available for the first use of flamethrowers against British troops, five months after Malancourt. The British troops appear to have been completely unprepared for the flamethrowers, so that the experience was like a first use of the weapon, as far as they were concerned. For the sake of consistency with other case studies, this material is presented under "Adaptation," below, rather than as part of this "first use" section.

Adaptation

German Adaptation in 1915

Following the success of the first flamethrower attack, the German high command ordered the effort expanded. In March 1915 the Abteilung Reddemann became the III Guard Pioneer Battalion, under Reddemann's command.(15) The men of the battalion were trained firefighters or volunteers for the new service. Later in 1915, two more flamethrower companies were added to the Guard Pioneer Regiment of which the battalion was part.

Meanwhile, the French had begun experiments with flamethrowers, probably in response to the German attack.(16) By 2 March 1915, just four days after the fire attack at Malancourt, a message from the French Minister of War to the Commander in Chief -- stamped urgent -- directed that flamethrower tests "take place with as little delay as possible."(17)

The second German attack probably took place on June 20, 1915, about four months after the first attack, in the Argonne area just northwest of Verdun. In any case the Germans used flamethrowers in an attack on French troops on that date, and made relatively large gains (300 to 400 meters of the French front line and another sector of trenches 200 meters wide and 100 meters deep).(18)

In their counterattacks, on 27 June, the French used their own flamethrowers for the first time, making little headway, and then losing still more ground to the new German attacks. A German

regimental history described the events of 27 June with a suggestion that the Germans had immediately adapted to the flamethrower, but no information on how they did: "Even the flamethrowers, which [the French] used for the first time, were not able to alter the situation; the Argonne fighters learned very quickly and skillfully how to defend themselves against this new weapon."(19)

The Attack on the British at Hooge

The first flamethrower attack against the British came at 3:20 AM on 30 July 1915, near the ruined village of Hooge, at the apex of the Ypres salient. The British troops were inexperienced, and had just taken over the trenches a few hours earlier. They found them protected by "no wire to speak of," with the front-line trenches so deep and narrow that communication along them was difficult; communication to the rear was also difficult. Enemy trench mortars had blown in part of the support trenches, so that most of them were not habitable. Too many men were consequently crowded into the front trenches, and the defense configuration had too little depth. A crater, which the British did not attempt to hold with troops, divided the front line position; bomber (grenade thrower) posts were set up on both sides of the crater. The troops were completely unprepared for a flamethrower attack. They do not seem to have heard about flamethrowers, and they certainly had no training or instructions on how to react to such an attack.(20) However, the war diary of one of the British battalions describes this as "the first use of liquid fire against the British," suggesting that some of the officers must have known of previous attacks against the French.(21)

The German attack began with a brief, intense artillery bombardment at 3:15 AM, just after the men had "stood to" in the usual predawn muster. Then came the "sheets of flame ... all along the front [of 100 yards] and clouds of thick, black smoke."(22) There was panic, and men fled the front trenches, enabling the Germans to break through at the crater and attack with grenades and then machine guns.(23)

A British counterattack failed, and British casualties were very heavy, most of them from gunfire and probably most of them in the counterattack. One battalion lost 80 percent of its officers and 64 percent of its men killed, wounded, or missing and presumed killed. Four of its five machine guns were also lost.(24)

The Germans consolidated their gains with a speed that impressed their British adversaries;(25) thus the failure of the British counterattack. However, they did not attempt to exploit their local breakthrough. Ten days later the British retook the ground lost, with heavy casualties.(26)

Descriptions of the flame attack by the troops who experienced it have already been cited. Briefly, they saw an uncannily silent explosion of fire and smoke, followed by jets of

flame that lasted less than five minutes, smelled like oil, seemed to waggle around as if they were jointed, and seemed to run along the ground and into the trench, but not into a trench where the observer himself was. In fact, the flames did not go over the parapets of the trenches, and men who stayed low in the trenches were not harmed by them.

Some of the men's psychological reaction can be deduced from this distorted perception of reality: the flames seemed to one officer to be flowing into the trench "as far as I could see, but not near me."(27) An officer said that the loss of the trenches was "entirely due to fire, and its moral effect." He added that although there was a very heavy bombardment, the troops "could have stuck that." He pointed out that the flames could have been avoided by lying flat in the trenches (28), as did 2d Lt. B. J., who was quoted earlier. Another officer said that all the men who came back were badly surprised, but none was burned; a rifleman said that very few of the men he saw leaving the trenches were burned, none seriously.(29)

Thus, for this early use, and first use against British troops, a number of first-hand observations of the event, made shortly after it, are available. They present a psychological picture of men panicked by an unexpected weapon that employed a dreaded substance -- fire -- a weapon which they had no preparation for or defense against. Many of them behaved in a counter-productive way -- leaving the trenches instead of staying in their protection -- and their panic caused loss of ground and, indirectly, heavy casualties.

British Use of Flamethrowers

Apparently in response to the German flamethrowers, the British, like the French, developed their own. They were first used on the first day of the tremendous Somme offensive, 1 July, 1916. Three large flamethrowers had been readied, and mines were dug so that they could be set up 60 yards from the enemy lines, which were 200 yards from the British lines. The apparatus was very heavy, and each part had been made light enough so that two men could carry it; this necessitated many parts and many trips. A gauge of the effort is the fact that to get the 100-yard range they wanted, the British had to use a ton of oil for each firing of each machine.

During the preparation for the offensive, the men and machines were temporarily buried by German artillery shells more than once, and one bombardment damaged a flamethrower so severely that it was cannibalized so that the other two could be used. They were fired on 1 July, at zero hour, attained ranges of 94 and 87 yards, and charred the German troops in the front-line trenches facing them. British infantry in that sector met no resistance at first.

The British developed flamethrowers of three sizes -- portable (one-man) with a range of 20-30 yards; portable (two-

man) with a range of 50 yards; and heavy, with a range of 70-100 yards. However, the British were never enthusiastic about the weapon. They decided that the large flamethrower, though effective, was not effective enough to justify the tremendous effort involved in mining to emplace it and carrying up its numerous heavy parts. As for the smaller flamethrowers, the British never could find a satisfactory mission for them. They believed the operator became too vulnerable to enemy fire if he got close enough to the enemy to use his weapon effectively.

No data has been found on the psychologcial reaction of German troops. British sources say that an attack by the British 48th Division near Pozieres on 23 July 1916 had an effect that was probably "only moral," suggesting the British believed there was some panic despite few casualties.(30)

British and German Attitudes

The British and German attitudes at the higher levels of command were in sharp contrast, and apparently this was true at the troop level also. The British attitude is summed up in the words of the leading British chemical warfare officer: "[On] the whole they were a disappointment and only a few of them were ever manufactured."31 The Germans, on the other hand, carried out the following numbers of flamethrower attacks: in 1915, 32 (or 30 in one source); in 1916, "over 160,"; in 1917, 165; and in 1918, 296. There were thus about 653 attacks, of which, according to one source, 535 were successful.(32)

These attacks were carried out by a sizable body of flamethrower troops. In 1916 the III Guard Pioneer Battalion was expanded to the III Guard Pioneer Regiment, with over 3,000 men. A large flamethrower factory was built in France, near regimental headquarters. Improvements were repeatedly made in the flamethrowers, and repair as well as manufacture was carried out by the factory.(33)

The differing German and British attitudes toward the weapon appear to be based on differing attitudes toward the danger the flamethrower operator ran, both from the weapon itself and, especially, from the hostile fire his exposed position invited.

A British chemical officer, Major Auld, writing during the war, stated that service in the German flamethrower regiment was a form of punishment, that men guilty of offenses in other regiments were sentenced to serve there. He told the story of two Flammenwerfer soldiers who were forced over the top in daylight with no covering fire, revolvers in their backs.(34) This story, raising as it does the question of why the Germans would want to waste the men's lives and the flamethrowing apparatus in this way, seems unlikely at best. However, it is evidence of British attitudes.

According to Auld, the flamethrowers were ineffective because if an operator got close enough to do any damage he was

almost certain to be shot, at which point he became a danger to his own side. In addition, since the flame tended to rise, if defenders stayed down in their trenches, they would not be harmed. Auld did, however, acknowledge that flamethrowers were useful to the Germans at Verdun, where they eliminated well-protected blockhouses by shooting jets of flame through their gun slits.(35)

In brief, the British attitude, at least in 1917 or early 1918, seemed to be that flamethrowers were not very effective, that they were not worth much attention as British weapons, and that they were easy to defend against.

The German attitude was very different. The Germans found the flamethrower to be effective in the specific kinds of situations for which they believed it was suited, and apparently decided it was worth the casualties.

The Germans found that the psychological impact of fire as a weapon was still strong, more than a year after the weapon was first used. A document dated 20 April 1916 states

> The moral effect of the flames was very considerable. Many of the enemy surrendered before the flames reached them, and frequently even when a smoke cloud was produced at some little distance from them. During the fighting at Samogneux and Haumont, the Flammenwerfer squads ran short of fuzes and continued to operate their jets without setting fire to them. Even this induced the occupants of houses to surrender. [Emphasis in original.](36)

The Germans did acknowledge that casualties were higher for flamethrower troops. A German division commander is quoted as saying this: "They advanced with supreme courage. . . . To be sure, their gains were at the expense of considerable losses, which were essentially higher than the infantry casualties. . . . A carefully selected and excellently trained and led elite corps."(37)

The key to the German attitude is the word "elite." The Germans did feel the flamethrower was effective, and after early experimentation they generally limited it to the kinds of missions in which it could be effective. They recognized the danger, but, deliberately or unconsciously, made it a virtue. After the 150th flamethrower attack, the Kaiser, on 28 July 1916, granted members of the III Guard Pioneer Regiment the death's head insignia, to be worn on the lower left sleeve. At this time, the German Crown Prince, who, as indicated above, had been an early advocate of the flamethrower troops, wrote this tribute for them:

> Constantly committed at the most difficult sites, officers and men made effective use of their weapon everywhere and in a short time became, for the French, one of the most feared enemies in close combat. I am convinced that this outer

symbol will always remain a reminder to the young corps to continue its further development in the spirit of death-defying joy in combat.(38)

If the German sources, admittedly sources produced by flamethrower advocates, are correct, the elite quality and spirit of the flamethrower troops were produced by careful selection, by thorough training and firm discipline, and by the pride they took in doing work that was perceived as both dangerous and important. Said Reddemann:

> In part, they were firefighters, and there were also men who had distinguished themselves in other units and who had a special preference for this special new weapon. A splendid spirit prevailed in the entire regiment -- a principal requirement for the brave soldier -- which never permitted any of the Death's Head Engineers to give up even in the most difficult situations, and which filled them again and again, despite losses which were sometimes not minimal, with new joy in combat.(39)

According to Reddemann, the flamethrower veterans formed an association after the war and always wore the death's head insignia on their civilian clothes at their meetings.(40)

German Tactics

British tactics were largely defensive, given British lack of enthusiasm for using the weapon, and these defensive tactics can be stated simply. "The method of meeting attacks by Flammenwerfer is to look out for and shoot down the men of the Flammenwerfer detachment."(41) Auld put it this way: "Shoot the man carrying the apparatus before he gets in his shot if possible. If this cannot be done, take cover from the flames and shoot him aftgerward."(42)

The Germans, on the other hand, did use the weapon quite frequently, and developed tactics tailored to its offensive capabilities and limitations. After the first few tries, it was not used as part of a mass assault, the way cloud gas and tanks were, and the way the Germans used it at Malancourt and Hooge or the British used it at the Somme. Rather, it was used to reduce isolated defense positions that were holding up or might hold up an advance. Later in the war, the small, portable flamethrowers seem to have been used more and the large ones less. A German source acknowledges that the large flamethrowers were "brought up with great difficulty," although they were used effectively in some cases, including at Fort Douaumont at Verdun.(43)

Since the emplacement of the large flamethrowers had to be done at night, after mining or sapping to within 30 or 40 meters of the Allied trenches, and required carrying up very heavy apparatus, "beginning in 1916, preference was given to the more flexible attack with small flamethrowers, which depended on skillful command, silent approach of the flame carriers, and their support by machine gun fire and hand grenades."(44)

The tactics that were developed are best described by Reddemann:

> Flamethrowers constituted a close-combat weapon that at first seemed completely unsuitable for attacking machine guns, etc., at a distance of more than 30-50 meters. It was thus necessary to find tactics that would enable the troops to advance, without great losses, close enough to the . . . target to bring their frightful weapon into action in close combat. The rule of thumb was established . . . that the flamethrower troops must not advance with the infantry but rather go ahead of the infantry against especially important points of resistance. . . . Their purpose was to facilitate the advance of the assault infantry and to minimize their losses. . . . Hence tactics for a . . . "leaping attack" had to be created to prevent if possible the advancing flamethrowers from being shot down before they were in position to release their first jet of flame. The right method was found in the Indian method of stalking forward. The men did not leap out directly ahead, but individually, in a wide arc but still together, in very short leaps . . . , moving from one piece of cover to another toward their objective. . . If the enemy fired at an individual man, his shot usually came too late, when the man had disappeared into the terrain again. Often the men crept forward slowly. . . . . [In the "leaping attack"] the few men [that the enemy] saw jumping about the terrain, apparently leaping aimlessly from one piece of cover to another, just looked crazy to them. Once the troops had made a diagonal approach to within 60-80 meters of the target, one jet of flame, the so-called cover flame, was released. Under its cover of fire and smoke, the troops made their last leap and then released their fiery smoke into the narrow embrasures of the blockhouses, machine gun installations, etc. . . .This small corps received the designation Stosstruppe [shock troops], a concept only later used by other arms of service. This type of advance . . . naturally placed great demands, not only on the courage of the individual flamethrower engineer, but also on his skill and his understanding of terrain exploitation. As a rule, it could only succeed if supported by the fire of other weapons during the entire approach, up to the release of the first jet of flame. While the flamethrowers advanced, there was intense shelling by the trench mortars and machine guns of the assault infantry still in the rear, to force the enemy under cover, or at least to divert his attention. . . .
>
> Hundreds of times the flamethrower shock troops succeeded in getting close to the enemy in this way. . . . Only a few

mishaps occurred. Here casualties were sometimes high, but usually they were unexpectedly minor.(45)

Reddemann said that the flamethrower regiment called these tactics "pincers tactics," with the mortar and machine gun fire being one claw of the pincers and the other being the flamethrower troops, who had been advancing in their customary "leaping attack," and who then closed on the target at the last minute. He recounted an example from the German offensive of March 1918 in which a half-platoon of 20 men with 6 small flamethrowers, using "pincers tactics," destroyed a British tank and machine gun nest, capturing 3 officers and 72 men. Reddemann gave several other examples of successful use.

Although Reddemann was an enthusiast for his weapon, and his statements perhaps should be discounted somewhat, his descriptions of successful flamethrower use are convincing and are supported by the 1916 German document cited above. Flamethrowers in World War I have generally been ignored or deprecated in English-language treatments of the war; this may be partly because they were not used in the mass offensives that play the major role in general histories of the war, but rather in specialized offensive situations. Also, the British did not themselves find the flamethrower useful, and perhaps needed to convince themselves that the weapon was inherently ineffective, and that they could deal with it. The German attitude toward the tank is comparable.

The fact that flamethrower attacks increased by 80 percent from 1917 to 1918 suggests how much they must have been used in the great German offensives of the last year of the war.(46) Perhaps if Auld had been writing after those offensives he would have shown less scorn for the weapon.

Summary of Troop Reaction

The immediate reaction of French and British troops to the first use of flamethrowers included enough panic to produce losses of ground and, at least in the case of the British, a local rout. There is no evidence that German troops panicked when first hit by flamethrowers, and apparently there was no significant loss of ground. It is not known, however, whether the French flamethrowers the Germans faced were as effective as the German ones first used against the French and British.

The British used the flamethrower less and less as the war continued. Basically, British commanders seem to have decided that the ratio of casualties, materiel, and labor, on the one hand, to results, on the other, was too high. They were particularly impressed with the danger to the operators of the apparatus. They also thought that their own troops could deal effectively with German flamethrowers by picking off the heavily burdened operators as they advanced. British troops probably shared this confidence; perhaps in some cases, they appeared confident to cover fears. It seems likely that such stories as

the one about the German flamethrower operators forced over the top at revolver point originated with British troops.

The Germans, on the other hand, seem to have made a virtue out of the danger to the operators, deliberately building an esprit de corps based on selectivity, training, skill, and "death-defying joy in combat." They also carefully developed tactics that would minimize casualties and maximize military success, and they limited flamethrower attacks to the specific types of objectives for which they were best suited.

It may be that flamethrowers were used more frequently against French than British troops; the long and intensive German operations against French fortifications at Verdun would offer one reason why this should be true. In the quotation given above, the German Crown Prince mentioned especially the flamethrower troops' effectiveness against the French. This greater use against the French would help explain how British writers could speak so lightly of the weapon.

It seems possible that the flamethrower was even more feared than the heavy artillery bombardment by men who experienced both. This is said on the basis of the judgment of the British officer at Hooge, who said the men could have held despite the heavy artillery bombardment but had panicked when the flames hit, and of the German report that in spring 1916 the terror effect of the flames was such, over a year after the weapon's introduction, that men surrendered when the flames were not very near them and even when the oil was not ignited.

Certainly the Germans found that the weapon was not only effective in physically eliminating well-protected, isolated points of resistance, but that it continued, well after its initial use, to have a strong psychological impact on Allied troops.

Notes to Case Study on Flamethrowers

1. Fries and West, p. 352 or 401 (cited in Brophy, Miles and Cochrane, p. 139).

2. Gas and Flame, p. 185.

3. Cron, p. 186; Reddemann chapter in Heinrici.

4. This summary of the flamethrower's development is from Cron, pp. 186-87; Reddemann's chapter in Heinrici; and Wer Ist's, 1929 (for Reddemann's background).

5. The description of the flamethrower is from Auld, pp. 190-192.

6. Auld, pp. 193-194, 197.

7. Reddemann chapter in Heinrici.

8. Foulkes, p. 50; Auld , p. 188, says 29 July.

9. 2d Lt. B. J., Front Line, in "Very Rough Shorthand Notes," 16th Bn file (RRG9IIIC3, Vol. 4080, Folder 2, File 9), Canadian Public Records.

10. Lt. G., Rifle Brigade, ibid.

11. Gas and Flame, p. 185. Auld went on to say, as quoted earlier, that the flamethrower soon proved a failure.

12. Cron, p. 186; Reddemann in Heinrici.

13. Reddemann in Heinrici.

14. Cron, pp. 186-187; Reddemann in Heinrici.

15. Cron, loc. cit., and Reddemann, loc. cit., differ somewhat on the 1915 organization, but apparently this was a three-company all-flamethrower battalion that was part of the Guard Pioneer Regiment. All data on German flamethrower organization and tactics is from these sources.

16. The cause-effect relationship is a guess based on the timing and the fact that it was Germany that initiated most of the lethal chemical developments of World War I.

17. French National Archives, Fort de Vincennes.

18. Figures from France, Les Armees francaises dans la grande guerre, Vol. 3, p. 199. This paragraph is based also on Reichsarchiv, Der Weltkrieg, Vol. 8, p. 81.

19. Quotation from Oberst a.D. Simon, Das Inf. Regt. "Kaiser Wilhelm, Koenig von Preussen", Nr. 120, pp. 22-23. This paragraph is based also on Les armees francaises, Vol. 3, p. 200.

20. War diary, 8th Bn/Rifle Brigade. WO 95/1896, British Public Record Office.

21. War diary, 7th Bn/King's Royal Rifle Corps. WO 95/1896, British Public Record office.

22. Ibid.; 100-yard front from Lt. Col. B., Sherwood Foresters, in "Very Rough Shorthand Notes," 16th Bn File (cited above), Canadian Public Records.

23. Auld, p. 188, 8th Rifle Brigade war diary.

24. War diary, 8th Bn/Rifle Brigade.

25. War diary, ./King's Royal Rifle Corps.

26. Auld, pp. 188-189.

27. 2d Lt. B. J., "Very Rough Shorthand Notes," 16th Bn file, Canadian Public Records.

28. Lt. C., Rifle Brigade. 16th Bn file, Canadian Public Records.

29. Rfn. B., 8th Rifle Brigade, file cited above.

30. Foulkes, p. 166. Information on British flamethrower development is from Foulkes, pp. 111-112; information on the use of flamethrowers at the Somme is from Foulkes, pp. 162-164.

31. Foulkes, p. 112.

32. Reddemann in Heinrici; Cron, pp. 186-187 is the other source for this passage. Some figures on attacks in early 1916 are also found in a report from the Commander of Flamethrower Troops, 20 April 1916, in the Bavarian State Archives, Munich, Gen Kdo I.AK, Bund 99, Akt. 1.

33. Reddemann in Heinrici.

34. Auld, p. 194.

35. Ibid., pp. 198-201.

36. Germany, Message from C.G.S. of the Field Army

37. Generalleutnant von Woyne, quoted by Reddemann in Heinrici.

38. Quotation, Reddemann in Heinrici; other information from the same source and Cron, pp. 186-187.

39. Reddemann in Heinrici.

40. Ibid.

41. British comment on Germany, Message from C.G.S. of the Field Army, 20 April 1916.

42. Auld, pp. 200, 201.

43. Reddemann in Heinrici. This paragraph is based also on Germany, Message from C.G.S. of Field Army.

44. Cron, p. 187.

45. Reddeman in Heinrici.

46. Cron, p. 187; 165 attacks in 1917, 296 in 1918.

Air Attacks on Ground Troops

Introduction

The use of the airplane as a tactical weapon system in support of combat operations by strafing and/or bombing enemy troops has been of profound significance in the waging of war in the 20th Century. Although the airplane was used in this role in only a comparatively limited capacity during World War I, its newness as a tactical weapon system and its unique nature make the psychological impact of strafing and/or bombing of combat troops a worthwhile case study. It must be acknowledged that there is a paucity of sources that treat the reaction of infantrymen to attack from the air. However, there are accounts by the men who carried out the strafing and bombing missions that describe their reactions to the experience and also give the pilots' impressions of the reactions of ground troops.

It is not possible to ascertain the first time that an airplane pilot fired on ground troops because there appear to have been a number of occasions when pilots came upon troops in the open and treated them as targets of opportunity. But the first planned, organized, large-scale strafing mission was carried out by the German Air Force on 10 July 1917. The first similarly planned Allied strafing and bombing attack on German troops occurred some four months later at Cambrai on 20 November 1917.(1)

Early German Attacks

The 10 July 1917 German strafing mission took place in Flanders and was in support of elements of the Fourth Army. The attack occurred on the far left of the British lines near the Belgian coast. It was apparently an attempt to disrupt a British buildup; the British Second and Fifth Armies were massing for a major offensive.(2) The German strafing unit was a detachment of the 1st Combat Squadron. British war diaries for 10 July mention a strafing attack, but the report is matter of fact and gives no indication that the attack aroused unusual fear among the soldiers subjected to the attack.(3) However, this does not necessarily mean that the British troops were unawed or did not experience unusual fright; British war diaries, like most after-action reports, are generally matter of fact. The German official history of air combat in World War I asserts that the attack was both tactically effective and psychologically devastating.(4) The German pilots who carried out the attack concluded from its results that the airplane would be a very effective weapon in executing preemptive attacks against troop concentrations.(5)

Major Georg Neumann of the Imperial German Air Force wrote that the strafing and bombing of Allied troops from the air proved to be a very effective tactic and one which had a definite psychological impact upon both the German troops it was used to support and on the Allied troops that were attacked. Neumann's account is also significant because it describes action that

occurred well after the 10 July 1917 incident described above. This suggests that the airplane's psychological effectiveness did not diminish with its continued usage in combat. Let us examine Major Neumann's accounts of the effective use of the aircraft in strafing ground troops.

Neumann says that the Germans developed the tactic of strafing in order to protect their reconnaissance planes from ground fire. German "escort planes" (fighter planes) would fight through Allied aircraft and attack the ground troops that were firing on the German reconnaissance planes. Because of the effectiveness these pilots had in attacking ground troops they were given the name "storm squadrons," and their planes were thereafter called "strafing machines." Neumann claims the strafing machine was particularly effective when used after German infantrymen had attacked entrenched positions and there was inadequate artillery fire to repulse Allied counterattacks. The strafing machines solved this problem by repeatedly strafing Allied positions, keeping the Allied soldiers scattered, disoriented, and unable to mount counterattacks.

Neumann's account of the role the strafing machines played in the 25 April 1918 German attack on Kemmel Hill emphasizes the psychological impact the German air attack had on the ground troops that took part in the engagement.

> In this connection the attack on Kemmel Hill will be remembered for all time. In the first grey light of dawn the battle squadron flew raging to the attack like a flock of gigantic night birds; lower and lower they descended, until they were only a few feet above the heads of the men in our trenches, and when with a thundering hurrah the [German] infantry went over the top, the aeroplanes overwhelmed the enemy's resistance with furious machine-gun fire. Our terrified opponents offered very little resistance; the wiser individuals among them held up their hands, and were taken prisoner by our victorious infantry.(6)

It is obvious that, in Neumann's mind, the air attacks broke the will of the defenders quite easily. The Allied ground forces were completely overwhelmed by the machine-gun fire that literally rained down upon them. The shock effect was tactically decisive. Neumann continues the account by saying that, after the Storm Squadron attacked the trench lines, it attacked Allied supporting artillery and ammunition dumps with equal success. The Allied artillery crews had been "blazing away," but after being strafed they quickly surrendered. The immediate capitulation of the Allied artillerymen after being attacked from the air suggests the psychological effectiveness of the airplane in its strafing role, although it is possible that most of the men simply became casualties. Neumann's account of the attack on the reserves at Kemmel Hill is also enlightening.

> The enemy's reserves were situated in hollows and behind woods; it was the trench-strafing aeroplane's duty to

discover their whereabouts. What disorder and what loss of morale they caused, as they attacked with bombs and hand grenades, and their machine guns reaped their bloody harvest. Even now, I can see in my mind's eye that American battery near Verdun, which was standing in readiness behind the small wood; the wounded horses reared, the rest bolted into the surrounding country, and the entire unit was scattered.(7)

The description of the destruction of the US reserve artillery battery indicates panic among the American soldiers. Neumann's emphasis upon the loss of morale among the American troops tells us that, in Neumann's opinion, strafing did induce terror and unusual fright in combat troops. Neumann writes that the strafing machines continued their work for several hours, breaking up the forward movement of additional reserve units that tried to advance and regain the Kemmel Hill position. According to Neumann, the impact of the air attacks upon the morale of the Allied troops was the decisive factor in the engagement. Although it must be acknowledged that Neumann was not a disinterested observer, nevertheless, as a major in the German Air Force, and a participant in the events described, he was in the position to comment authoriratively on the effectiveness of air attacks on ground troops.

It should be noted, however, that Winston Churchill gives an account of the Allied loss of Kemmel Hill that does not mention the German air attacks. Churchill says that Kemmel Hill was valiantly defended by a single French battalion adn that the French defenders suffered heavy casualties in repulsing three German attacks. In these first three attacks, writes Churchill, the German employed minenwerfers (infantry mortars), machine gun fire, and artillery to no avail. But, during the fourth German assault the French broke and fled for the rear. Churchill says he does not know what caused the French to collapse suddenly after offering staunch resistance earlier.(8) It seems likely, in the light of the Neumann report, that the collapse was due to the German air strikes.

From both Neumann's and Hoeppner's accounts we can judge that the strafing machines had a positive psychological impact on the German ground troops. Infantrymen who were preparing to storm prepared defensive positions, and expecting to meet stiff resistancefrom defenders who had already turned back three assaults, saw and heard supporting aircraft overhead. They quite naturally greeted the arrival of the strafing machines with a roar of approval, and their enthusiasm was confirmed by the relative ease of their assault.

Neumann indicates that German pilots suffered many casualties while on strafing missions. Nonetheless, it was because of the strafing of ground troops that the escort units were renamed storm squadrons, a name that connotes honor. Neuman calls storm squadron a "glorious name." Thus the German pilots appeared not to have scorned the role of strafing.

Early Allied Attacks

As stated above, the first Allied strafing of enemy ground troops apparently took place at Cambrai in late November 1917. At this time British pilot Capt. Arthur Gould Lee had the mission of attacking a battery of guns in Lateau Woods. As he flew over German troops in the trenches he noticed that they were "staring up in incredulous amazement." Thus these troops were surprised by the presence of Allied aircraft over their lines, but they did not panic. Lee did not fire on them, nor they on him. Lee probably did not fire because his target, the artillery battery, was in the rear of the German defense line. He probably decided not to strafe them because he did not wish to reduce his chances of achieving surprise when he was over his assigned target; or perhaps he did not strafe because a smokescreen had obscured his vision until he was virtually overhead. At any rate the smoke screen inhibited the German infantrymen from firing at him and the other British pilots.

At the time the planes passed over the German trenches they were only 100 feet above them. But in order to bomb the artillery battery it was necessary to climb and then dive. Lee recounts the incident, which seems to have been more disconcerting and frightening for the user of the aerial bombing tactic than for those being bombed.

> The 5.9s [artillery pieces] below are firing, producing more smoke. Charles and Hanafy have vanished, engulfed in cloud and smoke, and so there we are, the three of us, whirling blindly around at 50-100 feet, all but colliding, being shot at from below, and trying to place bombs accurately. Even at this frantic moment, my mind switches to my beautifully dead-on practice bombing on our bullet-free, smoke-free aerodrome, but I don't have the time to laugh. The night before, Charles had indicated which of the seven groups of guns each of us was to tackle, but in the blind confusion there wasn't a hope of picking and choosing. The main thing was to get rid of the darned bombs before a bullet hit them. In a sharp turn I saw a bunch of guns right in line for attack, so dived at 45 degrees and released all four bombs. As I swung aside I saw them burst, a group of white-grey puffs centered with red flames. One fell between two guns, the rest a few yards away.
>
> Splinters suddenly splash in my face -- a bullet through a centre-section strut. This makes me go hot, and I dive at another group of guns, giving them 100 rounds, see a machine-gun blazing at me, swing on to that, one short burst and he stops firing.(9)

From this passage we may gather that although the events of the bombing mission made Lee both angry and frightened, he did not panic. Not only did he continue to carry out his mission, but he even saw the humor in the stark contrast between the ideal conditions of the training aerodrome and the highly confusing and

dangerous circumstances of real strafing and bombing runs.

However, Lee was frightened enough to drop all of his bombs at one time without worrying about whether or not this was his assigned target. Moreover, Lee's troubles were not over. Moments later, one of his fellow British pilots narrowly missed colliding with him. After this Lee spied an artillery detachment on the open road. He dove and strafed, destroying the detachment. Lee was unable to discern any psychological reaction on the part of the German artillerymen. He himself felt no pangs of conscience at having destroyed these men, but he did express remorse about the horses.

Later in the course of the mission he caught more troops on the open road and fired a hundred rounds at them. The men scattered and ran into fields nearby. This may well have been the first time these troops had been subjected to fire from airplanes, since this was one of the first Allied strafing and bombing missions. However, it is possible that they had been subjected to random fire from airplanes before this incident. In any case, their behavior tells little about any psychological reaction to a first attack, as it seems normal for any such attack.

Lee described this part of the mission -- low-level strafing well behind enemy lines -- as "easy hunting," suggesting that he did not find it particularly onerous, and even enjoyed it. But his initial impression when he found out that he was to carry out bombing and strafing missions shows that he held this to be a less desirable assignment than air-to-air combat.

> Imagine after waiting all those months for Camels, striving not to be shot down on Pubs [flying Pubs, a type of aircraft] and looking forward to toppling Huns two at a time with my two Vickers, to find myself switched to ground strafing.(10)

It would seem that the impact of strafing on ground troops did not diminish much with repetition. One report of a pilot who flew repeated strafing missions asserts that at one point, after a week of repeated strafing, a sign was noticed on the German trenches which read: "For God's sake, give your pilots a rest."(11) Nor did the psychological impact of strafing ground troops lessen for the pilots who had to fly the missions. The pilots felt extremely vulnerable to machine gun fire from the trenches, and if anything, the impact upon the pilots heightened as the air war wore on. Repeated flying of these missions caused terrific nervous strain on the pilots. Lee writes:

> Trench strafing was beginning to get on my nerves [August 1918]. Apparently I was yelling in a dream and Thompson had to come into my cubicle and waken me. I was shaking and sweating from it. In the nightmare I was diving, diving into a black and bottomless pit with hundreds of machine guns blasting endlessly up at me.(12)

Summary

In summary, the very limited accounts of the first air attacks on ground troops that have been found suggest the following reactions from airmen attackers and infantrymen attacked.

Strafing and bombing missions were very stressful for pilots carrying them out, largely because pilots were very vulnerable to ground fire, collisions with friendly planes were a hazard, and it was difficult to carry out missions successfully under the confused conditions that usually existed in dive bombing and strafing situations. There is evidence (from one British pilot) that bombing and strafing missions were less desirable -- and a suggestion that they were less prestigious -- than aerial combat missions. There is no suggestion, in the very few accounts found, of any feeling of moral repugnance or emotional distaste about attacking men on the ground from above.

The Germans seem to have made a virtue of the danger to the attackers that was inherent in early air attacks against ground troops. Air units carrying out these assignments received the honor designation of storm squadron and were apparently considered elite groups.

German troops on the ground being supported by the strafing machines enthusiastically cheered their appearance.

As for the reactions of the attacked infantrymen, several German accounts state that there was panic among Allied troops. The Germans gave the demoralization of enemy troops as a reason for establishing storm squadrons of "strafing machines."

Notes to Case Study on Air Attacks on Ground Troops

1. Ernest Wilhelm von Hoeppner, Germany's War in the Air (Leipzig: A.F. Koehler, 1921), p. 97, and Arthur Gold Lee, No Parachute: A Fighter Pilot in World War I (London: Jarrolds, 1968), p. 163.

2. Cyril Falls, The Great War, 1914-1918, (New York: Capricorn Books, 1961), pp. 229-301.

3. See for example, Great Britain, Public Record Office, Reference No. W.O. 95/1273, 2d Brigade, "Report on the Operations of July 10th, 1917."

4. Hoeppner, p. 96.

5. Ibid.

6. Major Georg Paul Neumann, The German Air Force in The Great War, J. E. Gurdon, trans., (Hodder and Stoughton Ltd., reprint edition, Portway, Bath: Cedric Chivers Ltd., 1969), p. 206.

7. Ibid., p. 207.

8. Winston S. Churchill, The World Crisis (New York: Charles Scribner's Sons, 1927), p. 166.

9. Lee, p. 163.

10. Ibid., p. 160.

11. Edward Mannock, The Personal Diary of Major Edward "Mick" Mannock (London: Neville Spearman, 1966), p. 61.

12. Lee, pp. 145-146.

Bibliography of Sources for Case Study on Air Attacks on Ground Troops

Books

Churchill, Winston S. The World Crisis. New York: Charles Scribner's Sons, 1927.

Falls, Cyril. The Great War, 1914-1918. New York: Capricorn Books, 1961.

Hoeppner, Wilhelm von. Germany's War in the Air. Leipzig: A. F. Koehler, 1921.

Lee, Arthur Gould. No Parachute: A Fighter Pilot in World War I. London: Jarrolds, 1968.

Mannock, Edward. The Personal Diary of Major Edward "Mick" Mannock. London: Neville Spearman, 1966.

Neumann, Major Georg Paul. The German Air Force in The Great War. J. E. Gurdon, trans., Hodder and Stoughton Ltd., reprint edition, Portway, Bath: Cedric Chivers Ltd., 1969.

Public Documents

Great Britain. Public Record Office. Reference No. W.O. 95/1273, 2d Brigade, U/I division, "Report on the Operations of July 10th, 1917."

ANNOTATED BIBLIOGRAPHY OF SOURCES FOR CASE STUDIES ON WORLD WAR I WEAPONS

Books, Periodicals, Articles, and Public Documents

American Expeditionary Forces. General Headquarters. Gas Manual. AEF No. 1475-1 G-5. 1919, 1920.

Manual in six separately boxed parts, dealing with tactical employment of gases; use of gas by artillery, gas troops, infantry, and air service; and defense against gas. Detailed tables and diagrams.

American Expeditionary Force. Memorandum on Gas Poisoning in Warfare. No. 28, G-5. November 1917. Reprint 4 June 1918.

Gives considerable attention to mustard.

Auld, S.J.M. Gas and Flame in Modern Warfare. New York: George H. Doran, 1918.

The author was a British chemist, Territorial officer, and Chief Gas Officer for the British Third Army. This is a good, full account of gas use against the British on the Western Front, with the emphasis on defensive measures. It is based on the author's experiences and observations, plus scraps of anecdotal material, but it is a thoughtful, analytic treatment. There is a brief and rather deprecatory treatment of mustard gas, which had not been in use long when the book was written. The last chapter, on flamethrowers, is a good account of this weapon in World War I from the British point of view.

Beebe, Gilbert W., and John W. Appel. Variation in Psychological Tolerance to Ground Combat in World War II. Prepared at the National Academy of Sciences for Medical Research and Development Board, Office of the Surgeon General, Department of the Army. 10 April 1958.

This study finds that eventually virtually all persons will require evacuation for psychiatric reasons if exposed to World War II combat conditions long enough. It provides some anecdotal evidence on the special psychological impact of artillery shelling. It is not clear that this impact is due entirely or even primarily to noise. Fear of being killed or wounded is, the authors find, the chief reason for psychiatric breakdown, with the hardships of combat (cold, lack of sleep, absence of loved ones, and so forth) playing a relatively insignificant role. Artillery shells caused the major number of casualties in World War II. The study deals specifically with the effects of long-term exposure to combat under fairly constant conditions, and thus is not immediately relevant for the current study.

Beebe, Gilbert W., and Michael E. De Bakey. Battle Casualties: Incidence, Mortality, and Logistic Considerations. Springfield, Ill.: Charles C. Thomas, 1952.

Statistics and analysis of battle casualties for World War II, with some data from earlier wars.

Bloch, D.P. La Guerre Chimique. Paris: Berger-Levrault, 1927.

The author was a lieutenant colonel in the French Army. The book describes World War I chemicals, methods of projection, protective measures, and the relationship between national industrial capabilities and chemical warfare. It includes unusually clear diagrams of weapons and projectors. There is nothing of value on first or early use of gas.

Brophy, Leo P., Wyndham D. Miles, and Rexmond C. Cochrane. The Chemical Warfare Service: From Laboratory to Field. United States Army in World War II. The Technical Services. Washington: Government Printing Office, 1959.

This carefully researched and documented volume contains chapters on toxic chemical agents, including phosgene and mustard; protection against toxic agents; and flamethrowers. There is also material on napalm. Good bibliographic footnotes are included.

Brown, Frederic J. Chemical Warfare: A Study in Restraints. Princeton, N.J.: Princeton University Press, 1968.

A valuable standard work with considerable historical material and analysis.

Canada. Public Archives. "Very Rough Shorthand Notes on Liquid Fire from Wounded Men at No. 10 Hospital by an Officer from G.H.Q." 16th Bn file (RG 9III C3, Vol. 4080, Folder 2, File 9).

Extremely useful document. The wounded men were all British, as was the interviewer, apparently, but the document had found its way into a Canadian battalion file. Attached is a message from 3d Canadian Infantry Brigade headquarters on measures to be taken against flamethrowers.

Casey, Irving J., and Wallace E. Larimore. Paraphysical Variables in Weapon System Analysis. ANSER Report AR 66-1. Analytic Services, Inc., Falls Church, Va., April 1966.

This paper does not present original research, but rather summarizes and organizes literature on psychological responses of combat troops to various weapons. The literature surveyed suggests that troops generally fear most those weapons that cause most casualties, and fear them for the attributes that cause casualties -- accuracy, lack of warning, and rapid rate of fire. However, noise and the invulnerability of the weapon (impossibility of fighting

back) also are reported by informants to cause fear (p. 15). Useful bibliography.

Churchill, Winston S. The World Crisis. Vols. 3 and 4. New York: Charles Scribner's Sons, 1927.

Churchill's excellent history of World War I does not have any useful material on gas, but it deals at some length, especially in Vol. 4, with the development of the tank -- in which Churchill was closely involved -- and its early use.

Clark, Dorothy K. "Effectiveness of Chemical Weapons WWI." ORO staff paper ORO-SP-88. Operations Research Office. Files of General Research Corporation, McLean, Va.

An excellent analytic history of the use of chemical weapons in World War I. A basic source.

Cochrane, Rexmond C. Gas Warfare on the Canadian Front: A Report of Survey. Mimeographed. March 16, 1956. Military History Directorate, Canadian National Defence Headquarters.

A report on a survey of materials available for a study of Canadian involvement in gas warfare in World War I.

_____. Gas Warfare in World War I. US Army Chemical Corps Historical Studies. Mimeographed. Office of the Chief Chemical Officer, Army Chemical Center, Md., 1957.

Twenty separate studies on US experience with gas warfare, bound together in four volumes at the Military History Institute library, Carlisle, Pa. Each study deals with a specific operation. Study 1, for example, is entitled Gas Warfare at Belleau Wood. Cochrane focuses on the role gas played in each operation, and deals with casualties, gas discipline, and the tactical effectiveness of gas. There is nothing specific on troops' psychological reaction to first experience with gas.

Cron, Hermann. Die Geschichte des deutschen Heeres im Weltkrieg 1914-1918. Berlin, 1937.

The section on flamethrowers, pp. 186-187, is useful.

Currie, J.A. "The Red Watch": With the First Canadian Division in Flanders.. Toronto: McClelland, Goodchild & Stewart, 1916.

A memoir of the author's first experiences at the front, including the first gas attack at Ypres.

Dahlmann, Reinhold. Res.-Inf.-Regt. Nr. 27 im Weltkriege 1914-1918. Berlin, 1934.

Full account of battle of Cambrai from point of view of this German regiment.

Deimling, Berthold von. Aus der alten in die neue Zeit. Berlin, 1930.

This is a useful memoir, with material on first use of chlorine, flamethrowers, and tanks. Deimling, commander of the German XV Army Corps in 1915, was a Social Democrat and became a pacifist after the war.

Deutelmoser, Adolf. Die 27. Inf.-Div. im Weltkrieg 1914-1918. Stuttgart, 1925.

Good material on German reactions to the tank in spring 1917.

Dupuy, Trevor N. The Evolution of Weapons and Warfare. Indianapolis, Ind., and New York: Bobbs-Merrill, 1980.

A survey of weapons and tactics throughout history.

Edmonds, J.E., and G.C. Wynne, comps. History of the Great War, Based on Official Documents: Military Operations, France and Belgium, 1915. Vol. 1. London: Macmillan, 1927.

This series, the British official history of the war, generally provides good accounts of operations. This volume is especially clear and detailed. Excellent maps.

Eimannsberger, Ludwig Ritter von. Der Kampfwagenkrieg. Munich, 1934.

An important work on tank combat which states that the German high command misread the battle of Cambrai, believing, as a result of the German success in turning back the British on the second day of the battle and holding them to very limited gains, that the tank was not a significant innovation, that German tactics and determination could stop tanks, and that there was no need fo the Germans to rush production of their own tanks.

Falls, Cyril. The Great War. 1959. Reprint. New York: Capricorn Books, 1961.

Good concise history of the war, used for reference in this study.

Fighting Tanks: An Account of the Royal Tank Corps in Action, 1916-1919. Ed. G. Murray Wilson. London: Seeley, Service & Co., 1929.

A collection of episodes and commentaries, one of which illustrates the tendency to personify the tanks. The book is generally popular in tone, with forced humor and a focus on individual gallant acts.

Foulkes, C.H. "Gas!": The Story of the Special Brigade. Edinburgh and London: William Blackwood & Sons, 1934.

The author commanded the Special Brigade, set up by the British to create a British chemical capability following the first German chlorine attacks. He planned, and commanded the gas troops in, the first British use of chemicals, at Loos, September 1915. He gives detailed information on this attack, including German reaction. Detailed maps showing gas attack plans and operations. There is good data on British gas casualties and gas attacks suffered throughout the war.

Fries, Amos A., and Clarence J. West. Chemical Warfare. New York and London: McGraw-hill, 1921.

A standard, early treatment of the subject. Little on first use, but one personal experience account is included.

Fuller, J.F.C. Tanks in the Great War. London: John Murray, 1920.

Fuller, the great theoretician of tank warfare, gives a valuable analysis of the nature and function of the tank -- briefly, "penetration with security" -- and a good account of the development of tank tactics. He includes Swinton's well-known memorandum giving his recommendations on how the new weapon should be used. There is very little on psychological reaction.

Gilchrist, H.L. A Comparative Study of World War Casualties from Gas and Other Weapons. US Army. Chemical Warfare School, Edgewood Arsenal, Md. Washington: Government Printing Office, 1928.

Useful statistical tables and charts. The author appears to be building a case for a US chemical warfare capability. Dorothy Clark questioned his figures on proportion of gunshot-wounded soldiers who died, finding them much higher than those of other sources.

Germany. Message from C.G.S. of the Field Army. No. 26655 op. Secret. Flammenwerfer. 20 April 1916. S.S. 459. Ia/14055.A.30.

Document captured and translated by British General Staff. Copy in HERO files, provided by Army Historical Branch, British Ministry of Defense. The original document in German is in the Bavarian State Archive, Munich.

Extremely useful document summarizing German flamethrower tactics and achievements as of its date.

Germany. Reichsarchiv. Der Weltkrieg 1914 bis 1918. Vols. 8-13. Berlin, 1933-1942. Vol. 13 was reissued in 1956.

This official German history of World War I is a valuable source.

Graves, Robert. Goodbye to All That. 1929. Rev. 2d ed. Garden City, N.Y.: Doubleday (Doubleday Anchor Books), 1957.

Graves, the poet, novelist, and critic, was present at the battle of Loos and gives a good deal of detail on preparations for the gas attack and the blowback of gas on British troops. A few other references to his personal experiences with gas are scattered through the book.

Great Britain. Public Record Office. Kew, London. War diaries for British units involved in first or very early use of chlorine, mustard, tanks, flamethrowers, and air attacks on ground troops.

Very little data on psychological impact is in these records. Two folders of chemical warfare reports (WO142/176 and 177) also contain little of value.

Great Britain. Royal Army Medical Corps. Report on Gas Attack, 23rd-24th May, 1915. Signed P. Dwyer, Capt., R.A.M.C. WO32/5169. Public Record Office.

An excellent report on this massive, high-concentration cloud attack. Describes use and effectiveness of first "smoke helmets" with mica eyepieces, effectiveness and problems of gauze respirators, and various shell-delivered gases the British thought they detected. Attached report by medical officer with 1st Royal Irish Fusiliers describes high effectiveness of their gas discipline during the attack.

Great Britain. War Office. Instructions for the Training of the Tank Corps in France. Issued by Headquarters, Tank Corps, British Army, December 1, 1917. Reprint. US War Department, War Plans Division, Document 826. July 1918.

Great Britain. War Office. Statistics of the Military Effort of the British Empire during the Great War. London: His Majesty's Stationery Office, 1922.

Includes casualties broken down by theater, campaign, and month, but no distinction between gas and gunshot casualties.

Groehler, Olaf. Der lautlos Tod. Berlin (East): Verlag der Nation, 1978.

Very full treatment of gas use in World War I that makes use of unit records and many earlier memoirs and studies.

Hanslian, Rudolf. Chemical Warfare. Translation of excerpts from Der Chemische Krieg (Berlin: E.S. Mittler & Sohn, 1927). Translated at Army War College, Washington, D.C., 1934. Typescript. Copies in US Army Military History Institute library, Carlisle Barracks, Pa.

One of the basic books on chemical warfare. Hanslian uses British, French, and US -- as well as German -- sources. Clear diagrams and maps.

Heinrici, Paul. Das Ehrenbuch der deutschen Pioniere. Berlin, n.d. (c. 1931).

The chapter on flamethrowers, pp. 516-527, was written by Bernhard Reddemann, one of the developers of the weapon, and commander of the Guard Reserve Pioneer [flamethrower] Regiment.

Hessel, Frederick Adam, M.S. Hessel, and J.W. Martin. Chemistry in Warfare: Its Strategic Importance. New York: Hastings House, 1942.

Pp. 82-108 have a useful summary of World War I gases and incendiary weapons, with accounts of their use. The rest of the book is not relevant to this study.

Hoeppner, Ernst Wilhelm von. Germany's War in the Air. Trans. J. Hawley Larned. Typescript. (German edition published Leipzig, 1921.) Military History Institute, Carlisle, Pa.

Brief discussion of air attacks on ground troops, p. 96.

Horne, Charles F., and Walter F. Austin, eds. Source Records of the Great War. Vols. 3, 5. N.p.(United States): National Alumni, 1923.

Not a scholarly work, this collection is nevertheless useful for the sources included. Vol. 3 gives the German press release on the 1915 use of gas; the account of Sir John French, the British commander; and a Canadian account. Vol. 5 includes comments by Field Marshal von Hindenburg on the Cambrai tank attack.

Juenger, Ernest. Storm of Steel: From the Diary of a German Storm-Troop Officer on the Western Front. Trans. Basil Creighton. Garden City, N.Y.: Doubleday, Doran, 1929.

Pp. 73-81 include first-hand descriptions of German troops' reactions to British gas attack in 1916, with several incidents involving use and nonuse of respirators, sight of animals killed by gas, and symptoms of gas poisoning. Graphic description of horror of artillery bombardments (p. 74).

Kirby, William. Manual of Gas Attack and Defense. New York: Edwin N. Appleton, n.d. [1917?]

A detailed training manual prepared by an infantry major. Small format, intended to be carried by troops during training. Rest is stressed for even the slightly gassed, an emphasis that would be likely to lead to reporting and evacuation of slightly gassed casualties, and to malingering. There is only a brief mention of mustard, and no instructions for mustard training and discipline.

Lee, Arthur Gould. No Parachute: A Fighter Pilot in World War I. London: Jarrolds, 1968.

This book is an edited collection of the letters the author, a pilot. wrote to his wife in 1917. It is valuable because the author was assigned to low-level bombing and strafing in the summer of 1917, was trained for this duty, and carried out many such missions. He is introspective and articulate, and the fact that his observations and reactions were recorded in the letters soon after the events in which he participated adds to the book's usefulness.

LeFebure, Victor. The Riddle of the Rhine: Chemical Strategy in Peace and War. New York: The Chemical Foundation, 1923.

Well-known early historical treatment by British author. Nothing on reactions to first use that is based on personal accounts. Useful narrative of use of chemicals in World War I, with information on heavy, carefully planned use in German offensive of 1918 and later retreat of same year. Material on flamethrowers is included. Author suggests they were more effective than generally thought (pp. 43-44).

Lewis, Cecil. Sagittarius Rising. 1936. Reprint. London: Peter Davis, 1966.

Considered one of the best books based on World War I air combat experience, this book unfortunately does not seem to have anything on attacks on ground troops. Lewis discusses pilot stress and psychological aspects of air combat.

Love, Albert G. War Casualties. US Army Medical Department. The Army Medical Bulletin, No. 24. Medical Field Service School, Carlisle Barracks, Pa., 1931.

Provides statistics on treatment of American war wounded and sick for World War I, with some data for earlier wars. The focus is on statistics needed to plan medical services for a future war; thus, a useful differentiation is made between gas-wounded and gunfire-wounded, but little data on those killed in action is given. Since the book treats only US casualties, which ocurred largely in the last year of the war, the gas casualties are predominantly from mustard.

McKinney, Leonard L. Portable Flame Thrower Operations in World War II. Bound mimeographed first draft. Historical Office. Office of the Chief, Chemical Corps, 1949.

Pp. 8-12 give World War I background, based on limited number of secondary sources. Not very useful for World War I information.

Mannock, Edward. The Personal Diary of Major Edward "Mick" Mannock. London: Neville Spearman, 1966.

This journal of a World War I ace includes one description of a strafing incident (pp. 156-157). Mannock expresses concern about "nerves" throughout the book, but not in relation to attacks on ground troops.

Mitchell, F. Tank Warfare: The Story of the Tanks in the Great War. London and other cities: Thomas Nelson and Sons, n.d. (1933).

Popular secondary work that includes both undocumented anecdotes and a good deal of apparently factual material. It is not clear whether the author was himself a tanker. The book devotes considerable attention to tanks in Third Ypres and includes a discussion of the "Robertson tradition" of tank leadership.

Mordacq, Jean Jules Henri. Le Drame de l'Yser: La Surprise des Gaz (Avril 1915). Paris, Edition des Portiques, 1933.

The author commanded the French 90th Brigade (African) at Ypres during the first German gas attack. The focus is on the progress of the battle and on incidents of great individual courage. Although Mordacq can not be an objective witness on the behavior of his troops, his accounts of what he actually saw just after the attack are valuable.

Moser, Otto von. Feldzugsaufzeichnungen, 1914-1918. Stuttgart, 1920.

Moser was a general who commanded the XIV Prussian Reserve Corps during the battle of Arras, April 1917. Excellent material on successful German response to British tanks at Arras and Bullecourt.

Neumann, Georg Paul, comp. The German Air Force in the Great War. Trans. J.E. Gurdon. 1921. Reprint. Portway, Bath: Cedric Chivers, 1969.

Useful for air-ground tactics. Some general comments on effects on morale of air attacks.

Paris Match, "Numero Tricolore," August 22, 1964. Pp. 43-45.

These pages give an account of the first attack with chlorine at Ypres and mention briefly protective measures and later uses of gas. There are good photographs.

Prentiss, Augustin M. Chemicals in War: A Treatise on Chemical Warfare. New York and London: McGraw-Hill, 1937.

A useful standard work.

Pries, Arthur, ed. Das R.I.R. [Reserve Infantry Regiment] 90, 1914-1918. Berlin and Oldenburg, 1925.

Good description of the tank battle at Cambrai from German point of view.

Reichsarchiv, The World War, 1914-1918: Military Operations on Land. Vol. 8, Operations in 1915. [Der Weltkrieg 1914 bis 1918: Die Operationen des Jahres 1915.] Extract: "The Gas Attack of the Fourth Army at Ypres." Translated at the US Army War College, 1933. Military History Institute Library, Carlisle, Pa.

Extremely useful brief (11 pages) German account, including plans and preparations for use, purpose of the attack, objectives, problems, tactical results.

Reid, Gordon, ed. Poor Blocdy Murder: Personal Memoirs of the First World War. N.p. (Canada): Mosaic Press, 1980.

This collection includes three accounts of the Second Battle of Ypres that report personal observations, experiences, and reactions to gas: those by Lt. Herbert Maxwell Scott (as reported by Lt. Ian Sinclair), Pvt. Frank V. Ashbourne, and Pvt. David Shand.

Rupprecht of Bavaria. Mein Kriegstagebuch. Berlin, 1929.

This war diary of Crown Prince Rupprecht, who held several important German commands during World War I, is one of the major German sources on the war. It includes useful accounts of gas and tank actions.

Schroth, Alfred. Bilder aus dem Leben der Gaspioniere im Feld. Tuttlingen, 1936.

The author, a physician, served with the 35th Engineer Regiment. His book includes first-hand descriptions of preparations for one of the first gas attacks (which was aborted because of unfavorable winds), and of the German cloud attack of 19 May 1916, when there was a blowback of gas on the troops of his regiment (pp. 17-19) and of the appearance of gas-injured troops.

Schwarte, Max. Der Weltkampf um Ehre und Recht. Leipzig, 1927.

Excellent source on gas and tanks.

Simon (Col., ret.). Das Inf. Regt. "Kaiser Wilhelm, Koenig von Preussen" Nr. 120. Stuttgart, 1922.

Regimental history; useful for accounts of flamethrower and tank operations.

Sims, Edward H. Fighter Tactics and Strategy, 1914-1970. New York and other cities: Harper & Row, 1972.

Chapter 7 is based on an interview with an airman veteran of World War I, Arthur Gould Lee, and on his letters to his wife, written in 1917. Lee gives several accounts of his bombing and strafing ground troops. This assignment was disliked by the airmen, not because of reluctance to attack troops from the air, but because it was considered very dangerous. "I must say I disliked shooting up troops. The odds were too much against us." (p. 43)

Stern, Albert G. Tanks, 1914-1918: The Log-Book of a Pioneer. London, New York, and Toronto: Hodder and Stoughton, 1919.

Sir Albert, a participant -- as Chairman of the Tank Supply Committee -- in the development of the tank, recounts that development and includes some anecdotes of early British reaction to the first use of tanks.

Sueter, Murray. The Evolution of the Tank: A Record of the Royal Naval Air Service Caterpillar Experiments. London: Hutchinson, 1937.

The author was a rear admiral involved in the development of the tank. He includes some anecdotal accounts of individual soldiers on early experiences with tanks.

Trinity War Book: A Recital of Service and Sacrifice in the Great War. Toronto: Ontario Press, 1921.

Includes one account by a Canadian veteran of his experiences in the German attack of 22 April 1915.

Trumpener, Ulrich. "The Road to Ypres: The Beginnings of Gas Warfare in World War I." Journal of Modern History 47 (September 1975): 460-80.

The author's thesis is that 22 April 1915 did not mark any new departure in warfare, since lachrymatory agents had been used earlier by both French and Germans. It was, he says, only the quantity of gas used at Ypres, not the kind of agent, that was significantly new. The article is useful as a recent summary of the beginnings of gas warfare that makes use of much earlier material in both English and German.

US Army. 16th Infantry Regiment. Unit History. Typescript. In folder of George Beekman, 1st Division. Veterans Survey, Military History Institute, Carlisle, Pa.

Includes a brief account of a gas attack, and some general comments on gas. There is very little mention of gas, and it is never singled out as a special hardship, as are artillery fire, the presence of suffering wounded in the trenches, and the discomfort of trench life.

US Marine Corps. 2nd Battalion, 5th Regiment, 4th Marine Brigade. Official History. Copy in folder of C.F. Rincker, Veterans Survey, Military History Institute, Carlisle, Pa.

Some information on gas, including chart showing casualties, with separate figures for gas.

US Army. Medical Department. The Medical Department of the United States Army in the World War. Vol. 14, Medical Aspects of Gas Warfare. Washington, D.C.: Government Printing Office, 1926.

Full medical information on World War I gases, with many clinical cases illustrating effects. This volume also includes detailed information on protective measures taken against gas. There is mention of "gas mania" -- panic induced among troops by light exposure to gas or the mistaken belief that they were being attacked with gas (p. 65). Valuable casualty statistics.

Viovenal, Paul, and Paul Martin. La guerre des gaz. Paris, 1919.

A useful book based on personal experience treating gas casualties in a French field hospital.

Volkart, W. Die Gasschlacht in Flandern in Herbst 1917. Beiheft 7 of the Wehrwissenschaftlichen Rundschau, October 1957.

This 82-page work is subtitled "a study on the use of a major weapon and its effects on the course of the war." At the time of publication, the author was a graduate engineer and colonel in the Swiss Bundeswehr, serving as an infantry training officer. This is a full and useful account of the German use of gas shell in the summer and fall of 1917. There is much information on mustard gas and on the German techniques of combining several types of gases to achieve specific military purposes. Volkart includes background information on earlier use of gas.

Wachtel, Curt. Chemical Warfare. Brookings, N.Y.: Chemical Publishing Co., 1941.

The author was a German-born chemist and physician who played a significant role in German chemical warfare in World War I and worked closely with Fritz Haber, Chief of the Chemical Section, War Ministry, the scientist chiefly responsible for the German chemical effort. Useful for background only.

Waitt, Alden H. Gas Warfare. Rev. ed. New York: Duell, Sloan and Pearce, 1944.

Full treatment, written for the layman. The account of the first use of chlorine is based on other published sources, and is not entirely accurate or clear.

Watter, Oskar von. Ein Gedenkbuch. Hamburg, 1940.

General Freiherr von Watter describes Cambrai tank battle and gives details on the training his men received to help them deal with tanks. Good source.

Williams-Ellis, Clough, and A. Williams-Ellis. The Tank Corps. London: Country Life and George Newnes, 1919.

This appears to be the best historical account of the development of the tank and its combat in World War I. The author was a tank officer.

Winter, Denis. Death's Men: Soldiers of the Great War. London: Allen Lane, 1978. Reprint. Harmondsworth, Middlesex, England: Penguin Books, 1979.

Based primarily on the letters, journals, and memoirs of well over 100 World War I soldiers, this book is social and psychological history, focussing on the life and death of the men in the trenches. There is little material immediately relevant to the current study, but one description of the psychological reaction to gas alarms is included.

_____. First of the Few: Fighter Pilots of the First World War. London: Allen Lane, 1982.

Recommended by the staff of the RAF Museum as a well-researched, useful work, this book is based largely on memoirs of fighter pilots. Chapters 13-16 deal with pilot stress. There is very little reference to air attack on ground troops.

Personal Accounts, unpublished.

Great Britain. Imperial War Museum, London.

Personal accounts held by the Imperial War Museum (IWM) for research purposes are in two categories: sound records, held by the Department of Sound Records, and written materials -- letters, journals, and memoirs -- which are held by the Department of Documents.

Sound records are in two categories: those conducted by IWM interviewers and those conducted by the British Broadcasting Corporation (BBC) for its series "The Great War." Transcripts of some of the IWM interviews have been prepared and have been used for this study. For all BBC interviews, the tape recording itself, not a transcript, was used in this research.

Unfortunately, the interviews are not dated, but they seem to have been conducted in the 1970s.

All interviews are protected by copyright held by the Imperial War Museum or the BBC.

Following are the materials from the Department of Sound Records that were used. The interviewee's rank and assignment during the war -- and if possible at the time of the experience he described on tape -- are given.

Barley, L.J. Captain. Army chemical adviser. IWM 000321/06, Reels 1, 4. Tape.

Buxton, B.G. Captain. Infantry company commander. 49th Division. IWM 000299/05, Reel 5. Transcript.

Cooney, R.C. Tank section commander. IWM 000494/06. Tape.

Hawkins. Probably British platoon commander. BBC 004130. Tape.

Hill. Captain. Engineer, apparently gas officer. BBC 004135. Tape.

Hutton. Tank subaltern. Commanded tank D-9 at Flers. BBC C04136. Tape.

L.J. Private, infantry. IWM 000041/04, Reel 2. Tape.

Laws, M.E.S. Captain. Artillery section commander. IWM 000490/06, Reel 6. Transcript.

Leigh-Jones. Captain. A Section, B Battalion, Tank Corps. At Cambrai. BBC 004161. Tape.

Neame, Philip. Lieutenant colonel. Engineer. Staff officer. IWM OC048/15, Reels 11, 13. Transcript.

Pratt, J.D. Lieutenant. Infantry platoon commander. IWM 00495/06, Reel 3. Transcript.

Reid, J.P.O. Sergeant. Infantry. Gordon Highlanders. IWM 000324/06, Reel 4. Tape.

Reiffer. Tank gunner. At Flers. BBC 004212. Tape.

Staddon. Infantry subaltern. At Flers. BBC 004235. Tape.

Underwood. Canadian infantryman. Enlisted man or noncommissioned officer. BBC 004247. Tape.

Wimberley. Machine Gun Corps colonel, in charge of 16 machine guns at Cambrai. BBC 004266. Tape.

IWM Department of Documents materials that were found relevant for this study are the following:

Abbott, S.B. Private, Royal West Kent (Territorial Force); later, Machine Gun Corps. 55=oir.

Bate, H.R. Subaltern, Infantry. Memoir.

Colyer, W.T. Subaltern, A Company, 2d Battalion (probably), Royal Dublin Fusiliers. Memoir.

Cotton, E.W. Enlisted man, A Company, 5th Battalion, Northumberland Fusiliers. Memoir.

Dennis, G.V. Corporal, Infantry. 21st Battalion, King's Royal Rifle Corps. Memoir.

German soldier's account of preparing to meet gas attack at Loos. IWM Miscellaneous document 469.

Howe, A. Corporal. 8th Battalion, Middlesex Regiment. Journal.

Kingsley, E.D. Squadron leader, 2d Battalion, Seaforth Highlander Regiment. Memoir.

McIntyre Hood, M. Corporal, 24th Battalion, Victorian Rifles of Canada. Interview transcription in Department of Documents.

Moir, K.P. Enlisted man. Cameron Highlanders. Letter.

Myer, H.D. Officer. 6th Battalion, London Regiment (Territorials). Memoir.

Plint, R.G. Corporal. 26th Battalion, Royal Fusiliers ("Bankers Battalion"). Memoir.

Quinton, W.A. Enlisted man. 1st Battalion, Bedfordshire Regiment. Memoir.

Robertson, F.M. Medical corpsman. Letter.

Routh, E.J.D. Wing Commander, Royal Flying Corps. Journal.

Stafford, R.S.S.R. Lieutenant Colonel, 171 Middlesex (1st Footballers). Journal.

White, D.N. Tanker. Letter.

HERO interviews.

Interviews were conducted by Gay Hammerman with the following in-pensioners of the Royal Hospital, Chelsea, on 4 July 1983: Mr. R.E. Worrall; Mr. Staff.

US Army. Military History Institute, Carlisle Barracks, Carlisle, Pa.

Since the late 1970s a survey questionnaire has been sent to groups of World War I veterans, with the aim of gathering information about their war experience from all surviving veterans. Veterans are also invited to donate any memorabilia, including diaries, letters, and manuscript accounts written after the war. For the current study, all replies received from veterans of the 1st and 2d Infantry Divisions and the 5th and 6th Marine Regiments -- about 100 replies altogether -- were read, and all references to gas were noted. These units were chosen because it was known that they received heavy gas attacks, although, of course, not all unit members were gassed, and most of those who were most seriously injured by gas probably did not survive to the present. It should also be remembered that gas was not a new, surprise weapon by the time the Americans entered combat.

There are very few mentions of gas. (There was no question specifically on gas in the questionnaire, but the questionnaire provided space for additional comments.) Mentions of gas are generally brief and matter-of-fact. A typical response is that of the veteran who, asked where he served, listed action at Belleau Wood and Chateau Thierry, ending with being gassed in action at Chateau Thierry and evacuated to hospital. Asked "What do you recall you were thinking and experiencing at the time?" he replied, "I certainly didn't enjoy being under enemy artillery fire." (Waggoner, R.K., 6th Marines.) What is remembered with most distress is high-explosive shellings; the stress of being in trenches with the suffering wounded before they were evacuated; and the anxiety of waiting to receive an expected attack.

Jets and Rocket-Propelled Aircraft

Introduction

The reasons for selecting German jet- and rocket-propelled aircraft for a case study for this report are threefold. First, the German jet and rocket aircraft which saw service during World War II differed enough in nature and performance from contemporary piston engine aircraft to warrant their being termed "new weapons." Second, sufficient data in primary and secondary sources was available to make the research possible and worthwhile. Third, the German jet and rocket aircraft almost exclusively affected military personnel of the United States Army Air Forces and other Allied air forces, and this fact satisfies the requirement that the new weapon should have been primarily employed against military personnel.

One special aspect of the research for this case study was the use of a questionnaire, consisting of nine questions, that was sent to US airmen who encountered German jet and rocket aircraft during World War II, and who volunteered to answer questions about their experience. A copy of the questionnaire is included at the end of the case study. The number of responses received in the relatively short time during which the case was researched reflects the enthusiasm with which many veterans responded. The value of these responses for this report cannot be overemphasized.

Two of the German jet aircraft in this case study were sometimes employed in the tactical bomber role.

Unfortunately, the paucity of data on ground personnel's reactions to bombing attacks by German jets makes any analysis of reactions to this kind of attack difficult. Therefore, this study will focus on the reactions of Allied airmen to German jets during aerial encounters.

The first combat encounters between German jet- and rocket-propelled aircraft and Allied aircraft occurred in the late spring and early summer of 1944. However, because of the vast geographical area covered in the aerial war in Europe, the limited numbers of operational German jet and rocket aircraft, and the slow pace at which they were committed to combat, many Allied airmen first encountered the Me 163 and the Me 262 as late as 1945, or not at all. Therefore, the following analysis of airmen's reactions to the Me 163 and the Me 262 will not concentrate on the actual first use of these aircraft but will concern Allied airmen's first experiences with the aircraft from the late spring of 1944 until the final months of the war.

The Weapons

On 27 August 1939 the Heinkel He 128, an experimental German jet aircraft, became the "first airplane to fly under power of a turbojet propulsion unit."(1) The history of German jet and

rocket development during the first half of World War II is confusing, and a description of it is beyond the scope of this case study. However, it should be noted that following the He 128's maiden flight the course of the war, personal intrigue among the German military leaders, the failure to encourage jet and rocket engine research, and the complications that accompany any technological innovation retarded German jet and rocket development. As a result, the first uses of the three aircraft described below were not until the late spring and early summer of 1944.

The three unconventionally powered German aircraft which saw oprational service during the last year of World War II were the Messerschmitt Me 262 jet fighter/fighter-bomber, the Messerschmitt Me 163 rocket fighter, and the Arado Ar 234 jet bomber/reconnaissance aircraft. The most prevalent in terms of numbers produced and of operational use was the Me 262. Altogether, 1,443 of these jets were manufactured (2), compared to 364 Me 163s and 210 Ar 234s.(3) Since the Ar 234 was most successful in its reconnaissance role and infrequently encountered by Allied airmen, its impact does not receive consideration in this study. However, a description of the aircraft is presented for comparative purposes.

The Me 262 was a low-wing, twin-engine, single-seat aircraft which first flew under jet power on 18 July 1942. Some versions, trainers and night-fighters, had two crewmen, but the majority of the aircraft were manufactured as single-seat fighters and fighter-bombers. Powered by two Junkers Jumo 004B turbojet engines, the Me 262's maximum speed was 540 miles per hour at 19,685 feet.(4) Typical armament for the fighter version consisted of four MK 108 30mm cannons with 100 rounds for each upper, and 80 rounds for each lower, gun.(5) Some later Me 262s carried 24 R4M 55mm air-to-air rockets.(6) With its low-slung jet engines, swept wings, shark-shaped fuselage, and lack of propellers, the formidable-looking Me 262 resembled no previous operational aircraft.

From July 1944, when Me 262s of Erprobungskommando Schenk (an operational detachment led by Major Wolfgang Schenk) first flew ground attack missions out of Chateaudun, France (7), until the end of the war, Me 262s operated as fighters, fighter-bombers, reconnaissance aircraft, and night fighters. Primarily used in the first two roles, the jet was most successful when employed against Allied bombers.

Unlike the versatile Me 262, the single-seat, rocket-powered Me 163 was used exclusively as a fighter. Powered by one HWK 109-509 liquid rocket motor, the production version of the Me 163, the Me 163B, was first test-flown on 23 June 1943.(8) Performance specifications for the Me 163 were a top speed of 590 miles per hour above 30,000 feet(9) and a rate of climb of nearly 20,000 feet in 2 minutes, 16 seconds.(10) Armament in later versions of the Me 163B consisted of two MK 108 30mm cannons, the same weapon used on the Me 262, with 60 rounds per gun.(11) To minimize

weight and allow a more aerodynamic airframe (12), the Me 163 used a two-wheeled, reusable wooden dolley for take-offs and landed on an extendable skid on the bottom of the fuselage. With its lack of a horizontal stabilizer and propeller and its short, stubby fuselage and large swept wings, the unusual-looking Me 163 closely resembled a flying wing.

The Ar 234 was a high-wing, twin-engine, jet bomber/reconnaissance aircraft that was first test-flown in the summer of 1943.(13) Powered by two Junkers Jumo 004B engines (the same power plants used on the Me 262), the mass production version of the Ar 234, designated the Ar 234B, had a maximum speed of about 460 miles per hour at 20,000 feet.(14) Armament for the Ar 234 in the bomber version usually consisted of one 1,100-pound bomb carried externally.(15) Some later examples of the bomber version mounted two rearward-firing fixed 20mm MG 151 cannons with 200 rounds per gun.(16) Reconnaissance Ar 234s carried no bombs or guns. The lack of propellers on the underwing jet engines, the long cigar-shaped fuselage, and the rounded all-glass canopy located at the front of the fuselage gave the Ar 234 an "extremely clean" appearance.(17) One pilot, who doubled as bombardier on bomber Ar 234s, made up the aircrew.

The primary difference between the performance of the Me 262, the Me 163, and the Ar 234 on the one hand, and that of conventional Allied and German aircraft on the other, was the superior speed of the jet and rocket aircraft. The top speed of the Me 163, 590 miles per hour, was over 100 miles per hour faster than any operational piston-engine aircraft of World War II.(18) The reason for the superior speed of the German aircraft was their propulsion units: the Junkers Jumo 004B turbojet engine on the Me 262 and the Ar 234, and the HWK 109-509 rocket motor on the Me 163. Although the principles of operation for jet and rocket engines differ, the advantages of the two engine types are similar.

In a turbojet engine,

> Air taken from the atmosphere is compressed to 3 to 12 times its original pressure [in an axial compressor in the 004B engine]...Sufficient fuel is added to the air and burned to raise the temperature of the fluid mixture...The resulting hot air is passed through a turbine [which] drives the compressor. If the turbine and compressor are highly efficient, the pressure at the turbine discharge...produce[s] a high-velocity stream of gas and hence a thrust.(19)

In the Me 163's lightweight rocket motor, the mixing of the highly unstable and corrosive fuel T-Stoff (essentially highly-concentrated hydrogen-peroxide and water) with the fuel C-Stoff (hydrogen-hydrate and methyl alcohol) caused a violent chemical reaction which produced "high temperatures and powerful thrust."(20)

The advantages of both engines are accurately summed up in

the following quote from an article on Aircraft Propulsion in the Encyclopedia Britannica.

> The most important advantage of the jet engine is that it is extraordinarily light compared to an engine-propeller combination having similar thrust at cruising speed. This advantage makes it possible to use much more powerful engines in jet planes. In addition, the elimination of the propeller makes possible a simpler, lighter, and aerodynamically cleaner...air frame. Furthermore, the propulsive efficiency of a propeller is low at high (above 500 m.p.h.) forward speed, while the propulsive efficiency of a jet is particularly good at very high speed.(21)

The disadvantages of the 004B turbojet engine included a relatively short life span (22), poor acceleration at low speeds requiring careful handling of engine controls (23), a high fuel consumption rate (24), and other minor problems of the kind frequently associated with new mechanical inventions. The HWK 109-509 rocket motor, in addition to a phenomenally high fuel consumption rate, used a temperamental and very lethal fuel mixture that exploded at the slightest provocation (i.e., contact with organic material or an improper mix ratio).(25) With the Me 163B, whose total loaded weight of 8,700 pounds included 4,440 pounds of fuel (26), fatal accidents involving pilots and ground crews were a common occurrence.

High speed made the Me 262 and the Me 163 difficult targets to catch and hit for Allied fighter pilots and air gunners on bombers. Bomber crews were alerted to "sight 'em first" in a confidential Target Victory memorandum dated 16 September 1944.(27) The memo warned gunners that they would have less time to sight and hit the "hopped-up go buggies," and that if one broke into a bomber formation, they had to be "proportionately faster...in recognizing, sighting [and] firing."(28) Even fighter pilots who invariably showed enthusiasm in trying to intercept the jet and rocket fighters were hard-pressed to catch them. The Me 262 and Me 163 had maximum speeds in level flight substantially greater than the P-47 and P-51, the swiftest of the US escort fighters. However, the superior speed of the German aircraft worked against the German pilots in some ways, allowing them less time to line up and fire at targets.(29) At slower speeds, the Me 262 and the Me 163 became increasingly vulnerable to Allied piston engine fighters, since the German aircraft were not as maneuverable.(30)

The estimated final tally of kill ratios indicates that the German jet and rocket aircraft were not invulnerable. For a total of about 150 Allied aircraft destroyed, approximately 100 Me 262s were lost in aerial combat.(31) With the Me 163, which probably destroyed no more than 16 Allied aircraft (32), the Germans' own losses in aerial combat and to accidents probably exceeded that low score.

Of the three German aircraft considered for this case study,

only the Me 262 and Me 163 significantly affected Allied aerial operations. Analysis of the ordnance carried by these aircraft shows that the Me 262 demonstrated an appreciable improvement as a weapons platform over previous Allied and German conventional aircraft.

The Me 163B's two 30mm cannons jammed easily (33), and their relatively slow rate of fire rendered accurate high-speed attacks on Allied bomber formations very difficult.(34) The 30mm cannon's low muzzle velocity also meant that the rocket fighter pilot had to close within effective range of bombers' defensive armament to hit his target. Nevertheless, one well-placed hit from the cannons could be fatal for an Allied aircraft.(35)

The Me 262 had a much more lethal impact on the Allied air forces. The jet's standard armament, four 30mm cannons, were bothered by the same problems as the Me 163's weapons. However, the Me 262's longer endurance, almost one hour (36) compared to about five minutes for the fuel-thirsty Me 163 (37), allowed the jet considerably more time for attacking enemy aircraft with twice the number of guns. The R4M 54mm air-to-air rockets introduced in March 1945 (38) were the world's first practical example of this type of weapon and proved to be quite successful when employed against Allied bombers. The combination of the swift Me 262 and the deadly rocket permitted Me 262 pilots to attack "outside the effective range of the defensive fire of (Allied) bombers," where "a well-aimed salvo (could) probably hit several of them simultaneously."(39)

The Messerschmitt Me 163 Komet

In the brief operational life span of the Me 163 Komet, only a small number of the rocket fighters saw use with front-line units. The Komet's small development program, a shortage of trained pilots, and Allied bombing raids that set back rocket aircraft and rocket fuel production were among the reasons.(40) Thus, the Luftwaffe could never really exploit the superior performance characteristics of this exotic weapon. Instead, the Luftwaffe committed the Me 163 piecemeal, without ever building up an adequate reserve.

A 25 August 1944 memorandum from the headquarters of the US 2d Bombardment Division listed in a chart of to-date sightings of "Enemy Jet Propelled Aircraft" an Me 163 on 25 April 1944.(41) However, the first well-documented report of an Me 163 encounter was made on 31 May 1944 when the pilot of an RAF photoreconnaissance Spitfire (a high-performance, single-engine fighter that was sometimes used for reconnaissance), flying at 37,000 feet, witnessed an unidentified "nearly all wing" aircraft over northwestern Germany.(42) This was an Me 163 of the 1.Staffel of Jagdgeschwader 400 (the approximate English translation is the 1st Squadron of the 400th Fighter Wing), a newly-formed unit flying Me 163s from bases in northwestern Germany.(43) The Me 163 flew an interception course but did not attack the Spitfire; it disappeared after climbing to within

3,000 feet of the RAF aircraft.

The Me 163 was originally designed as a bomber interceptor and was used as such during its entire career. Jagdgeschwader 400 was still in training at the time of the encounter with the reconnaissance Spitfire, and during the months following this encounter, the unit moved to a base at Brandis in eastern Germany.(44) This move supplanted a plan to establish a line of Me 163 bases within range of each other along the frontier of northwestern Germany for defense against Allied bombers flying from Great Britain.(45) Concentrated US daylight strategic bombing attacks on oil production facilities, some of which were located near Brandis, had begun to tell on this vital sector of the German war economy, hence Jagdgeschwader 400's relocation. (46)

The initial aerial encounters with the Me 163 in the late spring and early summer of 1944 came as no surprise to Allied intelligence.(47) For several months before the Komet's first operations, photoreconnaissance surveillance had followed developments at known jet and rocket aircraft bases.(48) However, as the 31 May report of the RAF Spitfire pilot and another encounter report of a B-17 of the US 385th Bombardment Group on 7 July 1944 demonstrate, early Me 163 sightings were unexpected for Allied airmen. Both the RAF pilot and the US aircrew described the rocket aircraft, but the Spitfire pilot did not identify the "unknown aircraft" which flew an interception course toward him.(49) The B-17 crew also apparently failed to identify the Me 163 which they encountered over northwestern Germany on 7 July 1944 until they saw a provisional drawing of the aircraft after they returned to base.(50)

Allied Reactions to the Me 163

The specific initial psychological reactions of the airmen in these early Me 163 encounters are unknown. As with most of the Me 163 encounters which were researched, some reading between the lines is required to determine defenders' first responses to the Me 163. Fortunately, the accounts of two USAAF airmen in separate incidents specifically describe their first reactions to the Me 163 and are a useful starting point for determining the effects of the Me 163 on Allied airmen.

Lt. Col. John B. Murphy, a P-51 fighter pilot of the US 359th Fighter Group, who on 16 August 1944 was credited with the first confirmed kill of an Me 163, wrote at the end of his report:

> My first impression when I saw the jet plane was that I was standing still. It seemed hopeless to try to overtake them (sic), but my actions were prompted by a curiosity to get as close to them as possible. I believe that will be the reaction of every pilot that comes in contact with them. Another thing that is very noticeable is that their speed varies considerably, but it's hard to realize this until you find yourself rapidly overtaking them.(51)

Likewise, Storm C. Rhode, a navigator/bombardier in a B-17 of the US 100th Bombardment Group later recalled:

> When reports were made of bat-shaped jets in the locale, my first reaction was of great curiosity and I moved to a window at the top of the aircraft waist to see an object plus a contrail moving rapidly upward and over us.(52)

In both cases curiosity was apparently the airmen's first reactions. Murphy, on a bomber escort mission southeast of Leipzig, first "noticed a contrail climbing rapidly up toward the bombers," which he recognized "as being produced by a jet-propelled aircraft because of its speed."(53) When the contrail ceased he kept the Komet in sight as he would "any other aircraft."(54) Flying a fighter, Murphy was able to pursue the Me 163. In doing so he moved close to the rocket fighter and, after scoring hits on but losing this Komet, shot down another one. Rhode, on the other hand, obviously could not fly his B-17 closer to the Me 163, which flew near his bomber, but he did move from his windowless navigator/bombardier position to a better vantage point.

The Me 163's impressive performance capabilities and unique appearance seem to have been the rocket fighter's most noticeable features for Allied airmen judging by their frequent mention in encounter reports. The Komet performed like no previous conventional aircraft, Allied or German, and it impressed Allied airmen accordingly.

With a top speed of nearly 600 miles per hour, the Me 163's quickness was at least apparent to, and probably amazed, all Allied airmen who witnessed it flying at full throttle.(55) Along with its fast rate of climb and maneuverability, the speed of the Me 163 impressed the crew of the US 385th Bombardment Group B-17 during their 7 July encounter.(56) Col. Avelin P. Tacon, Jr., a P-51 pilot and the commanding officer of the 359th Fighter Group, describing the first sighting of Me 163s by US Eighth Air Force fighters on 28 July 1944, "conservatively" estimated that the Me 163s "were doing between 500 and 600 m.p.h." and that he "had no time to get [his] sights anywhere near them."(57)

Equally astounding for Allied bomber crews and fighter pilots was the Me 163's rapid rate of climb. As previously mentioned, the US 385th Bombardment Group B-17 crew were impressed by the Me 163's rate of climb in addition to other performance characteristics.(58) Various reports from the 16

August encounter in which Colonel Murphy destroyed an Me 163 also noted the Komet's fast rate of climb and the steep angle at which it shot up into the sky. One intelligence memorandum read: "First seen climbing vertically at unusual speeds..."(59) Another version of the 16 August encounter claimed that the Me 163 was observed to be "climbing faster than airplanes cruise straight and level."(60) Propelled by a rocket motor capable of developing 3,700 pounds of static thrust (61), and unhindered by the limitations of a piston-engine-powered propeller, the Me 163 probably most astounded Allied airmen by its rapid climbing.

Invariably accompanying the Komet in its steep climb, and nearly always mentioned in Allied airmen's reports, was the characteristic dense, white vapor trail which the aircraft's rocket motor emitted at full power. Murphy, Rhode, and Tacon all reported seeing vapor trails (although Murphy observed a horizontal trail) as did airmen in numerous other reports. Often the vapor trail appeared intermittently, "like blowing smoke rings"(62) to some airmen, as the Komet pilot throttled back and reduced his motor to lower power to conserve his limited fuel supply.(63) At the top of the Me 163's climb, the vapor trail often disappeared entirely as the pilot cut his motor for a gliding attack approach.(64)

The unique appearance of the Me 163 with its stubby fuselage, large swept wings, and lack of horizontal stabilizer appear to have been as impressive as the rocket fighter's performance. The RAF photoreconnaissance Spitfire pilot described the unidentified aircraft which he saw as "'nearly all wing' which possibly had a marked sweep-back."(65) The US 385th Bombardment Group B-17 crew was "certain that the [enemy aircraft] had no horizontal stabilizer."(66) And the "predominating impression" of the Me 163s encountered on 16 August was of a "flying wing." Colonel Murphy, who viewed an Me 163 from 750 feet before he shot it down, stated that the German aircraft "looked more like a flying wing than the published drawing, with a very blunt nose, sharp dihedral on swept-back mainplane, no horizontal tail-plane, and extremely thick tail..."(67)

Since the Me 163 was in many respects a completely different machine from any previous German or Allied aircraft, it is not surprising that Allied airmen had some incorrect and conflicting perceptions about the Komet, especially in the early encounters of the summer of 1944. Rocket and jet propulsion for aircraft were still quite new at this time, and Allied airmen could not be expected to distinguish between them; that some in fact failed to do so is obvious from the various references to the Me 163 as a jet-propelled aircraft.(68) Airmen's subjective impressions, such as the color of Me 163s encountered or how the aircraft resembled or differed from provisional illustrations seen at debriefings, often differed, and this seems to indicate that the Me 163 confused both airmen and intelligence officers.(69) First Lt. Cyril W. Jones, Colonel Murphy's wingman on 16 August, thought at first that the three Me 163 vapor trails which he saw were either rocket flak or smoke bombs.(70)

Some confusion about the Me 163's purpose, performance, and limitations is also evident in the reports of Allied airmen. Storm Rhode of the US 100th Bombardment Group wrote "Since we never seemed to be attacked by the Me 163, we surmised that they climbed over our bomber stream to observe deficiencies in our long formations, then would probably report this to German conventional fighters."(71) However, no mention of this use of the Me 163 was found in any other source, and the Komet was most likely used exclusively as a bomber interceptor. Reports of Allied airmen mention the intermittent nature of the Me 163's vapor trail, which was sometimes mistaken for sporadic complete reductions in power, when it often only indicated a fuel-saving reduction of power.(72)

For all the awe it inspired and the confusion it sometimes caused, the Me 163 was treated by Allied airmen like any other German fighter. Bomber gunners shot at Me 163s when they attacked, and fighter pilots pursued them. Colonel Tacon's words probably best represent the reactions of fighter pilots:

> I immediately called them to flight as jet propelled aircraft...We immediately dropped tanks [external fuel tanks for increased range which were dropped when enemy aircraft were engaged because of their detrimental effect on the fighter's performance] and turned on gun switches while making a 180 degree turn back toward the bandits.(73)

The two Me 163s which were the subject of this report did not attack the bombers that Tacon was escorting, but the Me 163s that Colonel Murphy met on 16 August did. And despite the claim of bomber gunners that the Komets "were so fast that it was impossible to track them with turrets or free guns,"(74) Sgt. H. Kaysen, a tail gunner in a US 305th Bombardment Group B-17, fatally damaged an attacking Me 163.(75) No evidence to suggest that the Me 163 caused undue fear among Allied airmen was found in research, and lack of any extraordinary fear can probably be safely attributed to Allied fighter pilots in Me 163 encounters. For bomber crews under attack by rocket fighters, this assumption may appear less valid, but nothing was found to indicate that Me 163 attacks were more terrifying than attacks by conventional piston-engine fighters.

German Reactions to the Me 163

The words of Maloney and Feist, "If the Komet alarmed the Allies, it most certainly frightened its pilots even more," succinctly sum up the effects of the Me 163 on both those who flew the rocket fighter and those who fought against it.(76) For the German pilots and ground crews who worked with the Me 163, danger came in many forms, with the rocket motor's highly unstable and corrosive fuel the main cause of accidents. Knowledge that any contact with the corrosive element of the fuel would burn skin and that the specially designed protective flight suits were woefully inadequate must have disheartened pilots.(77)

Because of the fuel's temperamental nature Me 163s had to be handled with extreme caution, and the aircraft were liable to explode suddenly at any time. Several pilots barely escaped death when a small amount of rocket fuel came in contact with hydraulic fluid from the Me 163's extended landing skid and exploded on landing. Pilots were instructed to jettison leftover fuel before landing to minimize the risk of accident, and jettisoned fuel would collect in the landing skid well.(78) Ground crews repeatedly ran water around aircraft during fueling operations to dilute spilled fuel and prevent accidental explosions.(79)

Takeoffs involved the use of a detachable wooden dolley, an unsafe type of undercarriage for an aircraft loaded with explosive rocket fuel. Once in the air, early Me 163 pilots encountered problems with the Komet's compass, which spun rapidly during and after high-speed turns. The temporarily unusable compass made ground control directions for interception impossible until the Komet pilot flew straight and level long enough for the compass to stop spinning.(80) This type of flight was hardly appropriate with enemy fighters in the vicinity, and considering the Me 163's limited endurance.

The Me 163's high fuel consumption rate and consequent short endurance restricted the rocket fighter's operations. With insufficient flight time for searching for Allied bombers, the Komet could fly interception missions only on days with clear weather and good visibility.(81)

Before corrective measures were taken, a safety feature in the Komet's fuel feed system caused the Me 163's rocket motor to cut out when the aircraft leveled out after a steep climb.(82) Unable to restart his motor immediately,(83) a Komet pilot lost his tactical advantages of speed and altitude. In addition to the above mentioned problems, the Me 163's two cannons were prone to jam. Finally, when an Me 163 landed (landing on a skid was itself a dangerous undertaking), the lack of wheeled landing gear meant that the rocket fighter often could not be quickly moved off the landing strip, and it thus blocked the way for other incoming Me 163s.(84) With problems like these, it is no wonder that rocket pilot Mano Ziegler reported an "oppressive" atmosphere at Venlo, an early Me 163 base that he visited in 1944.(85) Not only was there apprehension about safety, but the unit had failed to destroy a single enemy aircraft in over a dozen missions.(86)

The Me 163, for all its drawbacks, fascinated the few German pilots and other personnel participating in its development and early use. Ziegler's book, Rocket Fighter contains many insights into the astounding performance capabilities, as well as the peculiarities, of the Me 163. His first impression of the aircraft in the summer of 1943 shows the awe which the small and powerful aircraft inspired.

> A manned rocket aircraft -- terribly fast -- climbing like an arrow! It was too absurd...yet was it? I stood...peering curiously into an empty sky...As I watched, a tiny black

> speck appeared, growing with phenomenal speed into a boomerang-shaped object which turned, dived, levelled-off, and swept past soundless as a phantom.(87)

Later, when Ziegler first saw a prototype Me 163 under power, he recounted:

> ...Suddenly I was startled by an ear-splitting roar. It sounded as though an immense red hot iron had been plunged into a huge bathtub -- a veritable hiss of Siegfried's dragon! My head spun around and my surprised eyes saw a violet-black cloud driving a leaping, skipping "something" ahead of it, faster and faster until the object leaped from the ground, jettisoned a pair of wheels, and shot up into the sky. By the time I had closed my mouth, which had opened in astonishment, the thing had disappeared. There was nothing left to indicate that I had not suffered an hallucination apart from a dissolving violet-grey smoke trail. A little while later the strange craft reappeared and, like the other I had seen when standing on the station platform, glided soundlessly through the air, circled, and dropped on the ground.(88)

Thus amazement, approaching disbelief, was Ziegler's reaction when he first saw an Me 163 prototype. One factor which Allied airmen flying in loud aircraft and wearing headsets could not have experienced was the extremely loud noise produced by the Me 163's rocket motor. In his first flight in the rocket fighter, Ziegler felt a wonderful sensation of climbing nearly vertically at high speed.(89) One benefit for Me 163 pilots was a special diet for high-altitude flight consisting of foods that Ziegler rarely saw in wartime Germany.(90) Summing up his feelings for the Me 163 with its high performance capabilities and inherent dangers, Ziegler compared the rocket aircraft to a beloved woman who "takes all the money from your pocket all day and then deceives you every night."(91)

Allied Countermeasures to the Me 163

Alhough Allied military commanders greatly feared the employment of Me 163s in large numbers, committing rocket fighters in mass against Allied bombers was never feasible for the Luftwaffe.(92) The Me 163, fraught with dangerous and limiting idiosyncracies, never appeared in great numbers in the air war over Europe. Only two respondents to the research questionnaire positively saw an Me 163 (out of approximately twenty total responses), and this small number reflects the infrequency with which the Komet challenged Allied aircraft.(93) No rocket fighter was ever developed to counter the Me 163, nor was there a need for one. Superior numbers of high-performance conventional piston engine fighters, such as the P-51, proved to be adequate for defense against the Me 163. Even though the Komet could easily outdistance any Allied fighter in a climb and in level flight, Komets were certainly not invulnerable. Allied fighter pilots soon learned that at high speeds the Komet was not

as maneuverable as piston-engine aircraft, while slowing down simply lost it its principal advantage -- speed. Fighter patrols were maintained over known rocket fighter bases to hit the Me 163s at takeoffs, and especially at landings, when they made easy targets as they landed without power.(94) For Allied aerial gunners, faster reflexes were required to hit the speedy Me 163, but one consolation for bomber crewmen was that at top speed the German pilot had less time to hit his target.(95)

Me 163 Summary

In conclusion, it is fair to say that the impact of the Me 163 Komet was greater, and more detrimental for the Germans who operated the aircraft than for the Allied airmen who encountered it. Undoubtedly it inspired some fear among bomber crews who defended against it. For fighter pilots, flying more competitive machines, it appears to have been a desirable target in a one-sided air war that by the late summer of 1944 offered increasingly fewer opportunities to engage Luftwaffe aircraft in the air. For both bomber crews and fighter pilots, the Komet seems to have been primarily an object of fascination and curiosity. By the time it appeared in appreciable numbers, the Me 163 could have little effect on the course of the war; its World War II role was that of an intriguing novelty weapon. As final evidence of the intrinsic dangers and low military value of the Me 163, no captured example flew under power in the United States after the war, even though Alexander Lippisch, the Komet's inventor, and test pilot Rudolf Opitz joined a test program in this country in 1946.(96)

The Messerschmitt Me 262

Compared to the Me 163, the Messerschmitt Me 262 jet was encountered more frequently by Allied airmen. This meant that the defenders' reactions to the jet aircraft were more varied due to the greater numbers of encounters and the different circumstances under which they took place. Because the Me 163 and the Me 262 were introduced into operational service at about the same time, similarities of Allied and German airmen's impressions of both aircraft did exist.

As in the case of the Me 163, the employment of sufficient numbers of operational Me 262s or the buildup of an adequate reserve of the jets for exploitation of its superior performance was never achieved. German aircraft industry manufactured over 1,400 Me 262s, but only a small proportion saw use in front-line units. For a variety of reasons, such as the determination of Hitler to produce the jet as a fighter-bomber and shortages of many vital services and supplies in late-war Germany, even fewer Me 262s engaged Allied aircraft. At the end of 1944, fighter-bomber Me 262s were flying more operational sorties than the fighter variant.(97) But it was in the role of a fighter aircraft that the Me 262 had the greatest effect on Allied military personnel.

The first reported encounter between an Allied aircraft and an Me 262 occurred on 25 July 1944 at 30,000 feet over Munich.(98) An unarmed RAF reconnaissance Mosquito (a twin-engine, high-performance aircraft often used for photoreconnaissance because of its high speed) of No. 544 Squadron was circling Munich when an enemy aircraft was first observed 400 yards astern. Surprised by the appearance of an intercepting Luftwaffe aircraft, the Mosquito pilot, Flight Lt. A. E. Wall, reacted by opening his aircraft's throttles to full boost and going into a shallow power dive. Speed was the reconnaissance Mosquito's only defense, but in the next 15 minutes Wall and his navigator, Pilot Officer A. S. Lobban, discovered that it offered no margin of safety. In at least three firing attacks, the Me 262, a jet from Erprobungskommando 262 (a test detachment training for fighter interception with trial flights against reconnaissance aircraft),(99) closed in on the Mosquito. Each time Wall evaded by turning inside the jet and avoiding the German aircraft's cannon shells. At one point, while in a tight descending spiral, Wall found his unarmed aircraft on the tail of the Me 262 in position for a shot at the jet. Finally, after diving to cumulus cloud cover at 16,000 feet, the Mosquito lost the jet and returned to its base in Italy. In addition to the first confirmed aerial encounter with the Me 262, this incident marked the beginning of the end of unchallenged Allied reconnaissance flights over Europe.(100)

Typically for Allied airmen in the early encounters with the Me 262, Wall and his navigator, whose aircraft was able to outrun practically any German fighter, had been surprised by the jet. The Me 262 appeared out of nowhere, and in the words of the authors of Fighting Jets, "streaked in like avenging lightning, faster than any airborne object [they] had ever encountered."(101) But, like the Me 163, the Me 262 did not take Allied intelligence by surprise, thanks in great part to the work of reconnaissance aircraft like Wall's. Intelligence memoranda concerning the Me 262 began to appear in the summer of 1944, and some Allied airmen were apprised of its appearance and estimated performance capabilities. Nevertheless, the jet continued to take Allied airmen by surprise long after its first use. There are several reasons for this. The jet's superior endurance, compared to that of the Me 163, allowed it a better chance for tactical surprise in aerial combat. The Me 262's formidable appearance and high speed could be unexpected, even to an informed pilot. Charles E. Yeager, a P-51 pilot in the US 357th Fighter Group, saw three Me 262s in the summer of 1944, and despite briefings on some of the jet's performance capabilities and characteristics, the speed of the jets still "came as a complete surprise...when I saw how fast they were."(102) Some airmen were surprised by the Me 262 simply because they did not know what it was and, as will be discussed later, had evidently not been informed of the jet's existence.

Allied Reactions to the Me 262

From the letters and responses to questionnaires received

from USAAF veterans, and from descriptions of Me 262 encounters in primary and secondary sources, the following generalizations can be made. Of the two main groups of Allied airmen who saw Me 262s (i.e. fighter escort pilots and bomber crewmen), fighter pilots reacted with less fear to the jet. The greater vulnerability of bomber aircraft to German antiaircraft and fighter defenses made a combat sortie over occupied Europe a more hazardous undertaking for bomber crews than for the pilots of escort fighters. Naturally, the Me 262, as the state-of-the-art German bomber interceptor, was good cause for concern among Allied bomber crews. On the other hand, the competitiveness and aggressive spirit of many fighter pilots made the jet less a weapon to be feared than a potential adversary and a possible target in a combat environment increasingly dominated by friendly forces.

For bomber crews the typical initial reactions in an Me 262 encounter were amazement and/or fear. Arthur Juhlin, a navigator in a US 100th Bombardment Group B-17, recorded in his flight diary on 24 and 31 December 1944 encounters with Me 262s.(103) On 24 December one jet "stayed out of range and kept shadowing" his formation. On 31 December Juhlin witnessed more aggressive Me 262s during a 30-minute attack by German conventional and jet fighters. Juhlin wrote that his reaction "was one of amazement at their terrific speed..."(104) Ralph Trout, a co-pilot in a US 401st Bombardment Group B-17 en route to a target in Germany on 6 December 1944, was alerted by the bomber's navigator that an Me 262 was in the vicinity. The jet "mushed along observing our formation" and just before the bombers reached the target "climbed away from the formation at an incredible speed," leaving him and his fellow crewmen "nonplussed, amazed [and] flabbergasted."(105) Likewise, C. V. Sochocki, a bombardier/navigator in a US 323d Bombardment Group B-26, recalled that on one occasion an Me 262 which he first spotted at a great distance invaded his formation for one pass and "surprised and amazed" him with its "tremendous" speed.(106)

The Me 262's unique appearance seems to have caused wonderment among the bomber crewmen who witnessed it. Just as the Me 163 aroused curiosity and fascination, so did the Me 262; but the latter, with its more formidable-looking lines, was viewed with apprehension as well as interest. Elmer Clarey, a 492d Bombardment Group B-24 co-pilot, recalled:

> Later, after the war, I saw several of these aircraft on exhibition and was thoroughly impressed with the configuration of each one, comparing the ME 163 and the ME 262. On an overall basis, the ME 262 looked much more formidable.(107)

As previously mentioned, Ralph Trout was "flabbergasted" by the speed of the Me 262 but his first reaction was that "the damn thing doesn't have any propellers!" He remembers that all of the cockpit crew of his B-17 commented on the lack of propellers. He wondered, "How can it fly along with us without props?" Jet

propulsion was, as Trout remarked in his response, "an unknown quantity to all of us at that time."(108)

On the basis of the Me 262's performance and armament, bomber crewmen had more to fear from it than from any other German interceptor. Its high speed, as Arthur Juhlin recalled, allowed it to "toy with" the bombers' P-51 escorts. On 1 November 1944, John Woolnough, a B-24 pilot in the US 466th Bombardment Group, witnessed the sudden disappearance of one of four escort fighter contrails. Later, when he heard from other bomber crews that an Me 262 had shot down the escort, his reaction was "one of wonderment and fear" and "disbelief" that anything could be that much faster than the P-51.(109) Robert Kirby, a US 100th Bombardment Group B-17 navigator, recalled that on a 12 March 1945 mission, P-47 and P-51 escorts "had trouble keeping the 262's away."(110) Another 100th Bombardment Group navigator/bombardier, Storm C. Rhode, described an incident which perfectly illustrates the ability of the Me 262 to run the gauntlet of the escort fighters to get at the bombers.

> This particular mission involved three bomb groups of the 13th Combat Wing, probably 100 B-17s in the entire bomber strike force, escorted by a small number of USAAF P-51 fighters. Early in the attacks Lt. Pointer's B-17 of our group suffered battle damage and dropped away from our formation, lagging further and further back. The 262's would leave our main 100th group and speed back to attack Lt. Pointer. He then would call for P-51 help and our U.S. fighters would scurry back to help whereupon the 262's changed back to hitting us. Surprisingly, Pointer...made it safely back to our home base in England, scared as hell but happy to be safe.
>
> Lt. Col. Graham [was] one of the leaders of the afore mentioned P-51's. He and I discussed this mission and he stated that the P-51's simply couldn't keep up with the 262's.(111)

Several veterans recalled that the Me 262 was extremely difficult to track and hit with a bomber's defensive armament. As previously discussed, Allied air gunners had the same trouble with the Me 163. In the words of Chaz Bowyer in his book, Guns in the Sky: The Air Gunners of World War Two:

> The initial impact of a Luftwaffe jet interceptor on any air gunner was to shock him -- the sheer speed of a jet baffled his senses and crumbled the lessons hard-won by dint of long experience in bomber-fighter combat.(112)

Arthur Juhlin, who witnessed Me 262s using "terrific speed" to "toy with" escort fighters, also wrote that their speed enabled them to "make passes...at velocities that made it practically impossible for our gunners to track them."(113) C. V. Sochocki, manning a .50-caliber machine gun in the nose of his B-26, "was reasonably sure that none of the gunners in my formation got a good shot [at the Me 262 that invaded his formation], due

to the fact that he came in at 2 o'clock high with the sun at his back and when he became visible in front of our formation, his speed was too great for our gunners to be able to adjust to."(114)

All of the above mentioned factors often led to feelings of fear and dread of the Me 262 among the bomber crews. C. V. Sochocki was "damned scared" when his formation was hit by a single Me 262 and was "very happy" when it made just one pass and was not encountered again.(115) Storm Rhode recalled that "the jets scared the hell out of me" and that during Me 262 attacks "my skin crawled."(116) Robert Arnold, a waist gunner in a 486th Bombardment Group B-17, remembered being afraid ("Foremost, I was scared.") when two German jets appeared below his aircraft, even though he was unable to determine their intentions.(117) An astounding example of the extreme measures to which a frightened Allied pilot could resort is found in the 15 August 1944 experience of a South African Air Force reconnaissance Mosquito of No. 60 Squadron.(118) Flying at 30,000 feet over the Munich area, the Mosquito was suddenly jumped by a single Me 262, which, unlike the jet that Flight Lieutenant Wall had met less than three weeks earlier, managed to open fire and damage the South African aircraft before the pilot took evasive action. During the ensuing 40 minutes, the Me 262, with reportedly "phenomenal" speed, chased the SAAF aircraft in much the same manner as Wall's Me 262 had done. After outmaneuvering the jet in a twisting and turning flight to 9,000 feet altitude, the Mosquito pilot "in desperation" attempted to ram the Me 262 when the jet drove in on a head-on attack. The desperate maneuver failed when the Me 262 overshot its quarry and the Mosquito pilot lost the jet by diving into cumulus clouds at 8,000 feet with a mere 500-foot clearance over the mountains. However, even this danger did not bother the pilot for, in his words, he "didn't care about that [because] the other risk was much greater."(119)

For pilots of Allied escort fighters -- most commonly US P-47s and P-51s by mid-1944 -- the Me 262 did not cause nearly as much alarm as it did for bomber crews, or, of course, pilots of unarmed reconnaissance aircraft. In fact, some Allied fighter pilots reacted to the sighting of an Me 262, particularly one in a vulnerable position, with elation. Walter Boyne writes in his book, Messerschmitt Me 262: Arrow to the Future:

> As the months wore on, Me 262 activity built slowly; attacks which had been conducted singly were soon conducted by flights of nine, twelve, and on rare occasions even 24 or 36 of the swift jets. Yet the attitude of the Allied pilots never changed. They wanted combat more than anything else, and if there were no [FW] 190s to mix it up with, then the 262 would serve perfectly well. The entire tone of the combat reports of the time reflect this lust for combat... find one in a vulnerable situation, perhaps landing or taking off, brought joy to an Allied fighter pilot's heart.(120)

Two US 55th Fighter Group veterans' responses demonstrate this reaction. Walter Konantz, flying a P-51 over a German airfield at Giebelstadt on 13 January 1945 observed three or four aircraft taxiing on a runway. One aircraft took off and Konantz, identifying it as an Me 262, "caught him easily as he was in a medium turn and got a long burst into him," which sent the Me 262 crashing into the ground.

> Of course we knew of such aircraft and had recognition pictures of them...so it was no great surprise to see one. My reaction was on of great glee that I would have the good luck to watch this one take off, make an 180 degree climbing turn under several other P-51s...and be able to shoot him down before any of my squadron mates did.(121)

McCauley Clark, another 55th Fighter Group P-51 pilot, spotted one Me 262 below him while he was flying alone at 10,000 feet over Germany in November 1944.

> My first feeling was one of elation, and not one of fear. I felt if I could get a German jet to my credit, this would be a "feather-in-my-cap."(122)

To a fighter pilot, the performance of the Me 262, most notably its speed and acceleration at high speeds, was often a cause for remark and sometimes of amazement. Lieutenant John R. McCullough, a P-38 pilot in the US 14th Fighter Group, saw several Me 262s while escorting a photoreconnaissance aircraft over Munich on 9 December 1944. McCullough reported that "before the attacks they accelerate at a tremendous rate which is very perceptible to the naked eye."(123) McCauley Clark, who had been elated when he spotted an Me 262 in a vulnerable position at a lower altitude, quickly found his elation turn to disappointment as the Me 262 escaped.

> I peeled off and closed within point-blank range. I'm sure the pilot did not know I was around. I hesitated a couple of seconds to make sure the aircraft was not an American A-20. This may have been a mistake, because when I opened fire I could see the tracers going over the wings on each side of the fuselage. By now the pilot was aware of my presence and in less time than it takes to tell, the 262 pulled quickly out of range and into the clouds. I guess you could say this is the story of the one that got away; of course, I was disappointed.(124)

John K. Brown, a P-51 pilot in the US 20th Fighter Group, encountered two Me 262s on 10 April 1945. At first he mistook them for two P-51s because from the head-on angle at which they approached, their twin jet engines looked like external fuel tanks on the P-51s. However, the speed of the Me 262s betrayed their real identity. Brown, watching their rapid approach said to himself, "My God what speed, they must be jets."(125)

In this encounter, the speed of the ME 262s also dismayed Brown because it permitted the German aircraft to attack the bomber formation under his protection.

> In spite of all our efforts we could not get into firing positions before the two Me 262's fired on our bombers from 6 o'clock. It was a very helpless, frustrating feeling seeing their gunfire hit our bombers and we could not stop them.(126)

Claude A. Chinn, a P-47 pilot of the US 56th Fighter Group, saw an Me 262 at extremely high altitude in August 1944. Not on an actual escort mission at the time, Chinn nevertheless realized the potential threat of the jet aircraft.

> I was flying one of the best fighters in the world: we were at maximum altitude...Here, 10,000 feet above me was something I was unable to do anything about. My thought was that if he had 500 of these and sent them down the bomber stream, we, the fighter escort, would be helpless against such numbers.(127)

Thus, just as bomber crews were averse to seeing Me 262s evade their fighter protection, escort pilots were concerned that the speed of the Me 262 could keep them from effectively defending the bombers.

Some airmen reported different reactions to the jet. As already mentioned, one of these was surprise. In a 2 October 1944 encounter involving the US 365th Fighter Group the surprise of the US fighter pilots is quite evident.

> The first warning that 1st Lieutenant Valmore J. Beaudrault had of this encounter came when his No. 3 yelled over the radio, "My God, what was that?" ...As Lt. Beaudrault looked around at the warning he was just in time to see a streak flash by his tail and then whip up into the clouds.(128)

Jack Ilfrey, a 20th Fighter Group pilot, wrote that his squadron and he wondered "what in the hell are those" when they first encountered Me 262s in August of 1944.(129)

Other airmen were not so greatly concerned with the Me 262 because of either greater uneasiness over other dangers or confidence in their own abilities, bomber crews usually for the former reason, fighter pilots for the latter.

Bomber crewmen Elmer Clarey and Robert Kirby reported that German antiaircraft fire was a greater cause for anxiety than the Me 262. Clarey wrote:

> From a crew standpoint, we were more concerned with getting hit by flak than being attacked by prop or jet aircraft. If there were jet or rocket aircraft in the air, they were accepted as part of the battle.(130)

Robert Kirby also mentioned flak as a cause of fear in his response about his reactions to the Me 262.

> I guess I'd say in general that I was too young and dumb to be impressed. But I was scared on several occasions -- mostly by flak which was more visible and audible than fighters.(131)

Aggressive Allied fighter pilots -- and this personality type was fairly common in USAAF fighter groups because of selection and technical training -- faced the Me 262 with confidence and evinced no undue concern when they encountered it. William A. Simpkins, a P-47 pilot of the US 373d Fighter Group described his feelings about the Me 262, which, judging by the similar opinions of US 361st Fighter Group ace Urban L. Drew and others, were shared by many fighter pilots.

> At that time during the war, I had completed about 85 combat missions...My view was, and still is, that an airplane is simply a mechanical device invented by man that has the ability to temporarily overcome the effect of gravity. The only important factor is the ability of the pilot flying the device.
>
> We observed the German jets on several occasions but they did not make any sort of hostile or aggressive move in our direction. Our group was flying P-47 fighter-bombers, mostly in support of the Third Army. Our pilots were experienced and confident that we could meet a jet with no fear. The only advantage they had was speed and that in itself was a trade-off because we had superior ability to maneuver at slower speed...I believed in an actual encounter, I would have the advantage because of my firepower, eight fifty caliber machine guns, and ability and experience.(132)

Simpkins also perceptively observed:

> The situation was different for bomber personnel. A bomber was always an easy target for an experienced fighter pilot.(133)

Walter R. Groce, a US 56th Fighter Group P-47 pilot, who shared in the destruction of an Me 262 on 1 November 1944, wrote about his fighter group: "I was not afraid to tangle with the jets and none of our pilots (56th Group) were afraid."(134) Urban Drew, a P-51 pilot who destroyed two Me 262s in the air on 7

October 1944, shared Groce's and Simpkins' feelings about the German jet.

> All the great fighter pilots were a total blend of aircraft and man, never having to think about doing this or that with the aircraft to accomplish any maneuver or take any course of action desired...The man and machine were totally melded and moulded together...and all actions by the fighter pilot in the aircraft were second nature and in most cases were not conscious efforts...In every case without exception, when talking to the fighter aces of WW II, whether German, British or American, this trait, or rather technical accomplishment of melding man and machine...was self-evident...Every single fighter ace will state the same thing...also the factor of total confidence in himself, as a fighting unit, was universally present in all the fighter aces...Therefore, I, and others like me, went actively looking for these "wonder jets"...to shoot them down, to blast them out of the sky, and with never a thought that they might blast me out of the sky...(135)

Captain Leonard M. Jackson, a pilot in the US 332d Fighter Group also reported a minimum of worry about the Me 262.

> The German Jet Fighters we met were not a source of great worry. They are too fast for maneuverability and accurate gunnery.(136)

The aggressiveness with which some fighter pilots pursued Me 262s is substantiated by Urban Drew's description of his first encounter with the jet.

> When I spotted my first Me 262, I called it out to our group leader and went after it with my wingman...it was obvious I wasn't going to catch it, unless he chose to turn and engage me...which he did up to a point...I fired at him even though I was well aware that he was out of range...a frustrating feeling firing briefly in my rage at not being able to properly engage him...I wanted to keep in sight of him, to learn all I could about how they operated, how they flew...and always with the outside hope that he would get close enough for me to really engage him...but it was not to be so...he was slowly dragging me nearer and nearer his airdrome, and the flak became heavy and intense, subsequently shooting down my wingman. I was furious with rage over not being able to get to him...and had to climb back to altitude to rejoin the squadron and return to base...The loss of my wingman in this encounter was an open wound, and I vowed that, if and when I had the opportunity, I would settle the score...I am sure in reading to this point, I will have answered your primary question of what was my reaction to the new German jet aircraft...I couldn't wait to get one in my sights and blow him out of the sky...(137)

Reactions among Allied military commanders to the Me 262 were generally those of concern about the possible effects of the jet on the course of the air war in Europe. Eighth Air Force commander General James H. Doolittle wrote on 11 January 1945 that "if the Me 262 could be thrown up in concentrated numbers daylight raids over Germany would become impossible."(138) A 10 January 1945 letter from American Strategic Air Forces commander General Carl Spaatz to General Henry H. Arnold showed an incisive analysis of the potential threat of the Me 262.

> The jet airplane [is a] very grave danger [and] could cause great trouble if employed in the proper manner. [It] could minimize the effectiveness of our fighter escort by forcing it on the defensive and rendering the bombers vulnerable to determined attack. One of the particular dangers...is the successful interception of so many of our reconnaissance planes.(139)

After the end of World War II, Spaatz wrote:

> Given the super-speed of the jet fighters, and given a sufficient supply of them, the Germans might have regained control of the air over Germany while we were waiting for our own jet production to catch up. In that contingency anything might have happened.(140)

Interestingly, one report to General Arnold, dated 1 December 1944, cited concentrated Me 262 attacks against Allied land forces as the "greatest threat" of the jet. This was the exact role which Hitler had originally desired for the Me 262.

> The greatest threat is considered to be the enemy's use of jet aircraft to attack our land forces. If they can do this on a sufficient scale to enforce dispersion of convoys on roads and all forces generally, the effect on the land campaign may be serious.(141).

This concern proved to be unfounded, however, because like the interceptor Me 262s, the fighter-bomber variant appeared in insufficient numbers and its effectiveness in the ground attack role was not notably better than that of conventional fighter-bombers.

The 1 December report to General Arnold outlined the countermeasure against Me 262 air attacks which really minimized the threat of the jet fighter: superior numbers of Allied escort aircraft.

> Although the threat [to] our Bombers operating by day is serious, it can be met partially by large escorts of normal fighters. The threat to our own ordinary fighters is not so serious, since, unless surprised, they can use their maneuverability to evade jet aircraft which will be at a disadvantage if they dogfight.(142)

During the last year of World War II, the threat of the Me 262 may have appeared serious to Allied air commanders but, as Sir Arthur Harris, leader of Britain's Bomber Command later wrote, the concern may have been overstated.

> The enemy's jet-propelled fighters, which were far in advance of anything the Allies had, and could have [had], disputed our air supremacy -- they would, however, have been too fast to operate by night against our [Bomber Command] bombers...As a result of stoppages and bottlenecks in the chemical industry and communications as a whole...the jet-propelled fighters were only able to play a very minor part before the end of the war.(143)

A final aspect of Allied reactions to the Me 262 should be mentioned before turning to the responses of German personnel to the jet. During research for this study it was difficult to ascertain how much advance information combat airmen received about the Me 262. In one of the first responses to the research questionnaire sent to veterans, Ralph Trout, a US 401st Bombardment Group B-17 co-pilot, wrote that after his 6 December 1944 encounter with an Me 262, the intelligence officer at debriefing "smiled knowingly" when Trout's navigator described the German jet.(144) But the intelligence officer, Trout wrote, "of course gave us no info about what we saw."(145) This raised the question about how much knowledge and information was imparted by Allied intelligence to combat aircrews concerning the new German aircraft. Differing reports of other airmen cloud the issue. Charles Yeager wrote that before his encounter in the summer of 1944: "We had been briefed on jet aircraft and on some of their performance and characteristics (sic)."(146) Walter Konantz, who encountered his first Me 262 on 13 January 1945, recalled:

> Of course we knew of such aircraft and had recognition pictures of them and even had been briefed on their capabilities, fire power, speed, etc. So it was no great surprise to see one.(147)

P-47 pilot William Simpkins, who did not specify the exact time when he first saw the Me 262, wrote:

> We received silhouette drawings of the units involved as well as their expected performances in the air...There were no formal briefing sessions about the possibility of encountering the German jets; however, each flight leader held a somewhat informal session with his pilots on this matter.(148)

The frequent mention in Allied intelligence memoranda (from the late summer of 1944 onward) on microfilm on file at the Office of Air Force History suggests that most combat airmen were indeed kept up to date on the latest information about the German jet. But C. V. Sochocki, like Ralph Trout, apparently had not heard of the Me 262 before his 25 March 1945 encounter, exactly

eight months after the first confirmed aerial sighting of the jet. His statement implied that he had not been briefed on the jet before seeing one in combat, long after Me 262s had first engaged Allied aircraft.

> When I first spotted the Me 262...I was unaware of the type of aircraft. It was later identified at briefing.(149)

One of the last responses to the research questionnaire came from US 361st Fighter Group veteran Urban Drew. His assertion that information about the Me 262 was often difficult to obtain suggests that information provided to Allied airmen was often spotty, at best.

> As we all know, we fighter pilots were expendable items...in the inventory of war...so ours was not necessarily to know, just to do...In that respect any information that our intelligence services had (British and American) of the new German jet aircraft, was most carefully reserved for themselves, or in fact, they knew very little about them; since we combat line pilots never received much if anything about them...except that they were jet powered, and much faster than us...We had no idea of their endurance capability, nor were we briefed on the calibre of the pilots who were flying them...nor were we given access to any but the most brief combat reports on the few pilots who had encountered them...Hindsight tends to make me believe that this lack of intelligence available to us, was an effort not to "scare us" with the technical superiority that the German jet had over anything in our aerial arsenal...Subsequent investigations by myself and others who have had an interest, confirm the later observation in general...In retrospect, our commanders and intelligence officers certainly did not give the proper credit to either the intelligence, integrity, or bravery of our own fighter pilots in this respect...(150)

After his first encounter with an Me 262, described already, Drew attempted unsuccessfully to acquire more information about the German jets.

> From this first encounter on, I continued to ask intelligence at every chance, where we could expect to find Me-262's, what bases they were operating from, etc...Intelligence could give me little or no information, and what they did give me was so sketchy as to be valueless...if the senior officers in the squadron and group had this knowledge, they did not pass it on to us...(151)

It is surprising that Allied intelligence apparently did not make a major and systematic effort to give combat airmen information on the Me 262 and thereby do everything possible to ensure their safety. However, the evidence of this research indicates quite clearly that this was sometimes the case.

German Reactions to the Me 262

Renowned German fighter ace Adolf Galland first flew the Me 262 on 22 May 1943.(152) Two months earlier, in March of the same year, Galland had opposed the initiation of mass-production of the jet in favor of the piston-engine Messerschmitt Me 209, a linear development of the standard Luftwaffe fighter, the Me 109.(153) After his first flight in the Me 262, Galland's feelings for the jet aircraft changed completely.

> I took off along a runway 50 yards wide at a steadily increasing speed...I was doing 80 m.p.h. when at last the tail rose...with reduced air resistance, the speed increased quickly, soon passing the 120 m.p.h. mark and long before the end of the runway the plane rose gently off the ground.
>
> For the first time I was flying by jet propulsion! No engine vibration, no torque, and no lashing noise from the airscrew. Accompanied by a whistling sound, my jet shot through the air. Later when asked what it felt like, I said: "It was as though angels were pushing."
>
> Yet the sober reality, conditioned by the war, did not allow me any time to enjoy to the full this new feeling of being pushed, while flying. Flying characteristics, manoeuvrability, top speed, rate of climb -- during that few minutes' flight I had to formulate my judgement of this new aircraft...
>
> On landing I was more enthusiastic than before. Feelings and impressions were, however, no criterion; it was the performance and characteristics that mattered. This was not a step forward. This was a leap!(154)

Galland then telegraphed a report to Generalfeldmarschall Erhard Milch, head of Luftwaffe fighter procurement.

> The aircraft 262 is a very great hit. It will guarantee us an unbelievable advantage in ops. while the enemy adheres to the piston engine. Its air worthiness makes the best impression. The engines are absolutely convincing, except during take-off and landing. This aircraft opens up completely new tactical possibilities.(155)

The Me 262 elicited similar enthusiasm from pilots in combat. With a top speed and rate of climb superior to the best Allied fighters, the Me 262 gave its outnumbered pilots a better chance in combat against Allied aircraft in the last year of the war in Europe. The Me 262 restored confidence -- "life insurance" as one pilot termed it -- and inspired its pilots with a feeling of invincibility.(156) Walter Boyne, in his book Messerschmitt Me 262: Arrow to the Future, describes the observations of German fighter ace Johannes Steinhoff:

> He fully appreciated all of the magnificent qualities of the Me 262, including its speed, climbing ability, heavy firepower and ability to either engage or disengage at will. But, more important, he recognized the advantage of the Me

262's low pressure tires which enabled it to operate from grass strips, its mechanical controls which were relatively invulnerable to fire, and its very heavy armament.(157)

The jet engines of the Me 262 were designed to run on "an inferior fuel to aviation petrol" similar to diesel oil, but this was only a minor advantage, since the entire German petroleum industry was crippled by Allied bombing in the last year of the war.(158)

Franz Stigler, a pilot in the legendary Jagdverband 44, which was an ad hoc elite Me 262 unit formed and led by Adolf Galland in 1945, also described some of the Me 262's advantages in combat.

> Normally with a 109 or 190 getting back in position for a second attack was a time consuming thing, but with the 262 and its vastly superior speed over the bombers, it was no problem at all. Within a minute or two we were back in position again...
>
> Usually to get at the bombers we had to break through the escorting fighter formations, but with our tremendous speed advantage this wasn't difficult. We just had to be careful they didn't get into position above and dive on us before we saw them...As long as we saw them, they posed few problems, because we could get away from them so quickly. Even with one engine out, we were generally faster than they were. I had an engine flame out once and still ran away from a flight of P-51s without any trouble. A slight dive and they couldn't catch me and soon fell behind.(159)

Problems Encountered by the Germans with the Me 262

Like the Me 163, the Me 262 had its problems, many of which impaired its combat effectiveness. The jet's engines required careful handling at lower speeds (takeoffs and landings being the most critical times); otherwise engine overheating and failure were liable to result.(160) At very high altitudes the jet engines were liable to flame out and could not be restarted until the jet descended to lower altitudes.(161) The engines required careful maintenance and their life span, for several reasons that included the use of inferior metals in their construction(162), was short. The Me 262 consumed fuel at a very high rate, compared to contemporary piston-engine fighters, and its one-hour endurance limited its radius of operation (163) allowing only a relatively brief time for combat.

The Me 262 was less maneuverable than Allied fighters, which made dogfights with the commonly encountered P-47 and P-51 risky undertakings. Tremendous exertion of strength was needed to operate controls at high speed.(164) The absence of maneuvering flaps or speed brakes on the Me 262 was another disadvantage hindering the jet's performance. The addition of these features to the jet would have allowed the pilot to decrease speed aerodynamically and not have to rely on the sensitive throttle

controls to regulate speed and risk losing power in the engines.(165) Most dangerously, the Me 262 had a tendency to become uncontrollable in steep dives, as it passed its compressibility threshold.(166) Because of its clean airframe, the aircraft tended to increase speed in a steep dive even when the pilot reduced engine power, and it was difficult to pull out of the dive.(167) Allied pilots sometimes noticed the jet pilots' apparent aversion to steep dives. 168)

These handling problems restricted the efficiency of the Me 262 in aerial combat. Its one great advantage -- its speed -- could also impede an attack on enemy aircraft. Johannes Steinhoff discovered this problem on a combat sortie on the Eastern Front. Spotting a flight of Soviet fighters, Steinhoff headed toward them with the sun at his back but failed to take into account the speed of his jet.

> ...in a split second what had been just black dots on the armored glass in front of his face became a swarm of fighter planes, and in another split second he had passed one as if it was hanging motionless in the air. He felt a twinge of doubt: "Is this really such a good fighter?"(169)

Me 262 pilots, like their comrades in the rocket-propelled Me 163, often found that high-speed attacks on Allied aircraft made accurate gunnery difficult. A reduction in speed, on the other hand, left the jet more vulnerable to Allied escort fighters and defensive fire from bombers. The R4M 55mm air-to-air rockets (unguided) mounted on some later Me 262s enhanced the firepower of the jet and somewhat alleviated the problems of high-speed attacks.

The worsening situation in Germany in the final year of the war led to difficulties with the Me 262 pilot training program. Pilots trained for flying the Me 262 received only cursory instruction on the operation of the plane due to circumstances which prohibited a longer training period.(170) Because of the fuel shortage, and the high attrition rate in pilots, many green pilots with no combat experience and insufficient training joined operational units. Inadequately trained pilots, some used to flying piston-engine aircraft, had a tendency to mishandle the jet's throttle controls and often damaged or ruined engines.

Because German fighter pilots did not normally receive in-depth training on instrument flying, some former bomber pilots, who had this kind of training in addition to experience with twin-engine aircraft, were employed in an operational fighter unit, Kampfgeschwader (Jaeger) 54. Veteran fighter pilots like Adolf Galland opposed this move because they viewed the bomber pilots' familiarity with twin-engine aircraft and instrument flying as poor substitutes for experience in the art of aerial combat.

Shortages of fuel and spare parts caused by the chaotic condition of German industry and a broken transportation net

rendered proper ground maintenance of the Me 262 extremely difficult. Air bases within Germany's shrinking perimeter were often put out of operation by Allied air attacks.(171) Me 262s were manufactured at factories dispersed throughout Germany and German transportation systems, hard hit by Allied aircraft, could not provide reliable delivery of finished jet aircraft to frontline units.

Me 262 Tactics

The fighter version of the Me 262 was employed against Allied photoreconnaissance aircraft, bombers, fighter-bombers and fighters. As already mentioned, unlike conventional German fighters, its great speed enabled it to catch and destroy high-speed photoreconnaissance aircraft. Against Allied bomber formations and their escorts, the Me 262 focussed attacks on the bombers, although the jet pilots "regarded the ideal role of the Me 262 to be that of a pure fighter, finding and destroying Allied fighters and fighter-bombers."(172) Late in the war the devastation caused by Allied bombing required the use of all available German interceptors against the heavy bombers.(173)

However, the Me 262 was not always used in a purely anti-bomber role. John Brown of the US 20th Fighter Group wrote that the Me 262s were sometimes used as bait for P-51 escorts while conventional German fighters went after US bombers.

> The Germans had a limited number of jets but plenty of Me 109s and FW 190s and they used them in a very clever way. Our P-51s could win consistently over the Me 109s and FW 190s so the Jerries would come in with one or two Me 262s and our fighters eager for a kill would all start after them. They would stay just out of gunnery range until they had drawn us away from our bombers we were escorting, then pour on the throttle and lose us. In the meantime, they would hit our bombers with Me 109 and FW 190s. After they pulled this tactic a few times our side developed a counter-tactic. Our escorting fighters were divided into "A" and "B" groups. "A" group could continue as before to seek aggressively the German fighters. "B" group was ordered to stay close to the bombers and could leave to chase enemy fighters only 2 at a time in two plane elements.(174)

A 30 April 1945 USAAF Intelligence Summary described the following Me 262 tactics:

> Recently returned 8th Air Force gunners (heavy bombers) reported formations...attacked in conjunction with FW 190s and Me 109s. Returnees felt that due to the tremendous rate of closure, jets were...attempting to break up formations for conventional fighters.(175)

And Julian Roadman, a B-17 pilot in the 401st Bombardment Group made this observation about the Me 262.

> My ship did not encounter the specified German aircraft, however sporadic condensation trails were observed 30 to 60 miles away...It seemed odd to me that these advanced interceptors were seldom used to knock down bombers. They appeared to be used mostly for observation to direct conventional propeller-driven interceptors.(176)

From the frequent mention of combat reports concerning Allied fighters and Me 262s it seems that Me 262 pilots, in addition to baiting fighter escorts or breaking up and observing bomber formations, also actively sought to engage Allied fighters. Considering the sheer numbers of Allied fighters accompanying the bomber streams and the natural proclivity of fighter pilots to mix it up with their own kind, this is not surprising.

Allied Countermeasures to the Me 262

Aerial gunners in Allied bombers needed quick reactions and in order to score hits had to lead the Me 262 more than conventional German interceptors. Allied fighter pilots quickly discovered the futility of trying to catch an Me 262 in a high-speed pursuit unless the jet could be boxed in and surrounded. Superior numbers and using altitude advantages to build up speed to a velocity close to that of the jet were the best tactics. In defending bomber formations from Me 262s, fighter escorts stayed closer to the bombers and used tactics like those described by John Brown. One of the best defenses for an Allied fighter pilot when tailed by an Me 262 was to use the piston-engine fighter's superior maneuverability and turn inside the jet.

Allied countermeasures against the Me 262 eventually concentrated on and around the jet airfields where the Me 262 was at its most vulnerable during take-off and landing, and while on the ground. "Capping" operations using standing fighter patrols over known jet airfields proved to be successful in catching the Me 262s.(177) To counter this danger the Germans heavily guarded their airfields with increased numbers of antiaircraft guns. As the number of operational jet airfields dwindled toward the end of the war, Allied countermeasures against the Me 262 were facilitated. Attacked on the ground by Allied bombers and harassed by fighter patrols at takeoffs and landings, the Me 262 pilots were deprived of secure and usable ground facilities and overwhelmed by the aerial and ground attacks of the more numerous Allied aircraft.

Me 262 Summary

The effects of the Me 262 jet on Allied airmen were varied. In general, the Allied bomber crews who saw or fought against the Me 262 regarded the aircraft with a mixture of amazement and fear because of the jet's great speed, its formidable appearance and its performance. Allied fighter pilots were also amazed by the jet's performance. Fear, however, seems to have rarely affected fighter pilots during Me 262 encounters who tended to view the new plane as a challenge to be met aggressively and with

confidence in their own skill and the maneuverability of their aircraft.

The same factors that inspired fear and amazement in Allied airmen restored confidence to the German pilots who flew the Me 262. In the hands of experienced, well-trained pilots, its superior speed and rate of climb, combined with its powerful armament, gave its pilots better odds for survival and successful combat against a vastly more numerous foe. The technical problems that troubled the Me 262 seem to have not appreciably lessened the German pilots' appreciation of and affection for it.

It cannot be asserted confidently that the employment of greater numbers of Me 262s at an earlier date might have altered the course of the European air war. The aircraft's performance was superior to the best Allied piston-engine fighters, but the Allies had developed and produced operational jet aircraft of their own and would have used them had the war been prolonged and the German jet menace become a major threat.(178) The Me 262, as the first operational jet aircraft used in combat, did usher in a new era of aerial warfare, and although it did not alter the course of World War II, the reactions of those airmen who flew in and against it foretold the dawn of the jet age.

Conclusion

In summing up the effects of the Me 163 and Me 262 on the airmen who flew and fought against these aircraft, a point-by-point compendium is used to demonstrate the main reactions to these aircraft.

Me 163

Allied:

Generally amazement, curiosity, and fascination at unusual appearance and performance, particularly speed and rate of climb.

German:

Consternation due to explosive nature of the aircraft. Apparently some frustration due to ineffectiveness of aircraft caused by mechanical problems, short range, and limited endurance. Amazement and fascination for same reasons as above.

Me 262

Allied:

Like the reactions to Me 163, fascination by appearance and performance (speed and rate of climb.) Because of greater numbers encountered and greater lethality of weapon, more fear, particularly among bomber crewmen. For Allied fighter

pilots, frequent aggressiveness and satisfaction in finding an opponent in a combat environment increasingly dominated by friendly aircraft.

German:

For experienced fighter pilots, satisfaction in flying an aircraft which increased the odds for survival and permitted the opportunity to engage destructive and overwhelming Allied air forces. Also amazement and fascination at performance capabilities.

Notes to Case Study on Jets and Rocket-Propelled Aircraft

1. Kenn Rust and William N. Hess, "The German Jets and the U.S. Army Air Force." American Aviation and Historical Society Journal, p. 155.

2. Walter J.Boyne, Messerschmitt Me 262: Arrow to the Future, p. 5.

3. Jeffrey L. Ethell and Alfred Price, The German Jets in Combat, pp. 99, 132.

4. Boyne, p. 118.

5. Ibid., p. 130; Ethell and Price, p. 60.

6. Ethell and Price, p. 60.

7. Ibid., p. 22.

8. Ibid., p. 108.

9. Edward T. Maloney and Uwe Feist. Messerschmitt 163, no page number.

10. Ethell and Price, p. 121.

11. Maloney and Feist, no page number.

12. Ethell and Price, p. 134.

13. Boyne, p. 139; Ethell and Price, p. 74. Boyne writes that the AR 234 first flew on 15 June 1943 and Ethell and Price state 30 July 1943.

14. Ethell and Price, p. 91.

15. Ibid.

16. Ibid.

17. Boyne, p. 139.

18. Wesley Frank Craven and James Lea Cate. The Army Air Forces in World War II, Vol. Six, Men and Planes, pp. 219-220. The P-51H had a top speed of 487 miles per hour. This aircraft might not have even seen service in the European Theater.

19. Edward Story Taylor, "Aircraft Propulsion," Encyclopedia Britannica, p. 433.

20. Maloney and Feist, no page number.

21. Taylor, p. 433.

22. Wolfgang Dierich, Kampfgeschwader "Edelweiss": The History of a German Bomber Unit, 1939-1945, p. 91.

23. Joseph V. Mizrahi, "Defending the Reich, Pt.1, Intercepting the American Bomber Streams." Airpower, p. 93; Report of Interrogation of Hans Fay, Messerschmidt Test Pilot, (Microfilm Index 1655, Roll B 1764, Frame 103, Office of Air Force History, Bolling Air Force Base, Washington, D.C. Hereafter referred to as AF History).

24. Ethell and Price, p. 113.

25. Mano Ziegler, Rocket Fighter: The Story of the Messerschmitt ME 163, p. 25.

26. Ethell and Price, p. 113.

27. Edward Jablonski, Air War: Wings of Fire, p. 106.

28. Ibid., p. 106.

29. Ibid.

30. 28 July 1983 letter from William A. Simpkins. Simpkins was a US 373d Fighter Group P-47 pilot who had completed over 85 missions by the time the German jets were encountered in numbers. His observation that Allied pilots in piston-engine fighters had superior maneuverability at lower speeds is correct and also mentioned in numerous secondary sources.

31. Ethell and Price, p. 55.

32. Ibid., p. 134.

33. Ziegler, p. 89.

34. Robert W. Randell, "Developing a Rocket Fighter," Flying Review International, p. 29.

35. Ethell and Price, pp. 28-29.

36. Mizrahi, p. 55.

37. Maloney and Feist, no page number. Five minutes was the time required to burn the Me 163's fuel at full throttle. Endurance could be prolonged by intermittent use of the rocket engine and by gliding attacks on bomber formations.

38. Ethell and Price, p. 45.

39. Adolf Galland, The First and the Last: The German Fighter Force in World War II, pp. 355-356.

40. Ethell and Price, pp. 113, 134.

41. 25 August 1944 Memorandum,headquarters 2d Bombardment Division, Office of assistant Chief of Staff, "Enemy Jet Propelled Aircraft," (Microfilm Index 1957, Roll B 5065, Frame 694, AF History).

42. Jeffery L. Ethell, Komet: The Messerschmitt Me 163, p. 98. Ethell and Price, p. 116.

43. Ethell, Komet, p. 98. Jagdgeschwader 400 was the main Me 163 unit during the war.

44. Ethell and Price, p. 119.

45. Ibid., p. 118; Ziegler, pp. 70-71.

46. Ethell and Price, pp. 118-119.

47. Rust and Hess, p. 161.

48. Ibid.

49. Ethell, Komet, p. 98.

50. 9 July Memorandum, Headquarters 3d Bombardment Division to Commanding Officer, Each Group, 3d Bombardment Division, (Microfilm Index 1101, Roll B 5537, Frame 1098, AF History).

51. Ethell and Price, p. 126.

52. 10 August 1983 letter from Colonel Storm C. Rhode, USAF Ret.

53. Ethell and Price, p. 125.

54. Ibid.

55. Jeffrey L. Ethell, "Rocket Fighter, Pt. II," Airpower, p. 39.

56. 9 July 1944 memorandum, HQ 3d Bombardment Division, (Microfilm Index 1101, Roll B 5537, Frame 1098, AF History).

57. "Encounter Report Received from a P-51 Pilot -- 28 July 1944," (Microfilm Index 1957, Roll B 5065, Frame 706, Air History); Ethell and Price, p. 119; Roger A. Freeman, The Mighty Eighth, p. 184; Rust and Hess, p. 162. The first source is quoted verbatim. The others describe the same incident.

58. 9 July 1944 Memorandum, HQ 3d Bombardment Division, (Microfilm Index 1101, Roll B 5537, Frame 1098, AF History).

59. Mediterranean Allied Tactical Air Force, Periodic Technical Intelligence Note No. 27, "Me 163 Rocket Propelled

Fighter," (Microfilm Index 1888, Roll A 6115, Frames 407+, AF History).

60. Report of Encounters with Jet Propelled A/C, Operation of 16 August 1944, 359th Fighter Group on Escort, (Microfilm Index 1514, Roll B 5053, Frames 1043+, AF History).

61. Maloney and Feist, no page number.

62. "Encounter Report Received from a P-51 Pilot -- 28 July 1944," (Microfilm Index 1957, Roll B 5065, Frame 706, AF History).

63. Ethell and Price, p. 116.

64. Rust and Hess, p. 156. Rust and Hess describe the standard operating procedure for Me 163 pilots on interception courses. Due to the Komet's short endurance, the pilot climbed under power, glided to contact, intercepted under power, and glided to land. An observed disappearance of an Me 163 also possibly indicated that the Komet pilot had inadvertently lost all power. See Footnote 82.

65. Ethell, Komet, p. 98.

66. 9 July 1944 Memorandum, HQ 3d Bombardment Division, (Microfilm Index 1101, Roll B 5537, Frame 1098, AF History).

67. Report of Encounters with Jet Propelled A/C, Operation of 16 August 1944, (Microfilm Index 1514, Roll B 5053, Frames 1043+, AF History).

68. Ethell, "Rocket Fighter Pt. II," p. 39. Tacon, Murphy, and other airmen's mistaken identification appears to have been typical for Allied pilots in early encounters. Under the circumstances, incorrectly designating an Me 163 as jet-propelled was an insignificant error.

69. In the encounter reports studied, some airmen stated that the Me 163 closely resembled the provisional drawings shown by intelligence officers while others claimed that certain characteristics of the drawings were inaccurate. From the provisional drawings seen in intelligence reports on microfilm at the Office of Air Force History, the most notable difference between the actual aircraft and the early illustrations was in the configuration of the canopy. The rest of the aircraft, down to the small propeller for the generator, is relatively accurate.

70. Report of Encounters with Jet Propelled A/C, Operation of 16 August 1944, (Microfilm Index 1514, Roll B 5053, Frames 1043+, AF History).

71. 10 August 1983 letter from Colonel Storm C. Rhode, USAF, Ret.

72. Ethell and Price, p. 116.

73. "Encounter Report Received from a P-51 Pilot -- 28 July 1944," (Microfilm Index 1947, Roll B 5065, Frame 706, AF History).

74. Mediterranean Allied Tactical Air Force, Periodic Note No. 27, "Me 163 Rocket Propelled Fighter," (Microfilm Index 1888, Roll A 6115, Frames 407+, AF History).

75. Ethell and Price, p. 124.

76. Maloney and Feist, no page number.

77. Ethell and Price, p. 113; Ziegler, p. 11. Ziegler, on page 21, describes an incident in which a test pilot was badly burned by leaking fuel after a crash landing. See Ethell, Komet, p. 98, for test pilot Rudolf Opitz' recollection of the inadequacy of his flight suit.

78. Ethell and Price, p. 127-128.

79. Ibid., p. 109, Ziegler, p. 25.

80. Ziegler, pp. 85-86.

81. Freeman, p. 193.

82. Ethell and Price, pp. 115-116, 118. To prevent an improper mix ratio of the two elements of the rocket motor's fuel and a possible resultant explosion, the motor automatically cut off if either fuel stopped feeding into the motor. When the Me 163 levelled out after a climb, feed pipes from the fuel tanks were sometimes uncovered when the fuel shifted in its tanks and the rocket motor shut down. This may have sometimes been the cause of the disappearance of a vapor trail which Allied airmen observed when the Me 163 reached the top of its climb.

83. Ibid., p. 115.

84. Ibid., pp. 119, 134.

85. Ziegler, p. 85.

86. Ibid.

87. Ibid., p. 1.

88. Ibid., pp. 1-2.

89. Maloney and Feist, no page number; Ziegler, p. 16.

90. Ziegler, p. 3.

91. Ziegler, p. 126.

92. Ethell and Price, p. 119.

93. A 10 August letter from Colonel Storm C. Rhode, USAF, Ret. and Response to Questionnaire from (then) 2d Lt. Elmer W. Clarey, a co-pilot of a 492d Bombardment Group B-24J who saw an Me 163 and was "more or less on the lookout for one." He reported that he was quite surprised when he saw one but that since it was at a much lower altitude and flying as though circling for a landing, he felt that it would not attack his aircraft.

94. Ziegler, p. 144.

95. Ethell, "Rocket Fighter Pt. II," pp. 46-47; Jablonski, p. 106; Randell, p. 29.

96. See Maloney and Feist, no page number, for a brief account of tests done on the Me 163 in the United States after the war. They state that the "dangerous nature of rocket fuels and inability to get the spare parts prevented actual flight tests of the 'Komet' under power."

97. Ethell and Price, p. 39.

98. Boyne, p. 41; Ethell and Price, pp. 28-29; Rust and Hess, pp. 161-162; Combat Report from a 25 August 1944 Memo, Headquarters 2d Bombardment Division, "Enemy Jet Propelled Aircraft," entitled "Reported Interception of PRU Mosquito by Me 262," (Microfilm Index 1957, Roll B 5065, Frame 694, AF History). All of these above sources contain accounts of the 25 July 1944 incident.

99. Ethell and Price, p. 26. According to the authors, EK 262 operated from a base near Munich so it was most likely this unit which sent the Me 262 after the Mosquito.

100. Ibid., p. 29.

101. Bryce S. Walker and the editors of Time-Life Books, Fighting Jets, p. 18.

102. Walter J. Boyne and Donald S. Lopez, The Jet Age: Forty Years of Jet Aviation, p. 101.

103. Response to Questionnaire from (then) Capt. Arthur Juhlin. Juhlin included xeroxed copies of three pages of a diary which he kept during his tour of duty.

104. Ibid.

105. Response to Questionnaire from (then) 1st Lt. Ralph Trout.

106. Response to Questionnaire from (then) T/Sgt. C.V. Sochocki.

107. Response to Questionnaire from Elmer W. Clarey.

108. Response to Questionnaire from Ralph Trout.

109. Response to Questionnaire from (then) Capt. John Woolnough.

110. Response to Questionnaire from (then) 1st Lt. Robert Kirby.

111. 10 August 1983 letter from Colonel Storm C. Rhode, USAF, Ret.

112. Chaz Bowyer, Guns in the Sky, p. 119.

113. Response to Questionnaire from Arthur Juhlin.

114. Response to Questionnaire from C.V. Sochocki.

115. Ibid.

116. 10 August 1983 letter from Colonel Storm C. Rhode, USAF, Ret.

117. Response to Questionnaire from (then) S/Sgt. Robert Arnold.

118. 17 August 1944 Memorandum to Department of Intelligence, Office of Air Ministry, "Interception of South African Mosquito A/C by Me 262 in Munich Area," (Microfilm Index 1514, Roll B 5053, Frames 1040-1040, AF History); 20 September 1944 Information Intelligence Summary No. 44-29, "Jet-Propelled Aircraft -- A New Encounter," (Microfilm Index 2438, Roll A 1243, Frames 1522-1545, AF History). Both sources are used in the following account.

119. 17 August 1944 Memorandum to Department of Intelligence, Office of Air Ministry, (Microfilm Index 1514, Roll B 5053, Frames 1040-1040, AF History).

120. Boyne, p. 4.

121. Response to Questionnaire from (then) 1st Lt. Walter Konantz. Konantz included a copy of his Pilot's Personal Encounter Report of 13 January 1945.

122. 6 August 1983 letter from Lt. Col. McCauley Clark, USAF, Ret.

123. Special Intelligence Report No. 85, 22 December 1944, Headquarters 15th Air Force,, Office of Assistant Chief of Staff, A-2, "Jet propelled A/C Activity -- period 1-15 December 1944," (Microfilm Index 1836, Roll A 6543, Frames 665+, AF History).

124. 6 August 1983 letter from Lt. Col. McCauley Clark, USAF, Ret.

125. Response to Questionnaire from (then) Capt. John Brown.

126. Ibid.

127. Response to Questionnaire from (then) Lt. Claude A. Chinn.

128. Rust and Hess, p. 165.

129. 1 September 1983 letter from Jack Ilfrey.

130. 29 July 1983 letter from Elmer W. Clarey.

131. Response to Questionnaire from Robert Kirby.

132. 28 July 1983 letter from William A. Simpkins.

133. Ibid.

134. Response to Questionnaire from (then) Lt. Walter R. Groce.

135. 31 August 1983 letter from Urban L. Drew.

136. 6 February 1945 report from Air Intelligence Contact Unit, Headquarters AAF Redistribution Station No. 3, Santa Monica, California, (Microfilm Index 1756, Roll A 1274, Frame 1480, AF History).

137. 31 August 1983 letter from Urban L. Drew.

138. Stephen P. Grossman, "Messerschmitt's Deadly Hunter," Air Classics, p. 56.

139. 10 January 1945 letter from Carl Spaatz to Henry Arnold, (Microfilm Index 1757, Roll A 1260, Frame 520, AF History).

140. Eugene M. Emme, Hitler's Blitzbomber, p. 1.

141. 1 December 1944 Revised Brief of Paper on the Threat of German Jet-Propelled Aircraft to AAF Bombing addressed to General Arnold, (Microfilm Index 1517, Roll A 1260, Frame 510, AF History).

142. Ibid.

143. Emme, p. 40.

144. Response to Questionnaire from Ralph Trout.

145. 28 July 1983 letter from Ralph Trout.

146. Boyne and Lopez, eds., p. 101.

147. Response to Questionnaire from Walter Konantz.

148. 28 July 1983 letter from William A. Simpkins.

149. Response to Questionnaire from C.V. Sochocki.

150. 31 August 1983 letter from Urban L. Drew.

151. Ibid.

152. Galland, p. 326.

153. Ethell and Price, p. 12.

154. Galland, pp. 327-328.

155. Ibid., p. 333.

156. Walter Boyne, "Return of the Swallow," Wings, p. 28.

157. Boyne, Messerschmitt Me. 262, p. 52.

158. Emme, p. 40; Galland, p. 331. Arthur Harris is quoted by Emme as saying: "The enemy's jet-propelled fighters...were designed to use an inferior fuel to aviation petrol used by normal aircraft. Jet-propelled fighters would probably have been able to operate long after the rest of the German Air Force was grounded but as a result of stoppages and bottlenecks in the chemical industry and communications as a whole, even this fuel was in short supply."

159. Mizrahi, p. 55.

160. Ethell and Price, p. 59; Mizrahi, p. 55.

161. Ethell and Price, p. 60.

162. Ibid., p. 15.

163. Mizrahi, p. 55.

164. Ibid.

165. Boyne, Messerschmitt Me 262, p. 52.

166. Ethell and Price, pp. 26-28, 59.

167. Ibid., p. 26.

168. US Strategic Air Forces in Europe Air intelligence Summary No. 53, Week Ending 12 November 1944, (Microfilm Index 2042, Roll A 5724, Frame 80, AF History); Informational Intelligence Summary No. 44-35, 30 November 1944, (Microfilm Index 2438, Roll A 1243, Frames 1544+). The first source states: "Operations of 6 November 1944. Reports from fighter pilots bear out previous

encounter reports -- jet's very wide flat turns, apparent aversion to climbing turns, notable aversion to steep dives..." The second source reads: "One encounter...revealed that the jet was superior to the P-47 on the level or in shallow dive...the German pilot appeared to be averse to steep or vertical dive."

169. Editors of Time-Life Books, The Luftwaffe, p. 98.

170. Ethell and Price, pp. 34-37, 50-52. The authors describe in detail the problems of the Me 262 pilot training program which are briefly mentioned in the following paragraph.

171. Ethell and Price, p. 31; Mizrahi, p. 55.

172. Ethell and Price, p. 63.

173. Ibid., p. 64.

175. Response to Questionnaire from John Brown.

175. Intelligence Summary No. 45-8, 30 April 1945, Headquarters AAF, (Microfilm Index 2438, Roll 1243, Frames 1544+, AF History).

176. Response to Questionnaire from Julian Roadman.

177. Ethell and Price, pg. 31, Mizrahi, p. 55, Rust and Hess, p. 174. As pointed out by Ethell and Price, the Me 262 airfields were made of concrete instead of asphalt which could catch fire from the Me 262's jet engines. The concrete runways were also very long to accommodate the takeoff and landing distances of the jet. For these reasons, the Me 262 airstrips were quite conspicuous and therefore vulnerable to Allied air attacks. In place of concrete airfields, autobahns were actually used toward the end of the war for Me 262 operations.

178. This aircraft was the Gloster Meteor, used operationally by the Royal Air Force beginning in the summer of 1944 to destroy V-1 rockets over England. Meteors flew missions over the European mainland in 1945 but never encountered Me 262s. See Boyne, Messerschmitt Me 262, pp. 133-134. Several respondents to the research questionnaire reported that the first jets they saw were British. Robert Kirby wrote: "No one was too well acquainted with jets or even how they operated. We could see an English jet or two on the ground or tailing off occasionally on our way back from a mission at restricted base in East Anglia." In an 18 August 1983 telephone conversation, Glen Hall, a P-51 pilot in the US 20th Fighter Group, reported that the first jet he saw was a Gloster Meteor in England, which he described as a "good looking plane." He also remembered that he had never heard of jets.

Bibliography of Sources for Case Study on Jets and Rocket-Propelled Aircraft

A Note on Sources

In addition to the secondary sources two other sources were used in research for this case study.

1. Microfilm of documents, reports, letters, memoranda, etc., from the Office of Air Force History, Bolling Air Force Base, Washington, D.C., were consulted. These are listed by their titles in the footnotes with their Index, Roll, and Frame numbers in parentheses.

2. Letters and questionnaire responses from USAAF veterans. These were invaluable for this case study. Some respondents sent both a letter and an answered questionnaire. Following is a list, alphabetically arranged and divided into groups of fighter pilots and bomber crewmen.

Fighter Pilots

Name	Reported Date of Incident	Group	Rank at Time
John K. Brown	10 April 1945	20th Fighter	Captain
Claude A. Chinn	August 1944	56th Fighter	Lieutenant
H.E. Comstock	1 November 1944	56th Fighter	Major
McCauley Clark	ca. November 1944	55th Fighter	Unknown
Urban L. Drew	7 October 1944*	361st Fighter	1st Lieutenant
Walter R. Groce	1 November 1944	56th Fighter	Lieutenant
Jack Ilfrey	August 1944	20th Fighter	Unknown
Walter J. Konantz	13 January 1945	55th Fighter	1st Lieutenant
William A. Simpkins	Unknown	373d Fighter	Unknown

*Urban Drew's date of first encounter was not given. 7 October 1944 was the date of his victory over two Me 262s.

Bomber Pilots

Name	Reported Date of Incident	Group	Rank at Time	Position
Robert Glenn Arnold	1944-45	486th Bombardment	Staff Sergeant	Waist Gunner
Elmer W. Clarey	July or August 1944	492d Bombardment	2d Lieutenant	Co-pilot
Jacob L. Grimm	22 March 1954	483d Bombardment	Unknown	Unknown
Arthur Juhlin	24 and 31 Dec. 1944	100th Bombardment	Captain	Navigator
Robert E. Kirby	21 March 1945	100th Bombardment	1st Lieutenant	Navigator
Wallace Wayne Patton	1 April 1945	445th Bombardment	Sergeant	Left Waist Gunner
Storm C. Rhode	Late fall 944 - April 1945	100th Bombardment	Unknown	Navigator/ Bombardier
Julian A. Roadman	October 1944 - February 1945	401st Bombardment	Unknown	Pilot
Ralph W. Trout	6 December 1944	401st Bombardment	1st Lieutenant	Co-pilot
John H. Woolnough	1 November 1944	466th Bombardment	Captain	Pilot

Printed Secondary Sources

The Air Ministry (A.C.A.S.(I)) The Rise and Fall of the German Air Force (1933-1945), Air Ministry Pamphlet No. 248. N.p., 1948.

Andrews, Phillip. "The Last Days of the Luftwaffe." Air News with Air Tech, v. 9, no. 6, December 1945, pp. 17-24.

Barker, Ralph and editors of Time-Life Books. The RAF at War. Alexandria, Va.: Time-Life Books, 1981.

Bowyer, Chaz. Guns in the Sky: The Air Gunners of World War Two. New York: Charles Scribner's Sons, 1979.

Boyne, Walter J. Messerschmitt Me 262: Arrow to the Future. Washington, D.C.: Smithsonian Institution Press, 1980.

_____. "Return of the Swallow." Wings, v. 10, no. 2, April 1980, pp. 14-29, 42-51.

_____ and Donald S. Lopez (eds.). The Jet Age: Forty Years of Jet Aviation. Washington, D.C.: Smithsonian Institution Press, 1979.

Carson, Leonard. "War Against the Jets, Part IV, The Last of the Breed." Wings, v. 6, no. 2, April 1976, pp. 26-36, 54.

Craven, Wesley Frank, and James Lea Cate. The Army Air Forces in World War II, Vol. Six, Men and Planes. Chicago: The University of Chicago Press, 1955.

Davis, Albert H. (ed.) The 56th Fighter Group in World War II. Washington, D.C.: Infantry Journal Press, 1948.

Dierich, Wolfgang. Kampfgeschwader "Edelweiss": The History of a German Bomber Unit, 1939-1945. London: Ian Allan, Ltd., 1975.

Editors of Time-Life Books. The Luftwaffe. Alexandria, Va.: Time-Life Books, 1982.

Emme, Eugene. Hitler's Blitzbomber: Historical Notes on High Command Decisions Influencing the Tardy Operational Use of the Me-262 in German Air Defenses. Maxwell Air Force Base, Alabama: Documentary Research Division, Research Studies Institute, Air University, December 1951.

Ethell, Jeffrey. Komet: the Messerschmitt Me 163. New York: Sky Boo Press, 1978.

_____. "Rocket Fighter, Pt. II." Airpower, v. 7, no. 3, May 1977, pp. 38-49, 64-65.

_____ and Alfred Price. The German Jets in Combat. London: Jane's Publishing Co., 1979.

Ford, Robert T., 1st Lt., Air Corps. Interim Report No. 1 on Me 163, Report No. F-IM-112A-ND. Dayton, Ohio: Headquarters Air Materiel Command, Wright Field, 14 May 1946.

Freeman, Roger A. The Mighty Eighth: Units, Men and Machines (A History of the US 8th Army Air Force). Garden City, NY: Doubleday and Co., 1970.

Galland, Adolf (Mervyn Savill trans.). The First and the Last: The German Fighter Force in World War II. New York: Henry Holt, 1954.

Girbig, W[illegible]ner. Six Months to Oblivion: The Eclipse of the Luftwaffe Fighter Force. New York: Hippocrene Books, Inc., 1975.

Grossman, Stephen P. "Messerschmitts Deadly Hunter." Air Classics, v. 5, no. 5, June 1969, pp. 50-61.

Hirsch, Robert S. and Uwe Feist. Messerschmitt 262. Fallbrook, Calif.: Aero Publishers Inc., 1967.

Jablonski, Edward. Air War: Wings of Fire. Garden City, NY: Doubleday and Co., Inc., 1971.

_____, and the editors of Time-Life Books. America in the Air War. Alexandria, Va.: Time-Life Books, 1982.

Maloney, Edward T. and Uwe Feist. Messerschmitt 163. Fallbrook, Calif.: Aero Publishers Inc., 1968.

Merrick, Kenneth A. Messerschmitt Me 262 Described, Pts. 1 and 2. Victoria, Australia: Kookaburra Technical Publications, 1969.

Mizrahi, Joseph V. "Defending the Reich, Pt.1, Intercepting the American Bomber Streams." Airpower, v. 5, no. 5, September 1975, pp. 22-37, 54-55.

Nelsson, John R. The Story of the Century. N.p., 1946.

Nowarra, Heinz J. "Politics and Airpower." Flying, May 1955, pp. 32-34, 66.

Olmstead, Merle C. The Yoxford Boys: The 357th Fighter Group on Escort over Europe and Russia. Fallbrook, Calif.: Aero Publishers, Inc., 1971.

Randell, Robert W. (As told to him by Rudolf Opitz in a series of interviews). "Developing a Rocket Fighter." Flying Review International, v. 21, no. 1, September 1965, pp. 27-29.

Rust, Kenn and William N. Hess. "The German Jets and the U.S. Army Air Force." American Aviation and Historical Society Journal, v. 8, no. 3, Fall 1963, pp. 155-84.

Sims, Edward H. The Fighter Pilots: A Comparative Study of the Royal Air Force, the Luftwaffe and the United States Army Air Force in Europe and North Africa 1939-1945. London: Cassel & Co., Ltd., 1967.

Smith, Hugh. "Jet Aircraft of World War 2." Air Power Historian, v. 9, no. 3, July 1962, pp. 166-172.

Taylor, Edward Story. "Aircraft Propulsion." Encyclopedia Britannica, v. 1, 1966.

Walker, Bryce S., and the editors of Time-Life Books. Fighting Jets. Alexandria, Va.: Time-Life Books, 1983.

Wendel, Fritz. "I Tested Messerschmitts." RAF Flying Review, November 1955, pp. 15-18, 27.

Ziegler, Mano. Rocket Fighter: The Story of the Messerschmitt ME 163. Trans. Alexander Vanags. London: Arms and Armor Press, 1976.

Annex to Jets and Rocket-Propelled Aircraft Case Study

QUESTIONNAIRE FOR AIRMAN'S REACTION DURING FIRST ENCOUNTER WITH GERMAN JET- OR ROCKET- POWERED AIRCRAFT

1. Date of Incident (Month and Year if exact date is not known):
2. Name:
3. Rank:
4. Unit (Squadron, Group, Air Force):
5. Type of Aircraft Flown During Encounter:
6. Position on Aircraft (If Bomber):
7. Type of German Aircraft Encountered:
8. Brief Description of Circumstances at Time of Encounter (Type of Mission, Location, Unusual Weather Conditions, etc.):

9. Describe Your Reaction:

The Proximity Fuze

Introduction

The proximity fuze (VT or POZIT fuze) was developed in order to increase the lethality of standard antipersonnel artillery fire and to improve the hit ratio of standard antiaircraft fire. As an antipersonnel artillery shell, the proximity fuze round was designed to attain greater precision in the height of air bursts above the target than could be attained by existing fuzing. Antipersonnel shells that burst in the air have greater lethality than shells that explode on impact, since with impact detonation a significant percentage of the shell fragments go into the ground, and any obstruction -- even an undulation in the terrain -- can offer troops protection and can reduce the shell's effectiveness, while air bursts can rain shell fragments directly down on personnel, even if they are in trenches.

Before the development of the proximity fuze there were two basic types of artillery fuzes that could be used to achieve an air burst: the time fuze and the delay fuze. Unlike the impact or quick fuze, which detonated on making contact with the target, the time fuze was set to detonate at a specific time after firing. The delay fuze was set to detonate at a specific time after impact. Unfortunately, from the artilleryman's perspective, to achieve an effective air burst with either the time fuze or the delay fuze required a highly skilled artilleryman. Careful calculations and adjustments were necessary to make the time fuze detonate when the shell was over the target and the desired height above it. It was at least as difficult to use the delay fuze to achieve an air burst. In the first place, the terrain had to be suitable -- gently rolling -- in order to get a shell to ricochet so that it reached the desired height in the target area at the moment the delay fuze detonated. With either of these methods an outstanding artilleryman could fire, at best, only three air bursts out of four rounds fired.

The proximity fuze solved the problem of attaining consistently accurate air bursts in antipersonnel artillery fire. This was achieved by a small radar set (advanced models were less than ten inches long) placed inside the nose of an artillery shell; the proximity fuze would emit radio waves, pick up their reflection from the object targeted, and detonate the shell within 20 to 55 feet of that target, showering lethal fragments on the target area.(1)

The proximity fuze thus made it possible for an ordinary soldier to achieve an air burst four out of four times, while highly skilled artillerymen could previously achieve air bursts only three out of four times. The result was, in effect, a new and much more lethal antipersonnel weapon.

Since HERO judged the proximity fuze to be a distinctly new weapon, since it was used against military personnel, and since it was introduced in World War II and thus would provide

chronological variety to the current study, the HERO research team believed it would be a good subject for a case study. Unfortunately, there is a scarcity of readily available data. For example, most of the German records from the Ardennes Counteroffensive, where the proximity fuze was first employed, were destroyed. Also, time constraints precluded making an in-depth exploration of the psychological impact of the proximity fuze.

Military Impact of the Proximity Fuze

The proximity fuze was used with antiaircraft shells in the Pacific theater to help repulse Japanese air attacks in 1943, and it was also employed in an air defense capacity during 1943-1944 in Europe. However, it was not employed by the field artillery in support of ground troops until December 1944 during the German Ardennes Counteroffensive (the Battle of the Bulge). Without doubt, the proximity fuze was tactically effective at the Bulge. Just how effective is debatable. General George S. Patton was reportedly so impressed with the role the proximity fuze played in helping to repel the German offensive that he reputedly said, "The new shell with the funny fuze is devastating ... I think when all armies get this fuze, we shall have to devise some new method of warfare."(2) In a similar vein the scientist Vannevar Bush, in his highly regarded book Modern Arms and Free Men, wrote, "the proximity fuze may well have saved Liege."(3)

Conversely, Hugh Cole, author of the US Army's official history of the Battle of the Bulge, relying on the "rigorous analysis" of Royce Thompson in a manuscript Thompson prepared for the Office of the Chief of Military History, concludes that "postwar claims as to the value of the... VT fuze in halting the German advance are grossly exaggerated."(4) Cole does not deny the proximity fuze's effectiveness, but he does take issue with the claim that it was a decisive, if not the decisive, factor in stemming the German advance. Cole points out that the weapon was not used until the sixth day of the battle and was used only in isolated instances; therefore it could not have been decisive in blunting the German offensive.

The first reported use of the new fuze was on 21 December 1944 during a German attack on a US position at Malmedy by Lt. Col. Otto Skorzeny's 150th Panzer Brigade. One of Skorzeny's attack groups, composed of two rifle companies and a tank company, was advancing to the attack in column along a secondary road when minefields forced it to halt in front of B Company, 99th Infantry Battalion. Intense fire from mortars, machine guns, and artillery repulsed the attack; the artillery rounds had the new fuze. Hugh Cole describes its impact:

> Here, on the first day of use of the new POZIT, the Germans were roughly dealt with. Nearly a hundred were killed by the shellbursts and for a moment panic spread among them, some running forward into the fire shouting "Kamerad." But Skorzeny's troops were tough and tried

> repeatedly to break [the American defenders.] German machine gun crews tried to set up their pieces right in front of the railroad embankment where B Company lay but were shot down or blasted by hand grenades. Several times the enemy infantry reached the foot of the embankment, but could go no further. Finally the assault died down.(5)

Thus the initial use of the proximity fuze proved to be tactically effective, although by no means decisive.

Two days later the 113th Field Artillery employed the proximity fuze in support of an American attack on elements of the 1st SS Panzer Division holding La Gleize. Intense artillery fire, its effectiveness increased by the use of the proximity fuze, drove the German defenders into the cellars of La Gleize. However, the new artillery round could not knock out the deeply dug in tanks and antitank guns, nor did it induce sufficient fear in the German tank and gun crews (once they were dug in) to drive them from their positions. The fact that German infantrymen were forced to take cover in the cellars of La Gleize indicates that the fuze was tactically effective.(6) Although seeking cover in cellars may be indicative of fear, it is an appropriate reaction for infantrymen who are under intense artillery fire. This reaction coupled with the staying power of the troops in the armored vehicles and manning the antitank guns, suggests that the soldiers deployed at La Gleize may have assimilated the effects of the proximity fuze.

Cole cites another incident in which the proximity fuze was used effectively in support of ground operations during the Ardennes Campaign. On 26 December 1944, after elements of the 3d Battalion, US 10th Infantry Regiment and supporting armor had gained a ridge overlooking the Sauer River at the town of Echternach, a number of concentrations of proximity fuzed artillery shells were fired at German troops attempting to escape across the river. The shells burst at a height of 30 feet with devastating effect upon the fleeing German troops. However, despite heavy casualties, they continued to use the river retreat route.(7) The psychological impact of the proximity fuze upon these German troops does not appear to have been more significant than would have been the case with standard fuzed rounds, even though these were unquestionably more lethal.

The incidents we have examined from the official US Army history suggest that the proximity fuze evoked no more terror than would have been created by standard artillery fuzed rounds. But, according to official ordnance reports, prisoners of war taken at the Battle of the Bulge were "unanimous in characterizing our artillery fire as the most demoralizing and destructive ever encountered."(8) On at least one occasion German prisoners reported that German soldiers had been executed for failing to obey orders to go on patrol, because they feared they would be subjected to fire from air burst shells.(9) These reports are significant, since they do suggest that these German troops apparently did realize that they were facing a new weapon

or firing mechanism.

Yet another incident involving the effective employment of proximity fuzed shells in the Bulge battle suggests that -- for the most part -- the Germans did not realize that a new weapon was being employed against them. In this incident, also recounted in an official US ordnance report, the crews of six German tanks got out of their vehicle at the edge of a wooded area to bivouac for the night. These Germans were observed by US artillery observers who called for fire on them from 155mm guns. Time on target salvos were fired using proximity fuzed shells. The results of these concentrations were impressive. When US troops occupied the area on the following morning they noted that fragments from the shells had penetrated the thin armor of the tanks' turret tops and horizontal surfaces and knocked them out. Many of the tanks' crewmen had been killed, and the survivors, including the unit's CO, were still dazed. Upon interrogation, the German commander attributed the destruction of his unit to "super quick" fuzed shells, that is, shells fuzed to detonate immediately on impact with the target -- not air burst.(10)

The same US ordnance report also relates that Germans captured in the Bulge battle stated that on many occasions German units were hit by "unseen fire," which the report attributes to the proximity fuze.(11) The report does not explain what the German prisoners of war meant by unseen fire. It suggests, however, that a substantial psychological advantage was achieved by being able to place air bursts over the German troops without prior adjustment. One captured German officer offered corroborating testimony by stating that there was greater surprise among those in his unit when they were hit by the new artillery round than there had been when they were hit by other types of artillery rounds.(12) This also suggests that at least some Germans did realize that they were receiving fire from a new artillery munition. In the words of strategic theorist J.F.C. Fuller, "...the most potent of moral 'weapons' is surprise. The interplay between [moral and physical weapons] forms the backbone of the attack."(13)

The official report of the Chief of Ordnance on the effectiveness of the proximity fuze illustrates the validity of Fuller's comments.

> POW from 4th Paratroop Regiment, 1st Paratroop Division, states with regard to VT fuze shells: "The Allied artillery has been shelling our positions of late with a new type of airburst shell. I am referring to a shell with heavy splinter effect, which bursts 10 to 20 meters above the ground. These shells have a tremendous initial velocity, and due to this fact, we cannot hear their approach. This makes them particularly dangerous, since we can detect these shells only at the very moment of their burst and then we do not have time to look for cover. Even if we take cover in our foxholes, we are not protected against these deadly shells, since the fragments are falling densely and hit the

point of impact with an extraordinary power of penetration. We are surprised again and again at the accuracy of fire obtained with these shells..."

Other PW's corroborate the fact that approach of this projectile cannot be heard, and specify that the velocity and accuracy of this type of ammunition is causing great confusion in the German lines and an increased feeling of insecurity in the individual front line soldier, who realizes that no amount of caution can protect him from these shells.(14)

These accounts suggest that the proximity fuze did have considerable psychological impact and that its precision air burst had an adverse psychological effect upon the German combat troops. Moreover, the accounts indicate that a number of German troops did attribute the precision air bursts to a new shell. The German prisoners' comments on the velocity and silence of the shells are puzzling, since the shells actually differed from standard artillery rounds from the same guns only in their fuze and the consistent air bursts it produced. It seems likely that the Germans, accustomed to several ground bursts during the American artillery adjustments for time-fuzed air bursts, were surprised to receive air bursts without prior adjustment, and this surprise led them to an incorrect perception that the rounds had arrived with extraordinary speed and silence.

American reports seem to suggest that employment of the proximity fuze had a tactical effect that had psychological results by destroying telephone lines and disrupting telephone or signal communication.(15) This must be considered doubtful, since any artillery fire had similar effects.

A HERO researcher had private conversations with a number of American veterans of the German Ardennes Counteroffensive who had experience with the proximity fuze.

These veterans were in agreement that the proximity fuze had a psychological impact upon both the German troops who came under fire from this type of munition and upon the American troops who received the benefit of fire from it.

One such veteran was Charles Sweitzer, who was at Malmedy on 21 December when the proximity fuze was first used. Sweitzer states that the German troops who came under fire from the proximity fuze round appeared to be completely disoriented. Artillerymen in that sector told him that the German troops "did not know whether to go right or left, dig holes, go up in the trees. It shook them up. It completely destroyed their mentality as to what they should do."(16) That the German troops were so paralyzed mentally that they froze and were unable to decide how to seek cover suggests abnormal fear. However, it should be emphasized that Sweitzer did not say that he saw the panic of the German soldiers but rather that he was told about it by US artillerymen.

Neal Batterman, a former artillery sergeant, who was a section commander in a 105mm howitzer battalion, told HERO that on the first and only occasion that he fired the proximity fuze round it had a terrifying effect upon the German troops who were attacking US positions. Batterman remembers "many of the Germans tried to run and get behind trees," rather than hit the ground. The proximity fuze broke up the attack immediately, said Batterman.(17) There must be considerable doubt, however, if Batterman observed this personally, since his gun position was almost certainly never so located that there was intervisibility between gun and target. Presumably he was reporting what he learned from observers. However, it does suggest that on this occasion the proximity fuze did induce panic that contributed significantly to its tactical effectiveness. It must also be doubted whether or not the experience Batterman recounted (second-hand) was a first-time experience for the German troops who received fire from proximity fuze shells. Batterman says that the incident took place sometime between 18 December and 24 December. This time frame suggests that the incident could have been a first-time exprience for the German soldiers involved.(18) One thing is certain: Batterman was elated about the new munition, and he indicated that other US combat soldiers had similar emotions.

Another Ardennes veteran, Norman Sue, was able to discuss the fuze with a captured German SS officer who spoke English. The SS officer told him that the new munition being employed by the US artillery had a terrifying effect on the German front-line soldiers.(19) Like the incident in which the German troopers were executed for refusing to go on patrol because of fear of the proximity fuze, Sue's account suggests that at least some German troops recognized that this was a new and extremely lethal weapon, and that the terror this recognition inspired remained after their initial experience with it.

The account of another Bulge veteran, Marshall E. Martin, offered even more convincing testimony as to the continuing adverse psychological impact of the fuze on German combat troops during the Ardennes battle. Martin was an infantryman who was captured by the Germans on 24 December 1944. He is convinced that the proximity fuze played havoc with the German troops and disoriented them. He is of this opinion because when he was interrogated by his captors all of the questions that he remembers being asked concerned the new artillery munition that the Americans were employing.(20)

In the Pacific Theater there is also evidence of the proximity fuze's tactical effectiveness as an antipersonnel weapon in ground combat and of its psychological impact upon combat troops. There is, however, less such evidence than in the European theater, and for good reason. As Ralph Baldwin points out in his book on the proximity fuze:

> The VT fuze for field artillery is most effective in a war of movement where the enemy has not had an opportunity to

dig in or otherwise protect himself. The Japanese had well-prepared concrete fortifications on all of the smaller islands.(21)

Nonetheless, there are examples of effective use of the fuze in an antipersonnel capacity in the Pacific. In the Philippines on 19 June 1945 in the Aritao Region some 250 Japanese troops were sighted in the open on a trail. Artillerymen from the 1st Field Artillery Battalion, 6th Infantry Division, fired proximity fuzed rounds at the Japanese troops with devastating results. Following the artillery fire US infantrymen caught up with the Japanese and took 40 prisoners. Heavy Japanese casualties were reported, and the Japanese POWs attributed most of the casualties to fire from the proximity fuzed artillery shells. This episode certainly demonstrates the lethality of the proximity fuze but does not suggest that it necessarily broke the Japanese troops' will to resist. However, the official ordnance report states that US troops overran the Japanese after the artillery fire ended. The 40 survivors were uninjured from the artillery fire and yet were overtaken and surrendered.(22) These facts suggest that the survivors were too dazed to put up much of a fight. especially in light of the fact that Japanese troops did not often surrender. Thus, it appears that the proximity fuze destroyed the combat effectiveness of the unit while simultaneously smashing the will to resist of the surviving Japanese soldiers.

It is important to note that Japanese troops did not often surrender, since surrender, in the Japanese warrior code, meant personal and family disgrace. Thus, in this case, it is conceivable that the effective employment of the proximity fuzed shells not only broke the combat effectiveness of the uninjured survivors of the shelling but also induced behavior that was unusual and strongly sanctioned by Japanese culture.

The proximity fuzed shell was also used effectively on Okinawa, both for interdiction and as an antipersonnel weapon. But the Japanese made excellent use of the rugged terrain to construct a formidable defense system which limited the effectiveness of the proximity fuze. Moreover, the fuze's effectiveness was further limited because much of the US supply of proximity fuze shells was lost before it could be delivered to the beachhead from transport ships. The problem of effective use of the proximity fuze was further exacerbated by the fact that a large number of the 105mm howitzer shells armed with proximity fuzes were defective (or the fuzes were defective), causing a number of premature air bursts and consequent US casualties. Because of this misfortune the US infantrymen's morale suffered, and their confidence in artillery support temporarily waned.(23) Thus, unlike the Ardennes Campaign, early use of the proximity fuze on Okinawa had a negative psychological effect on US combat troops.

Summary

The VT Fuze was a technological improvement in artillery fuzing of considerable significance, which enhanced the effectiveness and lethality of standard HE artillery shells. The principal improvement was in the ability to achieve consistent air bursts of optimum effectiveness. Surprise fire was more a possibility with the VT fuze, since the number of rounds and amount of time needed to adjust fire were minimized. Shells fuzed in this manner, then, were highly effective against troops in the open and somewhat more effective against troops dug in without overhead protection than were time fuzed shells.

VT fuzed shells were first employed in ground combat by US troops during the Battle of the Bulge (December 1944-January 1945) and proved to be a valuable tactical asset. However, there is no basis for the relatively common assumption (especially prevalent in secondary sources) that their use turned the tide of battle in favor of the Allies.

There is a scarcity of reliable first-hand evidence describing the psychological reactions of troops using the VT fuze and troops subjected to its effects. Secondary, derivative, and hearsay sources for the most part (as noted above) exaggerate the effects of VT fuzed shells.

On the basis of secondary sources and interviews with US veterans of the Battle of the Bulge it would appear that American troops who knew of and understood the fuze's potential were impressed by it technically (and professionally). There are also indications that the fuze was a morale booster.

The reactions of German troops to fire from VT fuzed shells have been gleaned from PW reports and the impressions of American observers at the time. The US Army official history of the Ardennes Campaign indicates that the first use of the VT fuze in the Battle of the Bulge may have evoked a panic reaction in veteran German troops because of its surprise effect without prior adjustment. However, that account, and the records of other incidents, suggest that German troops adjusted to the new weapon quite quickly. German PWs who had been subjected to the fire of VT fuzed shells appear either not to have known a new weapon was being used against them -- in which case the predominant reaction was surprise at the effectiveness of the fire received -- or to have guessed that a new, more effective weapon was being used -- in which case the predominant reaction was insecurity and confusion.

The one incident discovered involving Japanese troops took place in the Philippines in 1945. In this case the uninjured Japanese survivors of a shelling with VT fuzed projectiles manifested behavior that was unusual by Japanese standards. Without further evidence, however, it would be impossible to analyze this incident beyond stating that in this case the weapon appears to have produced a profound psychological effect.

Notes to Case Study on Proximity Fuze

1. Ralph B. Baldwin, The Deadly Fuze: Secret Weapon of World War II (San Rafael, California: Presidio Press, 1980), pp. 24, 25, 183.

2. Cited in Curt Johnson, Artillery (London: Octopus Books, Limited, 1975), p. 109.

3. Vannevar Bush, Modern Arms and Free Men: A Discussion of the Role of Science in Preserving Democracy (New York: Simon and Shuster, 1949), p. 31.

4. Hugh M. Cole, The Ardennes: Battle of the Bulge. United States Army in World War II. The European Theater of Operations. (Washington, D.C.: Government Printing Office, 1965) p. 656.

5. Ibid., p. 361.

6. Ibid., p. 375.

7. Ibid.,p. 504; see also p. 501.

8. US Army, Office, Chief of Ordnance, Research and Development Service, Ammunition Development Division, The Story of Army VT Artillery Fuzes, 20 September 1945, cited in Baldwin, p. 280. It should be noted, however, that German troops captured in North Africa in 1943 and in Italy in 1943 and 1944 had made similar statements about American artillery fire at that time, without VT fuzing.

9. US Army Ordnance Department,The VT Fuze in Action, 1946, cited in Baldwin, p. 287.

10. The Story of Army VT Artillery Fuzes cited in Baldwin, p. 282.

11. Ibid.

12. Comments of German POW cited in Baldwin, p. 284.

13. The Foundations of the Science of War (London: Hutchinson and Co. Ltd., 1926), p. 276.

14. German POW interrogations from US Army Intelligence Report, 17 March 1945, cited in Baldwin, p. 286.

15. Ibid., p. 284.

16. Charles Sweitzer, private conversation with Gay Hammerman, 18 December 1982, at the Veterans of the Battle of the Bulge Convention.

17. Neal Batterman, private conversation with Gay Hammerman, 18 December 1982.

18. Ibid.

19. Norman Sue, private conversation with Gay Hammerman, 18 December, 1982.

20. Marshall E. Martin, private conversation with Gay Hammerman, 18 December, 1982.

21. Baldwin, p. 246.

22. Ibid., p. 247.

23. US National Archives, Record Group 407, File 224-0.3 - 0.10, XXIV Corps, Operations Report, Ryukyus Campaign, p. 42.

Bibliography of Sources for Case Study on the Proximity Fuze

Books

Baldwin, Ralph. The Deadly Fuze: Secret Weapon of World War II. San Rafael, California: Presidio Press, 1980.

Bush, Vannevar. Modern Arms and Free Men: A Discussion of the Role of Science in Preserving Democracy. New York: Simon and Shuster, 1949.

Cole, Hugh M. The Ardennes: Battle of the Bulge. The European Theater of Operations.United States Army in World War II. Washington: Government Printing Office, 1965.

Fuller, J.F.C. The Foundations of the Science of War. London: Hutchinson, 1926.

Johnson, Curt. Artillery. London: Octopus Books, 1975.

Private Conversations

Martin, Marshall E. Private conversation with Gay Hammerman. 18 December 1982, Veterans of the Battle of the Bulge convention, Arlington, Va.

Sue, Norman. Private conversation with Gay Hammerman. 18 December 1982, Veterans of the Battle of the Bulge convention, Arlington, Va.

Sweitzer, Charles. Private conversation with Gay Hammerman. 18 December 1982, Veterans of the Battle of the Bulge convention, Arlington, Va.

Operational Records

US National Archives [Federal Records Center, Suitland, Md.]. Record Group 407. File 224-0.3 - 0.10, XXIV Corps, Operations Report, Ryukyus Campaign.

Improved Munitions Technologies in the Vietnam War

Introduction

Two new types of conventional artillery ammunition, originally developed for use by US troops in the event of war with the Soviet Union and Warsaw Pact in Europe, were first used in combat by US forces during the Vietnam War. Previously, knowledge of the existence and nature of these improved munitions technologies was classified, and distribution of the munitions to units in the field in Europe was limited. However, after much deliberation, the Department of Defense decided to permit distribution of the less advanced types to units in Vietnam for use in emergencies, such as when a fire base or landing zone was in imminent danger of being overrun by enemy troops. Principally because of the tight security surrounding the development and distribution of these munitions, when they were first employed in combat their effects came as a surprise to both US troops and the enemy.

The two new types of artillery munitions first used in combat in Vietnam were the XM-546 Antipersonnel Projectile, called the "Beehive round," and the ICM (Improved Conventional Munition) projectile, also an antipersonnel round.(1) These munitions have been selected for a case study because of the surprise engendered by their first use, and because each represents an important advance in lethality over previously employed similar conventional antipersonnel artillery munitions.

The Beehive round, which is essentially a development and improvement of earlier canister type rounds, is a direct fire defensive antipersonnel projectile designed to be fired from the 105mm howitzer at a muzzle velocity of 549 m/s in a horizontal trajectory; its canister is filled with 8,500 steel flechettes. The Beehive round is detonated in flight by a time fuze, and the flechettes fan out in a shotgun-like effect.(2)

The ICM round is a grenade-filled base-ejection projectile with a mechanical time fuze. The body assembly contains many grenade sub-munitions. ICM rounds are provided for 105mm, 155mm, and 8-inch howitzers. The 105mm howitzer shell contains 18 grenades; the 155mm shell has 60 grenades; and the 8-inch shell houses 104 grenades. The time fuze is designed to detonate the shell above the ground at adjusted height of burst increments of 50 meters. A base ejection charge then expels the grenade sub-munitions, which scatter in the target area. Following expulsion from the shell, the grenades are stabilized in flight by small vanes which flip upward and arm the grenades. When the grenade strikes the ground a striker plate on its bottom hurls it back into the air, where it detonates at a height of five-six feet.(3)

The first combat uses of these improved conventional munition technologies are discussed below.

Combat Use of the Beehive Round

The Beehive round was first used in combat on 7 November 1966 in defense of the position area of A Battery, 2d Battalion, 320th Field Artillery, in the vicinity of Phan Rang, 260 kilometers northeast of Saigon. At that time the 2d Battalion, 320th Field Artillery was attached to the 1st Brigade, 101st Airborne Division. The circumstances of this first combat use of the Beehive round were as follows.

A North Vietnamese Army (NVA) raiding party overran an infantry listening post and penetrated A Battery's position area. There were 40 or 50 attackers, armed with automatic weapons, recoilless rifles, and 60mm mortars. In the close combat that ensued one US soldier was killed and six were wounded before the attackers were repulsed. The "key factor in stopping the attack," according to the duty officer's log, was the firing of a single Beehive round into the enemy troops. The round killed seven to nine of the enemy, and the survivors fled.(4) The fact that a single round repulsed the attack suggests that the munition was psychologically intimidating.

The Beehive munition was again used by US forces less than two months later, this time to repulse an NVA attack on Landing Zone (LZ) Bird, a US forward base located northeast of Saigon, some 50 kilometers north of Qui Nhon, which was used as a base for quick-hitting forays into the Kim Son and Soui Ca valleys.

The late S.L.A. Marshall, in his book, Bird, gives a detailed account of this particular action. Following his usual procedure, Marshall conducted after-action interviews with many of the US troops who participated in the defense of LZ Bird. Based upon these interviews, Marshall was able to reconstruct in detail the events of the combat. Marshall's book, the most complete source for the events of the defense of LZ Bird, is the principal basis for the following reconstruction.

Shortly after midnight on the night of 25/26 December 1966 elements of the 22d Regiment launched a two-pronged surprise attack against LZ Bird, which was defended by Company C, 2d Battalion, 12th Cavalry Regiment, 1st Airmobile Division, supported by Battery B (155mm howitzer), 2d Battalion, 19th Field Artillery Regiment, and Battery C (105mm howitzer), 6th Battalion, 16th Artillery. Company C was at half strength.

The main NVA attack struck the northeast perimeter of the LZ, while a secondary attack was made against the southern perimeter. Aided by surprise, both attacks penetrated the perimeter. Despite stiff resistance, which inflicted many casualties on the attackers, the NVA troops overran a 155mm howitzer position area in the northeast sector of the LZ. The US defenders were forced back and became disorganized. Some made their way to the southwestern sector of the LZ where there was a 105mm howitzer position; others were scattered in small groups throughout the base, pinned down by NVA fire. Among the latter were S. Sgt. Douglas

MacArthur Graham and six artillerymen, the crew of a 155mm howitzer overrun by the NVA. Graham and his men were pinned down just 17 yards from their howitzer, unable to advance or retreat.

While in this predicament, Graham and his men observed the NVA troops near their howitzer organizing for the final assault against US troops in the main remaining pocket of resistance in the southwestern sector of the base. These US troops were approximately 140 yards from Graham's position and 157 yards from the NVA at the captured howitzer. The attackers, possibly to build up their courage for a final assault, were taunting the US troops firing from the southwestern sector of the base.

At this juncture, Capt. Leonard L. Schlenker, commander of the 105mm howitzer battery in the southwestern sector of the LZ, ordered a Beehive fired at the NVA troops massed near Graham's howitzer. Lt. John T. Piper, the battery's executive officer, loaded a Beehive round into a 105mm howitzer, shouted "Beehive, Beehive!" and fired the round. Graham, who was in the line of fire but prone -- and therefore safe -- heard the round pass overhead and described it as "sounding like a million whips being cracked."

The round had its full effect on the NVA soldiers massed for the attack near Graham's howitzer. The arrogant chants of the NVA troops suddenly changed to screams of agony. According to Graham, their urgent chattering in Vietnamese seemed to express shock and fear. Exactly how much fear was produced by the sound of the round in flight ("a million whips being cracked") and its casualty effect as it hit home, cannot be measured. Nonetheless, it appears that the fear-producing stimuli, tangible and intangible, were profound in their effects. Within seconds, Lt. Piper fired a second Beehive round into the milling NVA soldiers. The NVA troops, hit hard again, withdrew immediately. Sgt. Graham witnessed the withdrawal and recounted for Marshall that the survivors were moaning in fear and pain as they dragged away their wounded.(5)

The use of the Beehive munition in this engagement had been tactically decisive -- as it had been in the first use on 7 November.

The NVA 22d Regiment, which moments before had been poised to deliver the knockout blow to the defenders of LZ Bird, had, in a matter of seconds, sustained a number of casualties and been forced to withdraw. Although many of the casualties suffered by the NVA attack force occurred before the Beehive rounds were fired, it was the Beehive munition that transformed the tactical situation and broke the will of the attacker. Just as in the attack on 7 November, the Beehive proved to be the decisive factor in turning back an NVA attack. The force attacking LZ Bird was physically and psychologically battered. The Americans defending Bird quickly went about their work helping wounded and placing artillery fire on NVA forces beyond the perimeter.

Prior to the use of the Beehive, the artillerymen at Bird were aware of its existence; they knew that it was a new weapon to be used when positions were in danger of being overrun. They had been reminded of its utility earlier, on Christmas Day, when a senior artillery officer, making his Christmas rounds, touted it as an effective antipersonnel munition.(6) It was obvious to Capt. Shlenker that this attack was the kind of situation for which the Beehive was designed, but he had waited for what he believed was the propitious moment. When he observed more than a hundred NVA troops massed for an attack, he knew the time had come, both because the mass represented an ideal target and because his position was about to be assaulted.(7) The riflemen of the 12th Cavalry Regiment were, however, unaware of the Beehive round prior to its use at Bird. According to Marshall, when Piper first requested a Beehive round from one of his crew, the riflemen nearby thought the ferocity of the attack had deranged him. "To them a beehive was a place to keep the bees," writes Marshall.(8)

The terrifying effect of the Beehive on those who come under fire from it for the first time is suggested by the following incident related to the writer by author James Webb, a former Marine captain and platoon and company commander in Vietnam.(9) The incident occurred on or about 20 March 1969. Webb was a platoon commander in Delta Company, 1st Battalion, 5th Marines, 1st Marine Division. Delta Company was at a position the Marines called Liberty Bridge, eight miles east of the An Hoa defended area. Four men from the 1st Platoon, which was commanded by Lieutenant "Chip" Pilkington, drew listening-post (LP) duty outside the Liberty Bridge position. They were at the LP when NVA regulars launched a night attack against the position. The position came under fire from mortars, and NVA troops infiltrated the perimeter. Meanwhile, "outside the wire," the four men from Pilkington's platoon were trapped, pinned down by enemy machine-gun fire. A radio message from Liberty Bridge told them to move so that artillery fire could be directed at the machine-gun position; they complied with the order. While they were moving to a new position, a Marine 106mm recoilless rifle crew mistook them for NVA troops and fired a Beehive round. One Marine was killed and one mangled; the third received only a slight wound, and the fourth Marine was uninjured. He was shaken, but able to return to combat. The Marine who sustained the slight wound was described by Webb as a "good troop" who had seen combat before, a "nice kid," and definitely not likely to use this bad experience as an excuse to avoid combat. Nevertheless, after this episode he was unfit for combat "because of the absolute terror evoked by experiencing fire from the Beehive."

On another occasion Webb again observed the effects the Beehive round had had on this Marine. After the incident at the LP, the Marine was assigned duty in the mail room at An Hoa, a "safe" fire base. Webb happened to be passing through the mail room there one day when a single artillery round was fired from the base. The Marine hit the deck, and afterwards was shaking uncontrollably. Webb says this reaction was genuine, and he

believes it can definitely be attributed to the previous experience of the Beehive. Webb had occasion to order Beehive rounds fired from 106mm recoilless rifles when he was an operations officer at An Hoa. However, it was impossible for him to observe their effectiveness there because of the range and because it was dark when he ordered them fired. This notwithstanding, the incident involving the four men at the Listening Post was enough to convince Webb that the Beehive must have terrorized any NVA and Viet Cong forces who encountered it for the first time.

Webb said his own reactions to first firing the Beehive were not particularly strong because he had gained a good idea of its effectiveness at the Marine Corps Basic School.(10) When asked how the Marines under his command felt about the Beehive round, he responded, "Any weapon that put distance between them and death they thought was great." The more effective and lethal the weapon was, the more the Marine Corps infantryman liked it. Webb went on to point out that the Marines he knew were especially fond of the new weapons used in Vietnam in support of infantry operations. He said that even more than the Beehive round, the Marines in his platoon and company liked the new automatic grenade launcher fired from attack helicopters in close support of their combat missions.(11)

Despite the effectiveness of the Beehive round, there is evidence that the NVA and Viet Cong did adjust to it and learn to react effectively when they faced it subsequently. For example, General David Ott, in his book on artillery use in the Vietnam War, avers that although the Beehive round was effective in defense of fire bases in the spring of 1967, NVA and Viet Cong troops soon learned to escape the lethal effects of the steel darts by dropping to the ground and crawling.(12) Perhaps the terrifying sound the round made alerted the NVA and Viet Cong and enabled them to hit the ground in time to avoid the flechettes. (However, this is normal reaction by any experienced soldier who hears the sound of incoming artillery fire.) The 21 March 1967 Viet Cong attack on Fire Base Gold illustrates the degree to which the Viet Cong had adapted to the Beehive round. Located near Suoi Tre, about 90 kilometers northwest of Saigon, Fire Base Gold came under a determined Viet Cong attack at 0630 in the morning of 21 March. The Viet Cong were armed with infantry mortars, recoilless rifles, RPG 2 rockets, automatic weapons, and small arms. The base was defended by the 3d Battalion, 22d Infantry, and the 2d Battalion, 77th Field Artillery.(13) By 0700 the base perimeter had been penetrated, and the company commander of the 3d Battalion's B Company called for close air support. Less than 15 minutes later he reported that the position of his 1st Platoon had been overrun by a human-wave attack and its survivors surrounded. He requested that the 2d Battalion, 77th Artillery use Beehive fire to support his beleaguered infantrymen. By 0840 Company B, which had been positioned on the eastern edge of the perimeter, had been forced to withdraw westward to the interior of the base and redeploy around the 3d Battalion, 77th Artillery's, position.(14)

> The howitzers of the artillery battalion, with their tubes leveled, began firing Beehive rounds into the Viet Cong. At point blank range, round after round of direct fire was delivered. When the artillery inside the perimeter had exhausted its Beehive rounds, it began to fire high explosive rounds at point-blank range. By 0900 the northern, western, and southern sectors of the perimeter were holding under Viet Cong pressure. The positions on the east had withdrawn even closer [than before], but the line was still intact.(15)

Reinforcements in the form of another infantry battalion, a mechanized infantry battalion, and an armored battalion repulsed the attack and then counterattacked, enabling the defenders to reestablish the original perimeter.(16)

Unlike the attackers in earlier incidents involving the Beehive, the attackers at Fire Base Gold were not repulsed by a few rounds of the new munition, but were able to maintain the momentum of their attack. This suggests that the NVA and Viet Cong adjusted to the effects of the Beehive rather quickly, and that its psychological effectiveness was ephemeral.

Employment of Grenade-Filled, Base-Ejection Projectile

The time-fuzed, grenade-filled, base-ejection projectile was first used on 12 February 1968 by Battery C, 1st Battalion, 40th Artillery (105mm howitzer). Battery C was firing in support of a South Vietnamese unit. The battery is credited with 14 NVA regulars killed, and an unknown number of wounded, as a result of 54 rounds of ICM fire. Subsequently, the ICM was used effectively during the Tet Offensive and throughout the remainder of the war in an antipersonnel capacity. The firing technique of using 8-inch howitzer time-fuzed projectiles, set to provide air burst at ranges of 200 to 1,000 meters was called "Killer Senior." The technique for employment with 105mm and 155mm howitzers was called "Killer Junior." This technique had been developed for use with high explosive (HE) rounds, but was found adaptable to firing ICMs.(17)

Col. Richard Bliss, USA Retired, recalls his first use of the ICM. This incident took place during the Cambodian incursion of spring 1970.(18) Bliss -- a major at the time -- was operations officer with the 7th Battalion, 8th Artillery (8-inch howitzer). His unit was part of the II Field Force Artillery, which was operating in support of the III South Vietnamese Army Corps during Operation Rock Crusher (29 April-29 June 1970). During the course of this operation, Bliss says it was necessary to displace batteries as many as two and three times daily to avoid the frequent counterattacks or raids by NVA regulars against South Vietnamese ground forces. These attacks brought the supporting US artillery units under fire.

On or around 8 May, according to Bliss, an NVA unit was observed massing for such a counterattack, but he was unsure of the exact nature of the NVA mission. The enemy may have wanted to

close on the South Vietnamese Command Post nearby, or they may have just wanted to engage any nearby US or South Vietnamese unit. In any event, C Battery came under fire from both front and flank. Bliss said that his unit attempted to silence the enemy fire by using HE munitions with a minimum time fuze setting, but hostile fire interfered. Bliss recalls suggesting the use of "Killer Senior" with the ICM round. The minimum time fuze setting of two seconds created an air burst at 1,000 meters. Eleven rounds were fired, and almost immediately, North Vietnamese firing ceased. The US artillerymen were elated. They praised ICMs and wanted to fire only this munition for antipersonnel missions for the remainder of the operation. Subsequent search of the area revealed blood and many body fragments.(18)

In this instance, the grenade-filled, base-ejection projectile was very effective. Its use brought about an immediate and dramatic transformation of the tactical situation. While Bliss does not know the psychological impact of the ICM on the NVA unit, the change in American morale and the tactical situation suggests that exactly the opposite reaction occurred with the NVA troops. Since ICM rounds of this nature had been in use against NVA units for the previous two years, the incident suggests that the ICM's effectiveness did not diminish with repeated usage.

Summary

On the basis of the limited evidence presented above, it is clear that both the Beehive and the grenade-filled, base-ejection ICM were extremely effective antipersonnel weapons. Added to the casualty effects, the Beehive's noise signature seems to have contributed to some extent a psychological effect to the casualty effects produced upon those subjected to its fire. On the other hand, although a short-range weapon, its low muzzle velocity seems also to have permitted troops under fire to minimize its effects by falling prone or taking cover as soon as this signature noise was heard. It is clear from the one detailed account of employment of the ICM that prior experience in being subjected to the new weapon did not in any way diminish its inherent, enhanced casualty effectiveness. And, since the round was closer to conventional HE in the nature of its delivery, troops receiving its fire had no advanced warning as was the case (even though brief in duration) with the Beehive.

Notes to Case Study on Improved Munitions Technologies in the Vietnam War

1. Maj. Gen. David Ewing Ott, Vietnam Studies: Field Artillery, 1954-1973 (Washington, D.C.: Department of the Army, 1975), pp. 61, 148.

2. Christopher Foss, ed. Jane's Armor and Artillery, 1979-1980 (London: Jane's Publishing Co., Ltd., 1980), p. 554.

3. US Department of the Army, Field Manual No. 6-30: The Field Artillery Observer (Washington, D.C.: Department of the Army, 1978), p. 6-1.

4. Ott, p. 61; US National Archives, Record Group 338 [Records of US Army Commands], 2d Battalion, 320th Field Artillery Regiment, Daily Staff Journal or Duty Officer's Log, 7 November 1966. The unit records and General Ott's account give varying numbers on the cause of the NVA casualties in this engagement. Ott states that nine NVA were killed by the Beehive round; the unit records indicate that seven were killed by the Beehive round and two were killed by small arms fire.

5. This account of the events of the defense of LZ Bird is based upon S.L.A. Marshall, Bird: The Christmastide Battle (New York: Cowles, 1968), passim; and Ott, pp. 108-110.

6. Marshall, pp. 101-102.

7. Ibid., pp. 102-103.

8. Ibid., p. 101.

9. Webb is a 1968 graduate of the Naval Academy where he received a special citation for outstanding leadership. He saw nine months of combat in Vietnam. For his service there he was awarded the Navy Cross, the Silver Star, two Bronze Stars and two Purple Hearts. He has written two novels, one of which, Fields of Fire (New York: Bantam Books, 1979), is based on his combat experience in Vietnam. For a realistic but fictional account of the physical and psychological impact of the Beehive see Fields of Fire, pp. 145-148. This account of the incident is based on Webb's description in a private conversation with the writer.

10. Webb claims that the Marine Corps Basic School (TBS) is the best school that he ever attended. At TBS, says Webb, the Marine second lieutenants fired every weapon in the Marine Corps arsenal and received thorough training in the combat usage of the weapons. Although Webb did not fire a flechette round from the 106mm recoiless rifle when he fired that weapon at TBS, he did receive instruction regarding its use and was well informed of its lethality.

11. Webb says that the first time he saw the M-129 automatic grenade launcher he was awed by its lethality and by the way it quickly and dramatically changed the tactical situation. At one moment the NVA unit was on the verge of escaping a trap, moving just beyond the range of the Marines' M-16 rifles, and the next moment the NVA force was at the mercy of attack helicopters, which were armed wth automatic grenade launchers and spewing grenades at them at 330 rpm. "We loved it!" says Webb.

12. Ott, p. 61.

13. Lt. Gen. Bernard William Rogers, Vietnam Studies, Junction City: A Turning Point (Washington, D.C.: Department of the Army, 1974) pp. 135-138.

14. Ibid., pp. 137-139.

15. Ibid., p. 139.

16. Ibid., pp. 139-140.

17. Ott, p. 61; Col. Richard Bliss, USA, Ret., conversation, 21 July 1983.

18. The description of this incident is based upon telephone conversations of 12, 18, and 21 July 1983 between the writer and Col. Bliss.

Bibliography of Sources for Case Study on Improved Munitions Technologies in the Vietnam War

Books

Foss, Christopher, ed. Jane's Armor and Artillery, 1979-1980. London: Jane's Publishing Co. Ltd., 1980.

Marshall, S.L.A. Bird: The Christmastide Battle. New York: Cowles, 1968.

Ott, Maj. Gen. David Ewing. Vietnam Studies: Field Artillery, 1954-1973. Washington, D.C.: Department of the Army, 1975.

Rogers, Lt. Gen. Bernard William. Vietnam Studies. Cedar Falls-Junction City: A Turning Point. Washington, D.C.: Department of the Army, 1974.

Webb, James. Fields of Fire. New York: Bantam Books, 1979.

Weeks, John, ed. Jane's Infantry Weapons, 1982-1983. London: Jane's Publishing Co. Ltd., 1983.

US Department of the Army. Field Manual No. 6-30: The Field Artillery Observer. Washington, D.C.: Department of the Army, 1978.

Conversations

Bliss, Colonel Richard. Telephone conversations. 12, 18, 21 July 1983.

Webb, James. Telephone conversation. 11 August 1983; private conversations 16 August and 6 September 1983.

Unit Records

Daily Staff Journal or Duty Officer's Log 0001 7 November to 2400 7 November 1966. RG 338, Records of US Army Commands, 101st Airborne Division, 2-320 Arty., 2-06 Daily Journals 1966.

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