

CLASSIFICATION OF CHEMICAL WARFARE AGENTS AND THEIR IMPLICATIONS FOR THE PORTUGUESE EXPEDITIONARY CORPS

A CLASSIFICAÇÃO DOS GASES QUÍMICOS E A SUA IMPLICAÇÃO NO CORPO EXPEDICIONÁRIO PORTUGUÊS

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Abstract

On April 22, 1915, the Germans attacked the Allied forces at the Ypres salient with an asphyxiating gas. Chlorine was used in quantities never before seen on the battlefield. The result was catastrophic for the Allied troops, who were unprepared to defend themselves against the new weapon at the front-line. The development of new, more lethal chemical agents evolved throughout the conflict. The English and the French started classifying these chemical agents according to the physiological effects they had on the victims. The Germans, on their part, had been grouping chemical agents according to the desired effects on the battlefield, taking persistence of contamination and lethal power into account. This classification was incorporated in German tactics. German doctrine was developed along with the conflict and the release of chemical compounds by German artillery in the preparation phase of the attack became a battlefield procedure. Artillery fire support to assault troops employed grenades filled with chemicals in order to provoke certain effects on the Allied defensive lines. This doctrine was widely used in the German 1918 Spring offensives. The Portuguese Expeditionary Corps (PEC) was victim to those same chemical warfare tactics in the battle of La Lys, in April 1918. The Portuguese troops had been in Flanders since 1917, but had only experienced minor combat prior to the Spring of 1918.

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They followed the British doctrine on chemical warfare and, during the Spring offensive of 1918, they had to face the new German approach to use of chemical agents on the battlefield.

Keywords: Portuguese Expeditionary Corps; Chemical Warfare; Chemical Agents Classification; Battle of La Lys; Bruchmüller.

Resumo

Em 22 de abril de 1915, os alemães atacaram as forças aliadas, no saliente de Ypres, fazendo uso de um gás asfixiante. Utilizaram cloro em quantidades nunca antes vistas no campo de batalha. O resultado foi catastrófico para as tropas aliadas que não estavam preparadas para se defenderem desta nova arma na frente de combate. O emprego de novos agentes químicos mais letais foi-se desenvolvendo ao longo do conflito. Os ingleses e os franceses foram classificando estes agentes químicos consoante os seus efeitos fisiológicos nas vítimas. Os alemães, por seu lado, foram agrupando os agentes químicos consoante os efeitos pretendidos no campo de batalha, tendo em atenção a duração dos seus efeitos e o seu poder letal. Esta divisão alemã foi devidamente incorporada na sua tática. A doutrina alemã foi-se desenvolvendo ao longo do conflito e o lançamento de compostos químicos pela artilharia alemã na fase de preparação do ataque passou a ser um procedimento no campo de batalha. O apoio de fogos da artilharia às suas tropas de assalto recorria ao emprego criterioso de granadas com químicos com vista a atingirem determinados efeitos nas linhas defensivas dos aliados. Esta doutrina foi amplamente usada nas ofensivas alemãs da primavera de 1918. O Corpo Expedicionário Português (CEP) foi vítima daquela tática de emprego de gases de guerra na Batalha de la Lys de abril de 1918. As tropas portuguesas estavam na Flandres desde 1917 mas tinham tido apenas pequenos combates antes da primavera de 1918. Utilizavam a doutrina dos britânicos relativamente à guerra química e tiveram de lidar com uma nova abordagem de emprego de agentes químicos no campo de batalha por parte dos alemães.

Palavras-chave: CEP; Guerra química; classificação dos agentes químicos; batalha de La Lys; Bruchmüller.

“Chemistry is one of the sciences that the Nation can best use for its defense.”

Lazare Carnot, 1794¹

“A surprise gas-attack carries off a lot of them. They have not yet learned what to do. We found one dug-out full of them, with blue heads and black lips. Some of them in a shell hole took off their masks too soon; they did not know that the gas lies longest in the hollows; when they saw others on top without masks they pulled theirs off too and swallowed enough to scorch their lungs. Their condition is hopeless, they choke to death with hemorrhages and suffocation.”

Erich Maria Remarque²

1. INTRODUCTION

In parallel with the emergence of combat aviation and tanks, the 1914-1918 soldiers faced the harsh reality of chemical agents and of “gassed” soldiers. With a new weapon on the battlefield, efforts were being conducted to come up with a countermeasure. Generally, the game played out as action-reaction and actually, a response to the first German attack came shortly, in the region of Ypres in April, 1915. In September, the British launched their first gas attack on the German forces in the region of Loos. Use of asphyxiating agents throughout the 14-18 War became normal, despite the countries involved in the war having signed the Hague Agreement, which prohibited the launch of projectiles containing toxic agents in combat. When Portugal entered the conflict, our military awoke to the harsh realities of chemical warfare. There were many situations where it was hard to tell what was more hopeless, life in the trenches or combat in contaminated environments, not to mention both situations normally happened at the same time.

Naturally, chemical warfare was analyzed, at times from a clinical perspective, others from a military perspective. The resulting studies contributed much to systematize our knowledge on handling casualties, or the “gassed”, and regarding the military use of chemical agents, on seeking to multiply their combat effectiveness. Different ways of looking at the issue led to divergent interpretations and classifications, with certain results on the different battlefields of the Great War. What is the classification of chemical warfare agents and what it implied for the Portuguese Expeditionary Corps (PEC) is the core issue under analysis in this essay. We will demonstrate that the Portuguese sector in Flanders was the setting for a degree of innovation.

This text is the result of the analysis of reports elaborated by the PEC immediately after the attacks, and of reports and books published after the Great War by military personnel

¹ Cited by Manuel de Mello Vaz de Sampaio in “Guerra Química” (“Chemical Warfare”), p. 3.

² Erich Maria Remarque, “A Oeste Nada de Novo” (“All Quiet on the Western Front”), p. 97.

involved in the conflict. For a better understanding of the context, section 2 highlights the fundamental aspects of Chemical Warfare, before and during the 1914-1918 War. Section 3 describes the classification of chemical warfare agents by the main countries intervening on the western front and section 4 describes the German offensives of 1918, highlighting Portugal's position, and the implications of the use of chemical agents for the PEC sector. The doctrine evolution underlying the use and classification of chemical agents appears in section 5 of the final considerations. In section 6, the conclusion, the central question is answered.

2. CHEMICAL WARFARE

"The 22nd of April 1915 had been a warm and sunny day, but towards the end of the afternoon a breeze sprang up. It came from the north, from behind the German lines, blew across No Man's Land, and gently fanned the faces of the Allied soldiers in position around the village of Langemarck, near Ypres.

They were new to the trenches – French reservists and Algerians from France's north African colony. To them the fresh wind must have seemed a good omen, for a few seconds later, as if on cue, the German guns which had been bombarding them all day suddenly stopped firing. An abrupt silence descended over the front.

A few hundred yards away, four divisions - of the 23rd and 26th German Army Corps - crouched in their trenches. They had waited there since dawn, unable to move for fear of giving away their presence. Now, just as it had begun to seem too late, the moment had come. The wind had changed. An attack.

At five o'clock, three red rockets streaked into the sky, signaling the start of a deafening artillery barrage. High explosive shells pounded into the deserted town of Ypres and the villages around it. At the same time the troops sheltering near Langemarck saw two greenish-yellow clouds rise from the enemy's lines, catch the wind, and billow forwards, gradually merging to form a single bank of blue-white mist: out of sight, in special emplacements protected by sandbags and concrete, German pioneers were opening the valves of 6,000 cylinders spread out along a four mile front. The cylinders contained liquid chlorine – the instant the pressure was released and it came into contact with the air it vaporized and hissed out to form a dense cloud. At thirty parts per million of air chlorine gas produces a rasping cough. At concentrations of one part per thousand it is fatal. The breeze stirred again, and one hundred and sixty tons of it, five feet high and hugging the ground, began to roll towards the Allied trenches.

Chemical warfare had begun."³

The 1915 attack was not the first use of asphyxiating agents. It was the first large scale use of chemical agents, but asphyxiating products had been used before in the war. History reveals this to be true since ancient times. The beginnings of the use of chemicals with the intent to poison can be traced to the wars of Ancient Greece. In the Peloponnesian

³ Robert Harris and Jeremy Paxman, "A Higher Form of Killing: The Secret Story of Chemical and Biological Warfare", p. 1.

War (431-404 b. C.) between Athens and Sparta, fires made with wood imbued with tar and sulfur were used in siege warfare, with the purpose of asphyxiating the defenders. Oddly enough, this technique was copied hundreds of years later, when "...in 1812, North-Americans used tar and sulfur in the siege of Charleston."⁴

Between 82-72 b. C., the Romans used toxic fumes in the Iberian peninsula, quickly defeating their opponents.⁵ The Romans also suffered the effects of asphyxiating products. In January 19, 2009, BBC News published an article⁶ on the archeological excavations in the city of Dura-Europos, near Salhiyé, in current-day Syria. Skeletons were found, identified as belonging to Roman soldiers who had died on the occasion of the siege of the city by Persian forces. In their attempt to enter the city, the Persians built a tunnel under the wall. This mining operation had the purpose of either entering the city or tearing down the wall by burning the logs that supported the tunnel structure. The Romans realized what the Persians were doing and began building a tunnel towards the Persian one. This counter-mining action was met by the preparation the Persians had left for the Roman force. The Persians set fire to a mix of sulfur and tar and then sealed the mine. This was fatal to the Roman military force coming to meet them.

Ongoing developments in the use of poisonous chemical agents in warfare resulted in the first treaty that banned the use of chemical weapons – The Strasbourg Agreement of August 27, 1675, signed between France and Prussia.⁷

In 1885, during experiences carried out in France at the Camp de Châlons in the presence of Napoleon III, 30 dogs were sacrificed, killed by asphyxiating projectiles. In 1887, in Germany, at a conference in Munich, professor Bayer referred to a possible use of asphyxiating agents. Therefore, it is not surprising that, anticipating future wars, representatives of the various Nations agreed to ban the use of asphyxiating agents at the Hague Convention of 1899. "The terms approved at the Hague Convention in October 18, 1907 state that:

Art. 22 The right of belligerents to adopt means of injuring the enemy is not unlimited.

Art. 23 In addition to the prohibitions provided by special Conventions, it is especially forbidden:

- a. To employ arms, projectiles, or material calculated to cause unnecessary suffering;
- b. To employ poison or poisoned weapons."⁸

The prohibition of employing asphyxiating gases was ratified with one vote against, from U.S.A. Representative Navy Commander Alfred Thayer Mahan, who argued that:

"...it was illogical, and not demonstrably humane, to be tender about asphyxiating men with gas, when all were prepared to admit that it was allowable to blow the

⁴ Manuel Sampayo, Op. cit., p. 8.

⁵ Kim Coleman, "A History of Chemical Warfare", p.1.

⁶ Tanya Syed, "Ancient Persians gassed Romans".

⁷ Kim Coleman, Op. cit., p. 7.

⁸ Manuel Sampayo, Op. cit., pp. 8-9.

bottom out of an ironclad at midnight, throwing four or five hundred men into the sea, to be choked by water, with scarcely the remotest chance of escape.”⁹

In fact, the Hague convention did not prevent Nations from debating the employment of chemical weapons, and at least one country publicly employed asphyxiating agents – France. In 1912, the French police used gas grenades to stop a group of bank robbers in Paris.¹⁰

In August 1914, German forces invaded Belgium and were preparing to reach Paris, in a maneuver based on the Schlieffen plan. German soldiers said farewell to their families, hoping to return in October that same year. It would be a quick war and it would end all wars in Europe. It was the Great War. The movement crossed the neutral territory of Belgium, skirted the allied forces and attacked Paris from the north and west. Confrontations with allied forces and the arrival of troops in France showed a victorious German army and a disaster for the allied armies. By early September, general Klück's First Army and general Bülow's Second Army were approaching Paris, but not according to plan. One of the premises of the Schlieffen plan rested on the concentration of French forces near the border. The destruction of the French troops would open the way to Paris, just like in 1870, during the Franco-Prussian War. But the French army gradually withdrew, increasing the defense around Paris. A flank counter-attack against the Second German Army drew the army away towards the west, creating a breach between the First and Second German armies. This weakness in the positioning of German forces was identified by allied air reconnaissance. It was the river Marne region and French and British units were quickly reorganized to exploit this vulnerability in the German forces. There is a famous tale about red Paris taxis transporting troops to the battle front. It became known as the First Battle of the Marne.

After the Battle of the Marne, in September 10, 1914, German forces withdrew to a main line of resistance along the river Aisne, beginning the terrain preparation and field fortification. This maneuver from the German forces resulted in the stalemate that led to static trench warfare.

Germany was practically out of explosives and the blockade on German forces prevented the arrival of nitrates from Chile.¹¹ In this context, “gas was seen not as a substitute for explosives, but as a possible way of breaking through the stabilized front: an entrenched enemy was comparatively safe from projectiles but vulnerable to airborne poisons.”¹² A German scientist, Fritz Haber, was involved in finding a solution to the aforementioned issues. In 1909, Haber invented a revolutionary method of synthesizing ammonia from nitrogen in the air. The method was applied industrially by the chemist Carl Bosh. The Haber-Bosch method made it possible to produce ammonia sulfate and nitric acid, freeing Germany from having to import nitrates from Chile. Ammonia sulfate, an agricultural fertilizer, and nitric acid, an ingredient in the manufacture of nitroglycerin and TNT, were enough to solve the scarcity of food and explosives that the allied blockade imposed on Germany. It was also Fritz Haber, the then director of the Kaiser Wilhelm Institute in Berlin who, in 1914, proposed to fill artillery grenades with chlorine.

⁹ Cited by MAJ Charles Heller, in “Chemical Warfare in World War I: The American Experience, 1917-1918”, p. 3.

¹⁰ Charles Heller, *Op. cit.*, p. 4.

¹¹ Kim Coleman, *Op. cit.*, p. 15.

¹² Idem, *ibidem*, p. 15.

This compound was abundant in Germany. Chlorine was used in the chemical industry for paint production, and Germany was one of the world leaders in this sector of the economy. The German General Staff rejected the proposal due to a lack of artillery grenades. The Germans could not afford to try out non-explosive products on artillery grenades, as the combat front used up all their resources. In January, 1915, Fritz Haber suggested using cylinders containing chlorine. This proposal convinced general Erich von Falkenhayn, the German Chief of the General Staff, “who considered poison gas “unchivalrous” but hoped that its use would result in a decisive military victory”.¹³ The agent was first used in the region of Ypres, in Belgium.

The attack was carried out precisely in the afternoon of April 22, 1915. The days preceding the attack were not peaceful for the German General Staff. The first location for these chlorine cylinders was in the region of Gheluvelt, southwest of Ypres. The allied forces were not entirely unfamiliar with these chlorine cylinders. French and English reports had already divulged their existence. The issue was with the actual German command. The offensive that was planned for the invasion of the Ypres region and for tearing down the Ypres salient did not include the use of asphyxiating agents. Moreover, usage in large quantities had not been tested in the battlefield and would interfere with planned maneuvers. However, the German Chief of the General Staff, general Erich von Falkenhayn, did not abandon his belief and was steady in his defense of the employment of chemical agents. It was an opportunity to test the new weapon on the battlefield and to divert allied attention from the offensive planned for the eastern front. For the time being, and according the German General Staff, the western front would stay the way it was. Because the original location had already been discovered, the cylinders were moved to the area northwest of Ypres. The dominant winds in the Ypres region in Spring blow in the south-north direction, and consequently the first location was ideal for striking the allied forces east and north of the city of Ypres, the stress point of the German offensive. The new location depended much on significant changes in wind direction. All this delayed the German attack on the Ypres Salient. Conditions were met, as we know, in the afternoon of April 22. Allied response did not take long. The British carried out their first chemical attack in Loos, on September 15, 1915. Use of chemical agents became widespread in the battlefield, and each new gaseous substance possessed a boiling point higher than the ones already in use. We can trace the following evolution in the most frequently used substances:

Gas	Boiling Point (° Celsius)	First Use
Chlorine	-33,5	April, 1915
Phosgene	8	December, 1915
Diphosgene	127	May, 1916
Benzyl bromide	198	January, 1917
Yperite (mustard gas)	217	June, 1917
Diphenylarsine chloride	333	October, 1917

¹³ Jonathan Tucker, “War of Nerves”, p.12.

Morais Sarmento provides an explanation for this evolution in the following fundamentals:

- “1st Progressively larger distances to be transposed by gas projectiles imposed an increase in container resistance and consequently, a stronger explosive charge, which did not allow gases with low boiling points to reach an effective concentration level;
- 2nd The need to weaken rear defenses demanded a lasting impregnation of toxic in the atmospheres surrounding them, which was not easy to do with very volatile gases;
- 3rd Particles in which gases with higher boiling points dissociate less quickly are, under conditions identical for all gases, proportionally higher in density, and so exert a higher and faster irritating action on the nervous endings of the upper airways, nasal cavity, pharynx and larynx. The violent and sudden nature with which these effects were provoked prevented soldiers from putting on their respiratory masks and keeping them on, allowing the same gas or another to penetrate so deeply that the wounded would be definitively eliminated.”¹⁴

Use of asphyxiating chemical agents was not a novel occurrence in the First Great War. However, conversion of the chemical industry to support the war effort and the amount of chemical agents used in the battlefield was clearly a new path taken by belligerent nations. The use of gases in the battlefield was a possible solution for breaking the static line of trenches that tended to last through time. The Germans used chlorine in the Ypres region in 1915, using cylinders to spread the gas. The author of this technical solution was an eminent German scientist, Fritz Haber. Chemistry served the purposes of war like it never had before. To the chagrin of the allied powers, Fritz Haber was awarded the Nobel prize in Chemistry in 1918, for his work in synthesizing ammonia. The characteristics and effects of chemical warfare agents developed throughout the conflict. This tactical application was not an isolated study. Countries attempted to understand the phenomenon of chemical warfare agents, creating for that effect a classification for their respective arsenals.

3. THE CLASSIFICATION OF CHEMICAL WARFARE AGENTS

As stated by António Figueiredo “Not all known toxic agents are useful as combat gases.”¹⁵ According to Sartori¹⁶, thousands of substances that might be useful in the battlefield were examined during the conflict, a few dozen substances were tested, but only a dozen chemical compounds were actually used.

¹⁴ Moraes Sarmento, “As Intoxicações pelos Gases de Guerra” (“Intoxication by Chemical Warfare Gases”), p. 44.

¹⁵ António D’Almeida Figueiredo, “Gases de Combate”, (“Combat Gases”), p. 5.

¹⁶ Mario Sartori, “The War Gases”, p. vii.

António Figueiredo mentions that a theoretically perfect aggressive chemical must satisfy the following requisites:¹⁷

- a) high toxicity or clearly defined physiological action;
- b) stability in the presence of strong temperature variations;
- c) resistance to atmospheric agents, mainly humidity;
- d) durability (unaltered by time);
- e) gaseous density as high as possible, always greater than the unit (one);
- f) high volatility, for chemicals that act by inhalation, and low for those that act on the organism in liquid form;
- g) easily vaporized;
- h) ease of transportation and containment;
- i) ease and low cost of preparation.

Morais Sarmiento's 1919 report, regarding intoxication by chemical agents, systematized the classifications employed by the main antagonists.¹⁸

The French classification distributed these gases in the following manner:

- a) Choking agents, such as Chlorine.
- b) Vesicant agents, such as Yperite.
- c) Irritant agents, divided into Lachrymatory and Sternutatory.

Choking agents provoke the accumulation of fluid in the lungs (pulmonary edema) and victims die of so-called "dry drowning". The main physiological action of vesicant agents is an intense irritation of the skin that manifests initially as skin erythema, quickly followed by phlyctaena that are prone to infection, which then ulcerate and are hard to heal.¹⁹

Sternutatory agents are not gases in the physical sense of the word, but rather fine colloidal emulsions that permeate through the mask filters. These were used to force the soldiers to remove their masks, making them vulnerable to other, more toxic agents. They were called "mask-breakers".²⁰ These agents cause an increase in nasal secretions. Lachrymatory agents act on the eye with an irritant action that manifests as more or less intense lacrimation.

The British classification differentiates chemical agents according to the following criteria

- a) Pulmonary Irritants
- b) Nasal Irritants

¹⁷ António Figueiredo, *Op. cit.*, p. 5.

¹⁸ Morais Sarmiento, *Op. Cit.*, pp. 47-54.

¹⁹ António Figueiredo, *Op. cit.*, p. 19.

²⁰ *Idem*, *ibidem*, p. 21.

- c) Lachrymatory Irritants
- d) Vesicants
- e) Blood Intoxicants
- f) Nervous System Poisons

This classification is not entirely accurate. All pulmonary irritant agents are also bronchial irritants and lesions extend to the aerial tubes, according to their concentration in air and their respective boiling points and degree of solubility in organic secretions. Furthermore, all are also lachrymatory, to a greater or lesser degree, depending on individual sensitivity. They are equally nasal irritants and some can show a vesicant action.

As noted by Morais Sarmento “The only clinical classification, that is, one that attempts to summarize the main differences that distinguish warfare agents, must be based on practical experience and clarified by experimental studies, and must characterize forms of gassing by the pathological processes through which gases register morbid effects”.²¹

Thus, Morais Sarmento points out that it would be preferable to classify warfare chemical agents as:

- a) Blood Chemical Composition Modifiers;
- b) Lining epithelial tissue Cellular Irritants.

The German army classification was characterized by exclusively military criteria:

A 1st group includes all gases which, by irritating the mucous membranes of the conjunctiva and airways and by irritating and causing specific lesions in pulmonary tissue, quickly disabled injured combatants, who could die from pulmonary damage. This group includes the pulmonary irritants, lachrymatories and nasal irritants of the British classification.

The 2nd group includes mustard gas, as it took longer to remove the afflicted from combat and because it manifested slowly, immediate symptoms from skin contact with this gas being an exception.

This classification was not based on clinical criteria, rather on a differentiation between agents that quickly disabled the attacked and agents with delayed effects.

Engineering Lieutenant Santos Macedo designates the 1st group as rapid effect gases (non-persistent), appropriate for offense, and the 2nd group as persistent gases.²²

The PEC would face the issue of gas warfare when Portuguese forces advanced on Flanders in 1917. The situation at the Theater of Operations had evolved, requiring an additional effort from the Portuguese military.

The PEC had chemical warfare training at the *Gas School*, in activity since May 7, 1917, in Mametz, offering several courses with a maximum duration of 5 days, for officers and ranks who would be responsible for the anti-gas instruction of their respective units and the

²¹ Morais Sarmento, Op. cit., p. 53.

²² Santos Macedo, “Guerra Química – Sua Técnica e Tática” (“Chemical Warfare – Techniques and Tactics”), pp. 22-23.

establishment of a collective anti-gas defense in the trenches. On principle, all units and all officers and enlisted who served in the trenches, or even people simply visiting there must submit to a test that consisted in passing through a tear gas chamber²³. The school records show the passage of 1.432 officers and 36.730 enlisted, and the specialization of 60 officers and 597 enlisted.²⁴

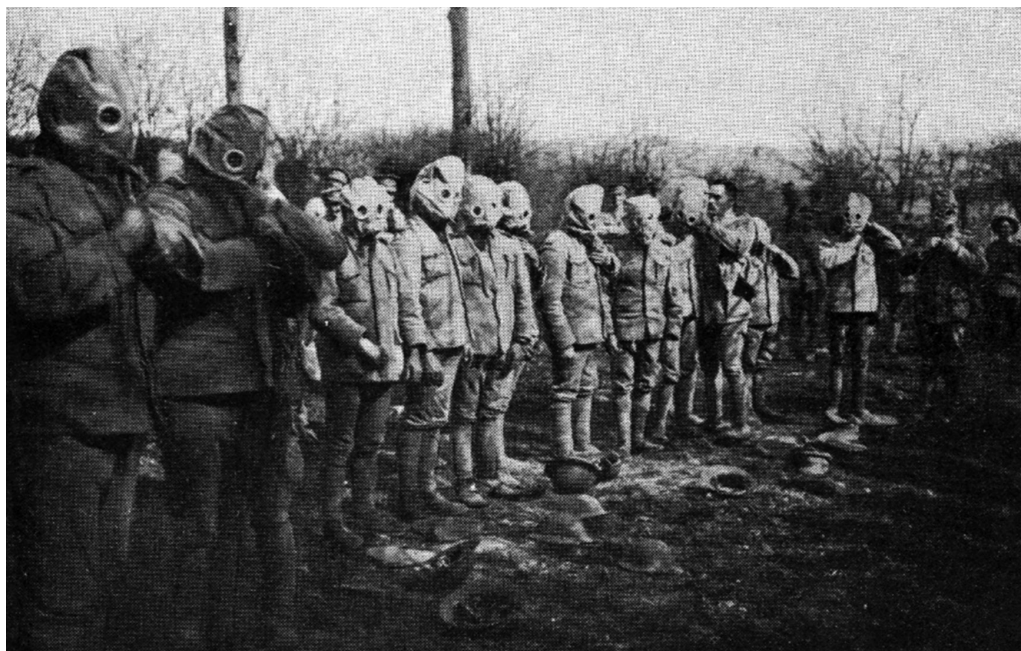


Fig. 1 – Mask training

Source: General Ferreira Martins, 1945, p. 527.

Sector occupation was divided by defense lines. Line A – the first line of defense and front-line – was the sector's anterior limit. In front of it was a strip of land, No-Man's-Land, about 400 meters wide, which separated opposing forces. The first line corresponded to the zigzag trenches. Two more lines ensured the defense of the front. Line B was the support line, and Line C, the sector's reserve line. These three lines formed an area, a first defense zone, approximately 2 kilometers deep. The second defense zone, 3 to 4 km from the front, connected to the first zone by a road, had two lines. These were the line of villages, where the Brigades Headquarters were located and the Corps line, where the Divisions Headquarters were located. Behind these lines was the Army line, in the third defense zone.

The plans of defense of the brigades made a mention of chemical agents, which read: "In case of an attack with gas, the 1st line troops will garrison the trenches at once. The

²³ Passing through the gas chamber is a way of training in an environment as realistic as possible, but at the same time allowing the soldier to recognize the protection afforded by his individual protective equipment. Carrying out his duties in a non-breathable environment did not make him anxious because he could trust his respirator. In the present day, in a Chemical Defense Course, passage through the gas chamber is called Respirator Confidence Test.

²⁴ Ferreira Martins, "Portugal na Grande Guerra" ("Portugal in the Great War"), p. 231.

batteries assigned to the attacked sector will immediately open fire against the 1st enemy line, maintaining it for 15 minutes, and will then scout the terrain between trenches with the purpose of stopping any attack forces that may be launched after the gas clouds; this slow barrage fire will be maintained until further instructions.”²⁵

Despite the plans, additional documentation had to be produced in order to complete and solve the issues at the front. On December 12, 1917, Circular nº 14, classified SECRET, offered the first instructions for chemical defense:

“Having come to the attention of this HQ that a great number of soldiers is on the front-line without their anti-gas apparatus, H.E., the Commander Gen of the PEC, determines that the following instructions must be observed:

I – The area of the Corps is divided into three zones:

a) Alert Zone:

Between the 1st Line and the Line that crosses CENSE DU RAUX – LACOUTURE – CROIX BARBEE – PONT DU HEM – LAVENTIE – FLEUR-BAIX. The first two towns are outside the zone. Always use the mask in alert position, on top of all other clothes. The strap of the steel helmet at the tip of the chin. The hood is not to be worn.

b) Prevention Zone:

Between the western limit of the preceding zone and the line that crosses LOGON – LA CROIX MARMUSE – LESTREM – LAGORGUE – ESTAIRES. All these towns are inside this zone. Always use the mask in march position.

c) Precaution Zone:

Between the western limit of the preceding zone and the line that crosses LILLERS – HAM EN ARTOIS – BERGUETTE – ISBERGUES – THIENNES – STEENBECQUE.

Either the hood or the mask can be worn.

II – Military police must receive instructions on what reports to make in case of infraction of the aforementioned orders.

III – Limits between zones will be noted on signs along the main roads.”²⁶

On the following day, December 13, 1917, a MEMORANDUM was sent out, also classified SECRET, stating the following:

“To inform, herein are published the details of a gas attack suffered by the English, north of the La BASSÉE channel.

I – The attack took place by 01 hours of the 11th of December. Gas cylinders were employed against both forward trenches in A.15.b (page 36 c NW 1 1/10 : 000).

II – The area of higher concentration of gas cylinders was around 250 yards wide and 200 yards deep.

²⁵ AHM, Box nr. 1389/5.

²⁶ AHM, Box nr. 1389/5.

III – It seems that the projection came from the German support trench, some 500 yards from their front line.

The projectile discharge caused a strong explosion and a great flame was seen in the trench where they were installed.

The trail of the cylinders was clearly visible by the flash of burning wicks.

The maximum range of the cylinders is calculated at around 1000 yards.

IV – The number of cylinders used cannot be calculated exactly, but a few hundreds must have fallen.

The cylinders blew up with quite a strong detonation, producing a thick cloud of gas.

A cylinder was found, revealed to be of the 17 centimeter “rum jar” type, which appears to have been launched by trench mortars or smooth bore projectors.

V – The gas employed is thought to be pure phosgene.

VI – The enemy covered the projectile launch with artillery fire, trench mortars and gas grenades.

VII – In some units, the alarm was sounded as soon as the detonations were heard and casualties were insignificant.

The Chief of the General Staff

Roberto da Cunha Batista

Colonel”²⁷

²⁷ AHM, Box nr. 1389/5.

Figure 2 presents a map of the sector occupied by the PEC, showing the defense lines and the three chemical protection zones referenced in the circular. The Alert zone is between the front-line and the village line. The prevention zone is between this line and the line defined by the La Lawe Channel. The precaution zone is behind this final line.

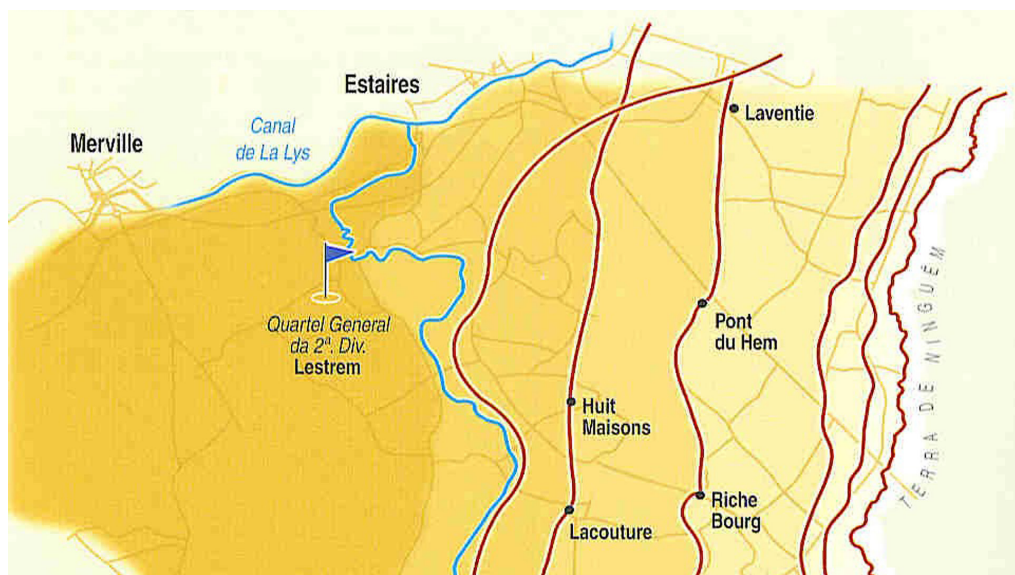


Fig. 2 – PEC Sector

Source: Henriques e Leitão, 2001, p. 46.

From December 31, 1917 (New Year's Eve) to March 15, 1918, eleven attacks with chemical agents were registered on the PEC sector.²⁸ The first attack, at the turning of 1917 to 1918, began at midnight and lasted for about 20 minutes, revealing the lack of preparation of the Portuguese troops. The attack took place in the town of Laventie and, according to the report, "the alarm was not sounded even though a few soldiers took to the streets, shouting "gas".²⁹ Another serious aspect and indicative of lack of training is the fact that some soldiers kept in their pockets pieces of grenade shards that eventually caused them serious burns. Still according to the observations of the report "In some billets, during the night of 31/1 there was not much smell of gas due to the cold. On the day of January 1, temperatures rose due to the sun and the fires burning inside the houses, and soon gas was produced again and more victims appeared."³⁰ The numbers reveal the same: on January 1, 116 casualties were evacuated to the blood hospital and another 76 the following day, a total of 192 casualties.

The second attack occurred on January 20, 1918, in the region of Neuve-Chapelle. There were six victims, caused by a delay in putting on the respiratory apparatus.

²⁸ AHM, Box nr. 1389/5.

²⁹ Idem, ibidem.

³⁰ Idem, ibidem.

Two days later, there was an attack along the whole Portuguese sector, making six victims in the Neuve-Chapelle sector and 18 victims in the Fauquissart sub-sector. Once again the lack of speed in putting on the masks proved fatal. In addition to that, some soldiers removed their masks in order to help their wounded comrades and this resulted in the higher number of casualties in the Fauquissart sub-sector.

On February 14, the region of Chapigny in the Fauquissart sub-sector was attacked. The attack resulted in 16 victims, for similar reasons.



Fig. 3 – Gas Alarm

Source: Jones, 2007, p. 19.

In the morning of March 2, an attack on the Neuve-Chapelle sub-sector caused five victims due to delays in mask placement. That afternoon, the attack was carried out along the whole front, resulting in 5 casualties in the Neuve-Chapelle sub-sector and 36 casualties in the Fauquissart sub-sector.

On the night of March 9 to March 10, victim numbers were much higher than before. There were 149 casualties in the Chapigny region. This time, the matter of putting on the

masks was not in question, as they were simply not used. The alarm did not sound because the gas was completely inodorous. The report on this attack observes: "In FAUQUISSART there was no gas. This inodorous gas is new. It is necessary to follow what is determined: To put on the masks as soon as bombardments begin, regardless of reconnaissance regarding use of gas grenades. It is the only way to avoid intoxication. The alarm must be sounded as soon as bombardments begin."³¹

On March 11 and 12, the region of Chapigny was again punished by chemical agents. The number of casualties was 134, which was high, but the level of casualties was light. On the 12th, the region of Richebourg suffered a blue gas attack which caused 9 casualties.

On the 13th, it was the turn of the 1st Brigade H.Q. Region (no victims) and on the 15th, the region of Estaires, where artillery was positioned, was attacked. Two casualties were registered. This was the last known report of a chemical attack and there were once again issues with the use of the mask. It was crucial to alert the troops for the chemical protection procedures. Therefore, on March 16, 1918, Circular nº 22 was published, stating that:

"His Excellency, the Commander General of the P.E.C., orders the following information to be made known.

The enemy employed, during the last week, gas grenades of the "Blue Cross" type.

This gas spreads at great distances with favorable wind, but dissipates quickly.

The effects of this gas are burning in the nose and mouth, which provokes sneezing and presents the sensation of a strong cold.

The sound these "Blue Cross" gas grenades make when exploding is much louder than that of other gas grenades.

His Ex., the Commander General of the P.E.C., also orders the troops to be informed that the adopted respirator offers absolute protection against all gases employed by the enemy and strongly recommends frequent respirator placement drills, noting that lack of speed caused many casualties during the last combats. (reports of the combat gas service for days 11 and 12 of the current month).

*The Chief of the General Staff
(a) João J. Sinel de Cordes
Colonel"³²*

³¹ AHM, Box nr. 1389/5.

³² Idem, ibidem.

The memorandum of March 16, in addition to the warnings on safety issues, was a clear warning regarding the gas employed by the Germans. It was the “Blue Cross” gas, another designation for diphenylarsine chloride. António Figueiredo provides an explanation for the code used by the Germans, here transcribed: “The Germans (...) divided gases into four groups which they signaled on the grenades with crosses of different colors.

One group, marked with a green cross, was formed by offensive agents, generally volatile liquids of high toxicity for the respiratory system and less damaging to others. It includes Phosgene.

Another group, marked with a yellow cross, was formed by less volatile liquids, moderately irritant, but very toxic and capable of attacking directly the skin and mucous tissues. It includes Yperite.

A third group, marked with a blue cross, formed by generally solid compounds of low toxicity but highly irritant properties. It includes diphenylarsine chloride gas.

A fourth and last group, formed by volatile but persistent liquids that mainly attack the eyes. It includes Benzyl Bromide.

It is clear that the first group contains choking agents; the second, vesicant agents; the third, sternutatory agents; the fourth and final group, lachrymatory agents.”³³

Note the reference to the first group as offensive gases, of quick aggressive action, that is, fugacious. It is the tactical classification Germans give to warfare agents.

Chemical compounds may be grouped according to their physical characteristics, their physiological effects, and according to the duration of their effects. It is common to speak of war gases in the First World War, but not all agents were gases. The mustard chemical agent is a liquid. Classification according to physiological effects is of crucial importance for the treatment of victims. This classification had an extraordinary impact in evaluation on the allied side. Division of chemical agents according to the duration of their effects is crucial for the tactical use of the various chemical compounds. This classification was relevant for the German army and was explicit in the way artillery grenades were marked according to their purposes. Reports from the Portuguese forces initially revealed concerns over training and individual protection and it was only later, in 1918, that they presented some details on what types of chemical agents the Germans were using. The understanding of the tactical use of chemical agents by the Germans would occur during the 1918 offensives.

4. THE LUDENDORFF OFFENSIVES

In the last months of 1917, the German submarine war had failed, the Americans arrived in France and the only good news for Germany seemed to come from the eastern front, with the Russian revolution. General Erich Wilhelm Ludendorff planned an offensive for the Spring of 1918, initially for the region between Saint Quentin, south of Arras, and Ypres. There, the terrain presented characteristics more suited to the progression of German

³³ António Figueiredo, *Op. cit.*, p. 13.

assault forces, as it was drier that time of the year, and the allied sector was thought to present a weaker defense.

It was the offensive of the Ludendorff Spring, with the aim of breaking through the Allied lines. It was a strategic window of opportunity that the Germans could not let pass. With the peace negotiations with the Russians, the Germans transferred their divisions in the eastern front to the western front, quickly concentrating their forces before American reinforcements arrived.

In March, 1918, the Germans had a potential 192 Divisions in the western front. The Allies positioned from the English Channel to Switzerland included in their organization 6 Belgian divisions, 58 British divisions, 2 Portuguese divisions, 103 French divisions and 5 American divisions.³⁴ These numbers included divisions in the front-lines and at the rear. We can easily conclude that, generally, the Germans did not have a great advantage if a large offensive were to be launched on the western front. The maneuver would have to be well articulated and explore the weak points of the allied forces. This offensive was based on the document of January 1, 1918, with the title *"The Attack in Position Warfare"*.³⁵ The German infantry was organized in depth for execution of the attack. Speed and depth allowed for the protection of the flanks and rearguard. Speed was necessary so as not to give the enemy time to react, and depth so that follow-up troops could isolate pockets of resistance as they were passed, preventing them from countering the continuation of the attack. Another crucial aspect was synchronizing fire support with the attack. If, during the initial phase of the war, there were massive artillery fires with long periods of preparation but with tactical objectives that were hard to determine, in the battle of the Somme, in 1916, the British executed an artillery preparation for seven days³⁶. The synchronization of fire support with the attack was the work of a German officer, lieutenant-colonel Georg Bruchmüller, who reorganized the German units and unit procedures to support infantry maneuvers and prepare the battlefield, with the purpose of wearing down the front-line enemy units, their reserves and rearguard.

Lieutenant-colonel Georg Bruchmüller developed and consolidated his experience at the eastern front. His revolutionary ideas of synchronizing fire support with the advancing infantry were successfully tested in September 1917, in Riga. Bruchmüller was then artillery commander of the 8th German Army of general von Hutier, but was quickly sent to the western front in time for the German counter-attack in the battle of Cambrai, in December 1917. The technique developed by Bruchmüller made it necessary to reorganize fire support and a consequent remodeling of the structure of artillery units.

Reorganizing fire support included systems of fire from artillery units and systems of fire from infantry units. Artillery units had the *Schwereste Flachfeuer-artillerie* (SCHWEFLA) at Army echelon level, aiming special targets, such as bridges, bunkers, and targets that demanded greater destructive power like concrete fortifications. These units were equipped with heavy ordnance. At the Army Corps level, there was the *Femkampf-artillerie* (FEKA) and

³⁴ Geoffrey David Blades, "The Battles of the Lys: The British Army on the Defensive in April 1918", p. 13.

³⁵ Timothy Lupfer, "The Dynamics of Doctrine: The Changes in German Tactical Doctrine during the First World War", p. 41.

³⁶ David Zabecki, "The German 1918 Offensives", p. 54.

the *Artillerie bekaempfungs artillerie* (AKA). The FEKA's purpose was to strike distant targets. It possessed long range howitzers for striking command posts and communications in the allied rearguard area, flanks and reserve areas. The purpose of the AKA was to provide counterbattery fire. On the Division level there was the *Infantriebekaempfungs-artillerie* (IKA). It was the artillery designed for close support of division maneuvers. In the army corps, 20% of systems were for counterbattery purposes and 75% of systems were designed to support division maneuvers.³⁷ The organic fire support of the infantry units was composed of the following units: *Minenwerfer* (MW), *Infantriebegleitbatterien* (IBB), and *Infanterie-Geschuetzbatterien* (IGB). The MW had trench mortars as their main equipment, supported the division during preparatory fire and supported battalions during the assault. The IBB accompanied the regiment maneuvers. It did not give support to preparation fire. The IGB was dedicated to battalions.

In order to integrate firing support, planning had to take into account the following elements: the organization of artillery for combat; the location of artillery units; the location of artillery command posts; the mixture of gases, its effects and expected duration; the duration and beginning of preparatory fire; the advance of barrage fire; maintaining support. Chemical warfare is explicit in these fire support tactics. Neutralization of enemy forces is crucial for the degradation of their potential and for ensuring the success of defensive operations. Bombardments with the purpose of denying certain areas of the terrain to the enemy, of protecting the flanks during the advance of infantry, and of disorganizing command posts and reserve zones were actions where artillery launched chemical agents were part of the German doctrine. Use of explosive grenades was combined with the use of grenades filled with chemicals.

David Zabecki summarizes this combination, presenting Bruchmüller's fire support plans for attack in the following manner:³⁸

Phase I – Preparation (10 – 30 minutes)

- Surprise concentration
- No counterbattery fire
- The targets are command posts, communication centers and troop concentrations
- All guns fire with mix of 9 Blue Cross grenades to 2 HE (high explosive) grenades

Phase II – Preparation (1 ½ – 2 ½ hours)

- Counter-battery fire
- IKA reinforces AKA

³⁷ David Zabecki "Steel Wind", p. 38.

³⁸ David Zabecki "Steel Wind", pp. 52-56.

- Mix of Blue Cross grenades, Green Cross grenades, explosive grenades (HE) and smoke grenades
- FEKA strikes the rearguard command posts, control and communications, and reserves

Phase III – Preparation (1 – 2 hours)

- IKA shifts back to infantry targets
- IKA fires 20% Blue and Green Cross grenades to 80% explosive grenades
- AKA fires 75% Blue and Green cross grenades to 25% explosive grenades
- All weapons switch to strike enemy forward positions ten minutes before the assault

The Assault

- Double barrage fire
- Explosive grenades line moves to a position in front of the infantry at a rate of 40 to 50 minutes per kilometer
- Another line of Blue, Green and smoke grenades moves to a position in front of the explosive grenades position, at least 600 meters in front of the infantry vanguard, timed in order to allow infantry to arrive after dissipation
- AKA continues counterbattery fire
- FEKA fires Yellow Cross grenades towards the flanks, to isolate the objectives

Phases II and III were interspersed with 10 minute fire towards the front-line with the purpose of confusing the enemy regarding the hour of the attack.

Synchronizing artillery (resorting to chemical warfare) with the German assault forces was the key to breaking the allied forces. The German assault forces (*stosstruppen*) explored the weak points in the allied front and infiltrated the inside of allied positions, which were continuously struck by German artillery fire. This doctrine was at the basis of Operation MICHAEL in March, 1918.

Observation of the chemical attack reports shows that on March 9, the chemical situation underwent a radical change. The following figure shows the March 1918 attack front, with the main attack in the south, in the region of Cambrai.

Timothy Lupfer describes the way in which chemical agents were integrated in this attack: “The Germans used gas shells extensively. In areas where an infantry assault was not planned, they used mustard, a persistent agent. In the areas where the German infantry

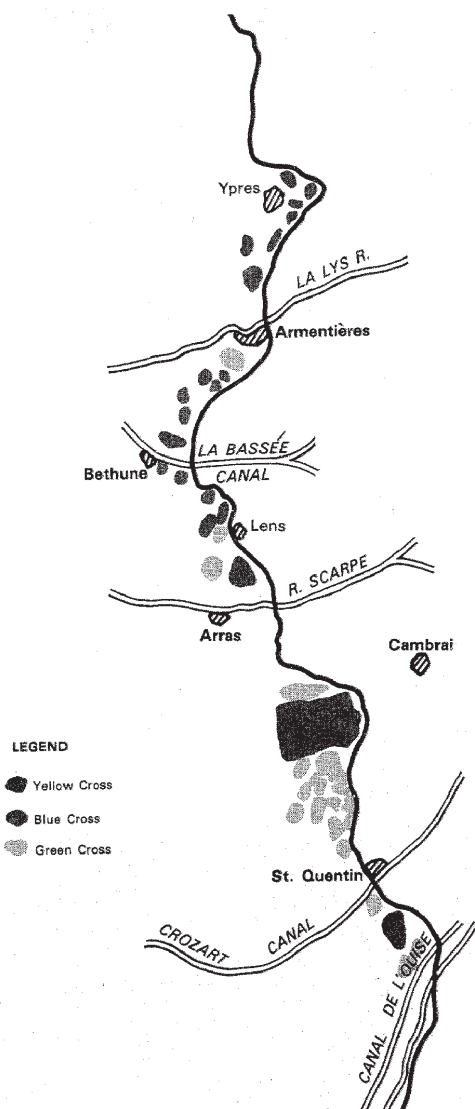


Figure 4 – German Offensive of March 1918

Source: Heller, 1984, p. 29.

would penetrate, the Germans delivered high explosive shells mixed with shells of chlorine and phosgene gas. The Germans also fired shells containing lachrymatory, a throat irritant. The Germans hoped that the irritant would penetrate the British masks, forcing the British soldiers to remove their masks, and thereby exposing themselves to the more lethal chlorine and phosgene.”³⁹

³⁹ Timothy Lupfer, *Op. cit.*, pp. 49-50.

Operation GEORGETTE, the second phase of the Ludendorff offensive for conquering the Ypres region, was initiated on April 7, 1918. The Fourth German Army was given the mission of conquering the Ypres region, and the Sixth German Army was in charge of penetrating the defensive line south of Armentières. The PEC defended the sector with the 2nd Division, seeking to deter the enemy opposing force: the divisions of the Sixth German Army. The German artillery initiated preparatory fire at 0415 hours in the morning of April 9, 1918. The artillery preparation for the Sixth Army⁴⁰ was as follows:

PHASE I (120 minutes)

- Fire strike with a mix of Blue and Green Cross grenades (called Buntkreuez by the Germans) against enemy batteries, trench mortars, headquarters, communication centers, and depots.
- Trench mortars are destroyed after 20 minutes of fire.
- 50 minutes after the beginning of preparation fire, 10 minutes of fire on front infantry positions and no counter-battery fire.
- Explosive grenade fire against the first allied defensive line; Blue Cross grenades against the second and third lines.

PHASE II (30 minutes)

- Fire regulation against the infantry positions.
- AKA continues counterbattery with gas.

PHASE III (115 minutes)

- IKA attacks only the first infantry positions outside mortar range.

The second and third positions are hit with massive fire, especially the break-in sector.

- AKA continues counterbattery.
- After 90 minutes, 10 minutes against allied artillery by the AKA and IKA.

PHASE IV (5 minutes)

- Saturation fire on the leading trenches of the first position.

By 08h45, Portuguese forces withstood the assault of German troops. Barrage fire (the Germans used the expression *Feuerwalze* – fire waltz) supported the mobility of assault troops, initially moving the fire to 300-400 meters inside allied positions. After that, the line of fire would be moved every 200 meters.

⁴⁰ David Zabecki "The German 1918 Offensives", p. 187.

But note the April 1918 offensive:

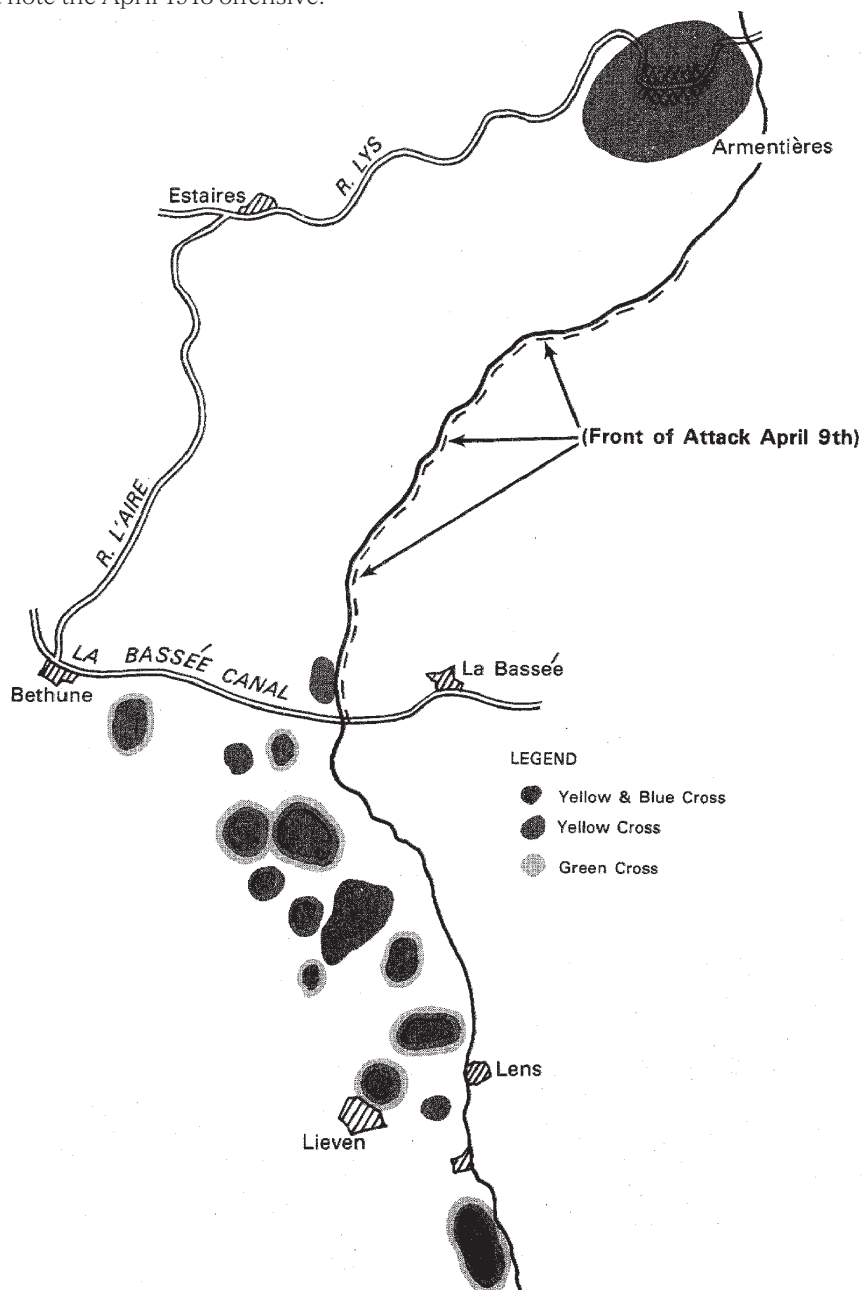


Figure 5 – German Offensive of April, 9, 1918

Source: Heller, 1984, p. 28.

The following is made clear by figure 5: an intense chemical attack was executed, aiming to pin down the British forces south of the La Bassée Channel, and the German effort was carried

out over a small front, in order to quickly breach Allied lines. Citing a reference from the Journal of the Royal Artillery of February 1920, Victor Lefebure stated: “Between the 7th April and 9th April there was no gas shelling between the La Bassée Canal and Armentières, while there was heavy Yellow Cross shelling immediately south of the Canal, and Armentières had such a heavy bombardment that the gutters were running with mustard gas. This indicated the probability of an attack on the front held by the Portuguese, which occurred on 9th April, Blue and Green Cross being used in the preliminary bombardment.”⁴¹ The Portuguese sector was located between the two mustard gas (Yellow Cross) areas.

Walter Goerlitz states that “On April 9th, Ludendorff began the second act of the drama and made a new attack, this time between Armentières and La Bassée. The chief weight of this fell on some Portuguese troops which overwhelmed by an enormous superiority of numbers, and the German masses poured through the gap, but this attack also had lost its force by April 25th.”⁴²

In April, the PEC was victim of a German attack doctrine that employed chemical agents duly integrated in their tactical maneuvers. Classification of gases as persistent and fugacious enabled them to potentiate asphyxiating agents on the battlefield.

Germans classified agents according to tactical use and their doctrine clearly defined rules for their employment. In conclusion, the main agents used by the Germans are summarized in the following table:⁴³

Shell Marking	Effect	Chemical Agent	Duration and Lethality
White Cross	Lachrymatory	Tear Gas	Non Persistent Non Lethal
Blue Cross	Sternutatory	Arsine	Non Persistent Non Lethal
Yellow Cross	Vesicant	Mustard	Persistent Lethal
Green Cross	Choking	Phosgene Chlorine Lewisite	Non Persistent Lethal

The marking and classification system of German grenades was adopted by allied forces. Brigadier General Amos Fries, in his final report on the Great War, published in 1921, defended a classification of chemical agents as persistent and non persistent.⁴⁴

⁴¹ Victor Lefebure, “The Riddle of the Rhine”, p.77.

⁴² Walter Goerlitz, “The History of German General Staff 1657-1945”, p. 195.

⁴³ David Zabecki “Steel Wind”, p. 35. António Figueiredo had already done this observation in 1938.

⁴⁴ Brigadier General Amos Fries, “Chemical Warfare (1921)”, p. 365.

This is also the current classification of chemical weapons regarding their tactical use.

Synchronization of fire support with infantry maneuvers was a German innovation in the battlefield. Use of grenades with chemical agents played a crucial role in this artillery tactic. Germans used non persistent agents in offensive actions and on locations that could be occupied by German troops. They used persistent agents to restrict access to certain areas and severely hit certain concentrations of allied forces. Artillery was crucial for German offensives during the 1918 Spring, thanks to the new methodologies implemented by lieutenant-colonel Georg Bruchmüller. One of the operations in this offensive had devastating effects in the PEC sector. The Portuguese forces were in the way of an attack planned and executed with a precision that was consistent with German doctrine.

5. FINAL CONSIDERATIONS

“The Portuguese went to war because they were told to, without enthusiasm, which only comes from a real, high and noble purpose, and that explains the churlish attitude of most soldiers setting out for France.”⁴⁵ As is evident, the psychic state of the Portuguese soldiers was not brilliant, and disorganization and apathy started taking over the PEC. These were not the ideal conditions for combat in a chemical environment. Training was what was possible under the circumstances, and the harsh conditions in the trenches degraded combat potential, and living under a climate of permanent threat, where it was required to put on a mask which made breathing difficult and increased exhaustion, led to the disorganization of defensive zones.

Moreover, lack of understanding of the imminence of danger was a reality in the PEC units. On this matter, General Ferreira Martins comments: “An interesting document on the peculiar psychology of our soldiers could be extracted from the unpublished reports of company commanders, the analysis of which would be most useful for the proper training of commands.

Intense bombardment; an officer walks by a *Line A* post and asks: *How about it, huh? How is it looking?* And the soldier, in his candor, replies: *Ah, my captain, it's not as bad as they said.* Another, walking down a communication trench, answers the same question: *“They buzz, but there's casqueiro”* (soldier's brown bread), and merrily goes on his way.

Distraction is manifest and on occasion approaches recklessness: “A section commander saw two soldiers removing their boots and equipment inside a shelter, preparing to go to sleep. They responded to the sergeant's energetic remark in this manner: *“We did not know we needed to keep our weapons, and keep all this on top of us; as we were not told anything, we thought we could now sleep better !...”*”⁴⁶

Desperation from prolonged life in the trenches, where chemical attacks were just another one of the routine bombardments that they had grown used to, with masks that only lowered morale, led to the state of neglect in which PEC personnel were often found.

⁴⁵ Mendo Castro Henriques, citing General Gomes da Costa, Op. cit., p. 31.

⁴⁶ General Ferreira Martins, “Portugal na Grande Guerra” (“Portugal in the Great War”), Vol 2, p. 256.

However, careful analysis of what was going on in the Theater of Operations, the observations and instructions gathered showed that there was an understanding of the situation. An analysis of chemical warfare demonstrated that Portuguese forces had been aware from early on of the evolutions developing in the battlefield, that they had the technical knowledge and acted according to certified procedures. But the PEC suffered the consequences of a doctrine that matured as the conflict evolved. The powerful German chemical industry had the opportunity to progressively leave its mark on the conflict, creating space for innovation and integration of technology in offensive maneuvers.

If a possible lack of morale among Portuguese troops was a weakness at the front, evidence of the potential of the German attack of April, 9 cannot be ignored. An analysis of the main battles that resulted from the 1918 offensive, as presented by David Zabecki⁴⁷, can be summarized in the following manner:

	St. Quentin	Lys	Chemin des Dames	Noyon	Champagne-Marne
Date	March 21	April 9	May 27	June 9	July 15
Attacking Armies	17th; 2nd; 18th	6th	7th; 1st	18th	7th; 1st; 3rd
Preparation Length	5 h	4 h 30 m	2 h 40 m	3 h 45 m	3 h 40 m
Opening Time	04h40	04h15	02h00	00h50	01h10
Preparation Phases	7	4	5	3	4,5
Rounds fired on day 1 (millions)	3,2	1,4	3,0	1,4	4,5
Gas proportion	1/3	1/3	1/2	1/3	1/8
Front width	75 km	17 km	55 km	33 km	88 km
German Guns	6.608	1.686	5.263	2.276	6.353
German Guns/km	88	100	95	70	73
Allied Guns	2.686	511	1.422	711	3.177
Artillery Comparative Strenght	2,5	3,3	3,7	3,2	2,0

⁴⁷ David Zabecki "Steel Wind", p. 68.

In the battle of La Lys, the Germans performed one of their larger artillery concentrations, with a relative artillery potential much greater than the allies' and with a proportionate use of chemical agents. This comparison, considering the numbers, reveals that the Portuguese 2nd Division was not faced with an easy task on April 9, 1918.

Major Kenneth McKenzie of the United States Marines summarized the doctrinal evolution of Germany's use of chemical agents. The following table presents the development of German chemical warfare from 1914 to 1918:

Period	Significant Battles	Expectations	Effects	Doctrine
1914-15	Bolimov, Neuve Chapelle, Ypres	none	mixed	none
1915-17	Verdun	low	indecisive, attritive	technical only, not linked to maneuver
1917	Riga, Caporetto	moderate	successful, attritive	informal technical and operational; linked to maneuver
1918	Michael	high	very successful	formal technical and operational; linked to maneuver

Chemical weapons require the present of the following elements: a chemical compound (or chemical agent); ammunition to store the chemical agent; a launching system to disperse or drop the agent on the desired location; and weather conditions. Throughout the First World War, these elements were taken into consideration in the development of chemical compounds and the manner of their placement on the battlefield. Weather conditions were naturally the hardest to control, or control was nonexistent. The systems in use evolved and influenced tactical and technical procedures in the battlefield.

The heavy gas cylinders needed to be transported, requiring the use of trains and available manpower, which meant using infantry troops and concentrating large quantities of these assets on rail terminals. That is, there were enormous known drawbacks. The infantry was busy with work other than maneuvers and the areas where the cylinders were located were easily identified by air reconnaissance. The element of surprise was lost in the attack preparation phase, and too much time was spent transporting the assets.

In the First World War, there was not much variety of agents available for large scale use. Chlorine and phosgene were the gases used initially by both Germans and Allied. Hydrogen sulfide, carbon monoxide and hydrogen cyanide were suggested and tested, but

were abandoned for one reason or another.⁴⁸ These chemical compounds can hardly be called chemical warfare agents. These compounds are extremely volatile, and so are vaporized very quickly under normal temperature and pressure conditions. They form a vapor which disperses into the atmosphere, decreasing their concentration and lethal effect.

As previously mentioned, gas cloud attacks depended heavily on weather conditions. Speed and wind direction were extremely important for a successful attack, driving the cloud into enemy lines, but attacking troops had to be forewarned that they needed to protect themselves if weather conditions were to change.

But evolution brought along a complete chemical weapon. Filling grenades with chemicals and using the artillery to launch them brought innovation into the battlefield. The use of gas in artillery grenades did not require specialized troops, because those grenades were fired in the same way as explosive grenades and by the same garrisons. When artillery fire is designed for ranges of two or more kilometers, wind direction and speed are of lesser importance. The chemical compound disperses in an area distant from the attacking troops. The only aspect that needed to be considered was regarding the chemical compound, that is, if it should be short or long lasting. If it was a persistent agent, the area where it was dispersed should be avoided by the attacking force. If, on the other hand, the effects were not persistent, the attacked area could be occupied by assault troops and the goal would be to degrade the combat potential of the defenders. Another factor that made artillery useful was its ability to achieve a high gas concentration, quickly and on distant targets, using larger caliber fire-mouths to fire gas grenades.

The second half of the war witnessed the use of mustard gas. It was a chemical compound with persistent, lethal effects. The designation of gas comes from the habit created since the beginning of the war. The first agents were gases and the name chemical gas warfare started coming into use, but mustard is a liquid.

The chemical composition of Mustard gas is dichloroethyl sulfide (ClCH_2CH_2)₂S. The name originated with the English, because the substance used primarily by the Germans suggested mustard or garlic. There have been other designations for the compound, like “Yellow Cross”, the markings on the German grenades, or “Yperite”, the French designation referring to the first use of the compound in Ypres, and vesicant gas, due to its effect on the skin. Mustard gas was used for the first time as an offensive agent by the Germans in July 12-13, 1917. The tactical value of the agent was immediately recognized by the Germans, and they used it in large quantities. For ten days during the Autumn of 1917, it is estimated that more than 1.000.000 were launched, containing some 2.500 tonnes of mustard gas.⁴⁹

Conclusion

The use of chemical warfare agents was a new weapon explored in depth during the First Great War. The manner in which the various contenders regarded this weapon was reflected in different ways on the systematization associated with the planning and employment of

⁴⁸ Brigadier General Amos Fries, *Op. cit.*, p. 17.

⁴⁹ Brigadier General Amos Fries, “Chemical Warfare (1921)”, pp. 150-151.

asphyxiating chemical agents. There are two perspectives on the question: **what was the classification of chemical warfare agents and what were its implications for the Portuguese Expeditionary Corps (PEC)**. The Allied classified chemical agents from a clinical perspective, and so directed their aim to the study of the symptomatology associated with the victims of these agents. Germany classified these agents from a tactical perspective, and so focused their plans on potentiating this weapon on the battlefield. The use of chemical agents was a decisive element in the large scale offensives of the Spring of 1918. Germany did not achieve decisive results, but the main attack on the PEC sector with use of chemical agents in support of offensive maneuvers ended up destroying the Portuguese forces.

The briefs and reports produced by the PEC regarding chemical attacks were simply alerts on protection measures and successive statements on troop disorganization at the front-line. Even planning was carried out according to English instructions.

The doctrinal development practiced by the Germans presented a battlefield logic that did not escape the observation of the Allied armies. The tactics used by the Germans and their discriminating use of chemical compounds, duly integrated in artillery support fire, were quickly analyzed by specialists in the post-conflict reports. The classification of chemical agents could not be limited to its physiological effects. A classification taking into account their tactical use was crucial, and one would be added to the field manuals of the forces participating in the First World War, Portugal included. And as chemical warfare was a reality that could never be ignored, everything that would later become a part of army instruction, training, and operations were lessons learned from the prior conflicts. The rule was set: chemical agent; munition; launch system; and weather conditions. The latter will not easily be altered. As for the first three, the future will tell.

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