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An Element of Controversy

The Life of Chlorine in Science, Medicine, Technology and War

Edited by Hasok Chang and Catherine Jackson

from research by undergraduate students at
University College London

British Society for the History of Science

2007

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Front cover illustration: Blueprint for a chlorine chamber for the cure of respiratory diseases. Reproduced by permission of Edward G. Miner Library, Rocherster, New York.

Back cover illustration: Chlorine gas, courtesy of the Department of Chemistry, University College London. Photo by Gretchen Siglar.

Contents

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Chlorine as the First Major Chemical Weapon

Frederick Cowell, Xuan Goh,
James Cambrook and David Bulley

1. Introduction

In standard accounts of the First World War (WWI), particularly those in works of fiction and popular history, the German use of chlorine gas at Ypres in April 1915 is portrayed as a dastardly action that terrorized soldiers, causing inhumane injuries and particularly agonizing death. The British, meanwhile, were reluctant to use gas on moral grounds and this is why they did not retaliate with chlorine until the Battle of Loos in September 1915. In this chapter we make a detailed examination of these two episodes and circumstances surrounding them, showing that the story of gas warfare is considerably more complicated than commonly suggested. The use of gas in WWI raised complex moral and military questions that were not easily resolved by any of the combatant nations. As the discussion in Chapter 8 will make clear, attitudes to gas varied widely even amongst military men. Gas was one of a number of powerful new military technologies, including the tank and the airplane, and the use of gas in WWI cannot be considered in isolation from the introduction of these technologies as a group.

In more recent military history, the German use of gas is now understood as an ultimately futile attempt to break the deadlock of trench warfare, which gave the defending side a significant advantage. Military tacticians hoped that gas would drive soldiers from their trenches, but such hopes were largely disappointed. Both sides quickly developed effective defensive strategies to limit the effectiveness of gas, and difficulties with its deployment meant that gas was rarely used to its full potential. The neglect of gas in general military histories of WWI suggests that many historians have concluded that gas was of no strategic

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importance to the progress of the war. The tank, which was a crucial strategic success, has received substantial coverage, whilst gas warfare rarely receives more than a mention. Our study suggests that although gas was rarely decisive, it continued to be a significant element of military strategy on both sides after April 1915.

This chapter presents a revised history of the use of gas in WWI, challenging two main assumptions found in popular historiography:

> (1) Gas was an immoral weapon of terror and British reluctance to use gas was driven by principally moral and ethical considerations.
>
> (2) Gas proved to be of little or no strategic importance and therefore does not warrant detailed treatment in military histories of WWI.

We will start by reviewing, in Sections 2 and 3, the sequence of events leading to the first large-scale German gas attack at Ypres in April 1915 and the British retaliation at Loos in September 1915. In constructing this narrative, we have drawn on some archival sources as well as synthesizing various existing accounts. In Section 4 we will discuss the strategic and tactical effects that the use of gas had in the remainder of the war. In Section 5 we will provide an account of the British soldiers' experience of gas, which is of interest in itself but also helpful in framing the questions about the ethical dimensions of gas warfare, which we consider in Chapter 8 more fully.

2. The arrival of gas warfare

2.1. The German use of gas at Ypres

When war broke out in August 1914, Germany implemented the Schlieffen Plan. Developed by the erstwhile Imperial Chief of General Staff, Alfred von Schlieffen, the plan was to ensure that Germany would be victorious in a European war fought simultaneously in both the east and the west. It had two components: a swift drive through Belgium to encircle Paris, followed by a rapid mobilization of forces in the east to defeat advancing Russian armies. The execution of the plan in 1914 by Schlieffen's successor Helmuth von Moltke and Field Marshal Erich von Falkenhayn ran into difficulties almost immediately. When the Germans marched into Belgium, they precipitated the British entry into the war in

response to a defensive treaty with France. The scale of fighting on the Western Front increased dramatically, and Russian mobilization was much more rapid than Schlieffen had predicted.[1] In the face of these new obstacles, the German General Staff deviated from the Schlieffen Plan. In September 1914 German troops approached Paris from the east, but their lines of communication were disrupted by the British Expeditionary Force (BEF).[2] Following the German retreat from the "gates of Paris", the Allied and Central powers tried unsuccessfully to outflank each other in a race to the northern French coast.

By the end of 1914 there was a deadlock on the Western Front, with armies from both sides dug into trenches 475 miles long, stretching from the North Sea to the Swiss border. The mass deployment of machine guns had ended the era of cavalry charges supported by artillery, which had been the mainstay of European warfare for over fifty years. As the Germans found out to their cost in 1914 at the Battle of the Marne and the First Battle of Ypres, machine-gun posts (or nests) and carefully aimed rifle fire could decimate advancing infantry in seconds.[3] For any assault to stand a chance of success, it was vital to neutralize the machine gun posts that lay between the front line and the support trenches.[4] The technique of "rolling" artillery fire was developed to deal with machine gun nests. This involved firing shells just ahead of the advancing infantry, but in the days before field radios these attacks were difficult to control and what are now termed "friendly fire" incidents were the norm of many battles of WWI. The "problem of the Western Front" was how to immobilize enemy fire during an attack, and it was in an attempt to overturn this advantage of defence over offence that gas, tanks and airplanes were used.[5]

Late in the afternoon of 22 April 1915, German commanders, including the chemist Fritz Haber, gave the order for the release of around 150 tonnes of chlorine gas from six thousand cylinders on a four-mile

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[1] See Strachan (2001), pp. 164–173, on the origins and characteristics of the Schlieffen Plan; see pp. 211–224 on the early stages of the war on the Western Front, and p. 312 on the unexpected swiftness of Russian mobilization on the Eastern Front.
[2] Sheffield (2001, p. 90) and Strachan (2001, p. 245) describe the change of direction that led German troops to approach Paris from the east rather than encircling it from the west as originally planned.
[3] Keegan (1999), Chapter 4.
[4] Sheffield (2001), p. 99.
[5] See ibid., pp. 102–103, on the introduction of gas and tanks to WWI.

stretch of the Allied lines near Ypres in western Belgium. As soon as the liquid from the cylinders had been released, it turned into a dense yellowish-green cloud which swelled over the Allied trenches. The German Army had waited for eleven days for the winds to turn in their favour before they dared release the gas.[6] As the cloud drifted over French defences at Langemarck near Ypres that were being manned by the 45th (Algerian) Division and the 87th Territorial Division, soldiers noticed "strange white puffs of smoke". Within an hour both units were retreating westwards, clutching their throats in agony and leaving a gap of 8,000 yards in the front.[7] The gas was quickly identified as chlorine by Canadian officers who had been chemists in peacetime. As early as 24 April, Canadian soldiers were ordered to improvise protective masks by soaking gauze in bromide or urine.[8] When the Germans launched a second gas attack on 24 April on the Canadian sector of the line, its effect was limited by even these improvised precautions. A third attack on 1 May, just south of Ypres on trenches manned by the 1st Battalion Dorset regiment, presented a much more serious threat. The gas attack in this case was followed by a massive infantry assault. Only great courage in the face of enormously high casualties enabled the Dorset regiment to hold their ground. An officer recalled that "200 men passed through my hands . . . some died with me, others on the way down . . . 90 men died from gas poisoning in the trenches; . . . of the 207 brought to the nearest dressing station 46 died immediately and 12 after long suffering".[9] The British estimated that as many as 5,000 men were killed and a further 15,000 injured.[10]

Sir John French, Commander-in-Chief of the BEF, sent the following dispatch:

> What followed almost defied description. The effect of these poisonous gases was so virulent as to render the whole of the line held by the French Division practically incapable of any action at all. It was at first impossible for anyone to realise what had actually happened. The smoke and fumes hid everything from sight, and hundreds of men were

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[6] Evans (2000), p. 21.
[7] Brereton (1915), p. 93; Spiers (1999), pp. 70, and 15.
[8] See Edmonds and Wynne (1928–47), pp. 215–220, cited in Spiers (1986), p. 16, on the first improvised gas masks used by Canadian soldiers. Groom (2002, p. 107) describes the use of improvised gas masks on 24 April by Indian soldiers at Ypres.
[9] Keegan (1999), 215.
[10] Evans (2000), p. 21.

> thrown into a comatose or dying condition, and within the hour the whole position had to be abandoned, together with about 50 guns.[11]

The Germans appeared to have executed the perfect surprise attack, but in fact the use of gas should not have been such a surprise. French intelligence reports received on 30 March and 15 April had indicated that the Germans were preparing an imminent gas attack. On 13 April, about a week before the first gas attack at Ypres, a German private carrying a primitive respirator was captured by French infantry. Aerial reconnaissance had already shown large cylinders being placed at the front line, and a joint intelligence report for both British and French forces had recommended that either troops from that sector of the line should be withdrawn, or the suspected gas emplacements bombed. No action was taken.[12] Moreover, the possibility of gas warfare was well-known to some high-level military figures including Winston Churchill, First Lord of the Admiralty at the start of the war and Munitions Minister from 1917.[13]

It was the *effectiveness* of the first gas attacks that was far more unexpected than the *use* of gas.[14] Many historians have commented that the German army had not placed an adequate number of troops at Ypres to exploit the breach of the frontline opened up by the gas attack.[15] As the German chemist Walther Nernst commented, however, "It was only an experiment".[16] German troops advanced cautiously behind the gas cloud, and this allowed the Allies to regroup and begin a counter-attack. Instead of resulting in a decisive victory for the Germans, the use of gas was resisted by the Allies, who held the Ypres salient.

2.2. Early British responses to Ypres

The British press was outraged by the use of gas. On 30 April, *The Times* thundered: Germany had "devised an atrocious method of warfare which would fill all races with horror. . . . the question is no longer a question of right, but merely a question of expediency".[17] The German

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[11] French (1917), pp. 362–363.
[12] Lloyd George (1938), p. 117.
[13] Churchill (1939), pp. 516–519.
[14] Cook (1998, p. 6) makes a similar point.
[15] See, for example, Spiers (1999), p. 70; Evans (2000), p. 22.
[16] Richter (1992), p. 8, footnote 10, refers to Nernst's comment: "Es war nur ein Versuch"; see also Haber (1986), p. 34.
[17] *The Times*, 30 April 1915.

use of gas was portrayed in the most negative possible terms. According to *Punch*, gas warfare was "an uglier outcome of the harnessing of science to the powers of darkness" than even the German poisoning of wells in south-west Africa. Meanwhile, individual heroism was celebrated as the British Tommy was praised for remaining "cheerful" in the face of "the odds with which our officers and men have to contend".[18] However, the moral outrage about gas did not persist. The press continued to report "tales of German frightfulness", but its coverage of gas warfare was substantially altered following the British decision to retaliate. The *Daily Express* report of the Battle of Loos did not mention gas once, preferring to concentrate on the "piles of German corpses". The German use of gas had been "frightful" and "atrocious", but in British hands gas warfare was cloaked in the morality of the cause. As Arthur Conan Doyle put it, gas became "that filthy treacherous ally" for the British.[19]

Defence against gas became a clear priority. The *Daily Mail* mounted a campaign, backed by the department store Harrods, to supply soldiers with respirators made from cotton wool in a gauze envelope. It called on the women of England to make these masks to its own pattern. Harrods removed spring fashions from its Knightsbridge shopfront and instead displayed the respirators, for which it sold both materials and pattern.[20] More than a million of these respirators were made and a large number were issued to troops at the front, but they were withdrawn by the British High Command a week later. The *Daily Mail*'s design caused suffocation when wet and these masks were responsible for scores of British deaths during that week.[21] A report to the War Office, dated 24 May, described all men having respirators, "though few had the official War Office pattern".[22] In fact, casualty rates were exceptionally high among those not wearing the official War Office design, and it was not until the issue of the Standard Box Respirator as part of standard kit in the summer of 1916 that British soldiers were routinely and effectively protected against chlorine and the gases that followed it.

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[18] *Mr Punch's History of the Great War*, London, 1920.
[19] Haber (1976), p. 5.
[20] MacDonald (1993), p. 232.
[21] Harris and Paxman (1983), p. 6.

Although the initial response to gas was *ad hoc*, more formal precautions developed quickly. By the summer of 1915, the British had started setting up bells and issuing rattles to frontline positions so that the alarm could be sounded when gas was sighted. In 1916, Strombous horns were introduced; these were klaxons attached to canisters of compressed air, issuing a piercing blast which could be heard up to a mile away. (The gas alarms, however, became rather useless once the Germans began to use the invisible, odourless gas, phosgene.) Within a month after Ypres respirator drills and gas watches were set up, and this began to incorporate gas warfare into trench routines. By the end of 1915, each soldier had to don his hood within six seconds while exposed to a cloud of tear gas, having first repeated his name, battalion and serial number twice. Such routine gas-mask drills were designed to give soldiers confidence under attack and to prevent panic.[23] According to a report on gas precautions, "there is and *was* no panic over gas. I hope there will hardly be any excitement next time".[24] Gas inspections checked troops regularly to ensure that they were carrying their respirators, but as a dispatch rider recalled, "helmets were taken everywhere . . . no one wanted to die of gas".[25]

Immediately following Ypres in April 1915, Sir John Boyd was appointed anti-gas officer for the 80th division. He received a modicum of instruction, for the most part resorting to "common sense" measures for dealing with the effects of gas poisoning. These included the administration of cough mixture to deal with congested lungs.[26] The following month, the Royal Army Medical Corps issued precautionary advice to all divisional Medical Officers concerning gas prevention. Most of this centered on the importance of gas mask drills, even though not all men had been issued with official gas masks at that point. In October 1915, arrangements were made for all divisional Medical

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[22] TNA: PRO WO 32/5169. In this and subsequent citations to materials held at the UK Public Record Office (PRO, now part of The National Archives), Kew, London, we make references using the Archive's official classification system.
[23] IWM Photograph Archive Q.24770. In this and subsequent citations to materials held at the Imperial War Museum (IWM), London, we use the Museum's standard catalogue numbers.
[24] TNA: PRO WO 159/453.
[25] This and other similar recollections are preserved in the Sound Archive of the Imperial War Museum, London.
[26] Boyd, cited in Whitehead (1999), p. 167.

Officers to meet the Director of the central laboratory for official advice and training on handling gas casualties. Five-day training courses were later set up to train Medical Officers "in how to deal with Boche vapours and stink pots".[27]

3. The British entry into chemical warfare

One major outcome of the first German gas attack at Ypres was to prompt retaliation in kind. Sir John French cabled London the following day urging "that immediate steps be taken to supply means of most effective kind for the use by our troops".[28] The War Minister, Lord Kitchener, replied that "before we fall to the level of the degraded Germans, I must submit the matter to the government".[29] How did the British government make its decision on this matter, which was in the end to enter into the arena of chemical warfare, setting aside its moral and political qualms?

3.1. The situation before Ypres

Despite Kitchener's revulsion at the German use of gas, the British had previously considered employing chemical weapons. In October 1914, the War Office rejected a proposal to drop bombs containing aqueous hydrocyanic acid on the basis that this violated the Hague Convention.[30] Towards the end of September 1914, the War Office and the Admiralty had prohibited the use of shells filled with tear gas for the same reason. Nevertheless, scientists continued to work on the development of chemical agents for use in war. Perhaps the most significant of these was the work of J. F. Thorpe and H. B. Baker at Imperial College London on tear gases. Their studies of ethyl iodoacetate, which could be prepared using readily available materials, led to the development of a practical tear gas by January 1915, code-named "SK" after the college's South Kensington location. Several tests of the new agent were conducted in a trench on college grounds, observed by Colonel Louis Jackson of the War Office, who declared it to be efficient.[31] But nothing more was done

[27] G. Moore, letter of 4 June 1916, quoted in Whitehead (1999), p. 168.
[28] TNA: PRO WO 142/241.
[29] Palazzo (2000), p. 44.
[30] Haber (1986), p. 22.
[31] Ibid., p. 23.

in this area until after Ypres, so although the British had some experience of research with chemical agents, no organized research infrastructure was in place.

Maurice Hankey, Secretary to the Committee for Imperial Defence and the War Council, was a key figure in coordinating early British plans for chemical warfare. He received input from independent individuals (many of them characterized as "cranks"), as well as powerful political figures, which he communicated to the War Office. The possibility of using non-asphyxiating gases was drawn to Hankey's attention in January 1915 by the Belgian doctor Smets-Mondez, who had identified amyl nitrate as being suitable to reduce the enemy's fighting capabilities by inducing sleepiness. Hankey recommended the use of chemical weapons to the War Office that month. Smets-Mondez's proposal was eventually rejected on the basis that, while it obeyed the letter of the Hague Convention, it betrayed its spirit. The British were clearly considering the use of gas, but they were restrained by compliance with international law.[32]

Winston Churchill also played a major role in raising the profile of gas warfare inside the British government, largely in response to his own beliefs concerning German scientific capability and attitude to the conflict. Churchill had discussed with Lord Dundonald plans to use smoke as a tactical weapon, designed to drive the enemy from their posts by using noxious, but not deadly, fumes. These ideas had originated during the Crimean War with Dundonald's grandfather, Admiral Cochrane. Despite their age, they interested Churchill and he was determined to preserve their secrecy. He claimed that "there can be no question that Lord Dundonald had grasped at this time [that] the whole idea of gas and smoke warfare [was] explicitly prohibited by International Law". Nevertheless, Churchill was so keen that these ideas should be pursued, that he not only suggested that Dundonald approach Hankey with the information, but referred to these discussions in his correspondence with the Prime Minister, Herbert Asquith.[33]

Before we enter into further details about the deliberations that were made within the British government on the question of using chemical weapons, we must make a brief detour to explain the structure

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[32] TNA: PRO CAB 21/83.

[33] Churchill (1939), pp. 516–519, direct quotation from p. 519. See also TNA: PRO CAB 41/36/18.

of British government at the time, since it has changed significantly in the last century. The present-day Ministry of Defence, for example, is a relatively new structure, which succeeded the more aggressively named Ministry of War. Then, as now, the most powerful body in the government, particularly with respect to decisions regarding military policy, was the Cabinet. In the early 20th century, the Cabinet was supported by a large number of committees which were responsible for specific areas of governmental policy and coordinated the executive functions of government departments. Defence was centralized within the Naval and Military Committee, created by Lord Salisbury in 1889–90.[34]

At the outbreak of WWI, the primary committee for defence and war was the Committee for Imperial Defence (CID). This body, which included the Prime Minister, was responsible for making military strategy and ensuring the preparedness of Britain for war. In the pre-war period, the CID studied the coordination of military affairs between different parts of the Empire and planned to mobilize industry and the economy. It also published the "War Book", which was a manual outlining the roles of the different departments associated with the CID and setting out plans for action in various contingencies.[35] The CID was officially in charge of the BEF when it was sent to France in the early stages of the war, but divided opinion over the decision to send forces to France attracted the attention of the entire Cabinet. The CID's influence on the overall direction of the war went into further decline as it was increasingly consulted only in connection with matters of Home Defence, with its subcommittees increasingly taking charge of forces in specific geographical areas overseas.[36]

The CID was superseded in November 1914 by Asquith's formation of the War Council. This body had rather indeterminate procedures and responsibilities. Many of its members were also Cabinet ministers, with the result that important issues were often discussed outside its formal meetings.[37] Churchill once told Hankey: "You must not suppose that the written records and formal meetings embody the whole discussion between members of the War Council. On the contrary, we

[34] Ehrman (1958), pp. 4–5, 28, 40–41.
[35] Keith (1952), p. 112.
[36] Turner (1982), p. 58.
[37] As in the case of the ill-fated Dardanelles expedition, which Kitchener, Churchill and Asquith discussed at length.

were always talking over the situation in twos and threes".[38] The War Council, moreover, had no executive power and concerned itself primarily with a systematic review of Britain's military position and enemy resources.[39] On 13 January 1915 it agreed on a statement of strategic intentions for the new year, including an attack on the Western Front.[40] The French refused to support a new offensive in the West, and the War Council reconvened on 28 January to review alternatives. Meanwhile, strategic thinking was increasingly directed by the Cabinet towards the campaign in the Dardanelles, which offered the possibility of opening up a new front by attacking the enemy from the rear. By February this was the main focus of the War Council, and its preoccupation with this issue signalled the end of its role as an advisory committee on strategy and policy for the war as a whole. The Cabinet itself assumed this broader responsibility and, although the War Council might have been expected to participate in the decision to use gas, there is no record of its involvement.[41] War Council minutes show that it met infrequently relative to the Cabinet during the relevant period, meeting on 6 April and then not until 14 May, a few weeks either side of the German attack at Ypres on 22 April.[42]

3.2. The decision to retaliate in kind

The Cabinet decision to use gas in WWI appears to have been made in a series of three meetings which took place between 27 April and 4 May 1915, although there is no explicit documentary evidence of the decision itself. Cabinet meetings were the only regular occurrence at the highest level of government, and their main purpose was the overall supervision of governmental business, planning of legislation, and handling of diplomatic emergencies (such as that in Ireland). The Cabinet

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[38] Hankey (1961), p. 291.
[39] Turner (1982), p. 58, citing TNA: PRO CAB 22/1.
[40] Ibid.
[41] Searches of the Public Record Office catalogue do not show any discussions of poison gas in War Council meetings. War Council minutes were kept as compressed debates within the main record, written by Hankey or an assistant. This record was not circulated, in an attempt to preserve secrecy. Instead, "conclusions" containing minimal information were extracted and sent to relevant departments. See Turner (1982), p. 70.
[42] See Ehrman (1958), p. 56, and Turner (1982), p. 59, on infrequent War Council meetings.

often reviewed War Council discussions and retained control of such essential matters as the choice of military objectives, the raising of men, the production of munitions and the financing of the war.[43] The only official record of Cabinet meetings before 1916 is contained in personal correspondence between the Prime Minister and the King. These letters were written on the same day as the meeting, or the following day. They were short, only providing a brief summary of discussions.

As mentioned previously, Sir John French had cabled London immediately following the German gas attack at Ypres on 22 April 1915, requesting permission to retaliate in kind. Even though he shared French's concern, Lord Kitchener had insisted on submitting the matter for government consideration. The reply was not speedy. Despite military perceptions that not to retaliate would be "suicidal", issues of law, ethics, morals and public opinion had to be taken into account.[44] The Cabinet met three times in the two weeks immediately following the attack at Ypres, on 27 and 28 April, and again on 4 May. According to Asquith's report on the meeting of 27 April to King George V:

> Some discussion took place on the recent resort by the enemy to the use of asphyxiating gases. As the gases are apparently stored in and drawn from cylinders and not 'projectiles', the employment of them is not perhaps an infraction of the liberal terms of the Hague Convention. Our soldiers are being provided with face and mouth pads of cotton steeped in bi-chlorate of potash as a protection. The Admiralty has been for some time past experimenting with a view to the production of smoke in large quantities for a screen.[45]

It seems clear that the Cabinet discussed whether Germany had broken any international laws, as well as how to deal with their actions. The meeting on the following day heard: "Inquiries and experiments are being made as to the best way of dealing with the resort by the Germans to asphyxiating gases".[46] The possibility that the British might use gas, however, only became explicit in the third meeting on 4 May, after which Asquith reported:

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[43] Keith (1952), p. 128.
[44] Richter (1992), p. 17.
[45] Letter from Asquith to the King, 27 April 1915, TNA: PRO CAB 41/36/18.
[46] Letter from Asquith to the King, 29 April 1915, referring to the meeting of 28 April, TNA: PRO CAB 41/36/19.

> Considerable discussion took place on Sir J. French's request that he might be supplied with the means of retaliating on the Germans by the use of some form of poisonous gas. The respirators sent out to the troops have not so far proved an effective protection, and Dr [J. S.] Haldane has gone over to France to make further inquiries. Meanwhile both the Admiralty and War Office are busy experimenting.[47]

There is no explicit documentary evidence as to when the authorization to retaliate was given, but it seems likely that it was made on 4 May, when Air Ministry records show that a committee appointed "to consider the use of asphyxiating and life destroying gases" held its first meeting at 3pm.[48] The decision to use gas had certainly been made by 17 May, when Lord Crewe (Secretary of State for India) wrote to Lord Kitchener on behalf of Lord Curzon (Lord Privy Seal) asking whether the use of gas against the enemy had been sanctioned. He received a terse reply: "The govt. is not prepared to allow our troops to fight at such an enormous disadvantage as would be created if we did nothing to make use of these methods".[49] Lord Kitchener elaborated on British plans for retaliation in a note to the Cabinet on the status of the war during the period from August 1914 to May 1915, which was issued in late May or early June 1915:

> It was decided that immediate provision should be made for the *use* by our troops of gases which were as harmful and deadly, but not much more so, than those employed by the enemy, and also *preparation* and *experiment* with more deadly things should proceed with all speed.[50]

It is impossible to be certain of the detailed content of the discussion, but the Cabinet considered two important issues concerning the German use of gas and British retaliation. First, it attempted to establish the legal position connected with the German use of gas and any potential British retaliation, paying particular attention to the Hague Convention of 1899 outlawing "the use of projectiles the *sole object* of which is the diffusion of asphyxiating or deleterious gases".[51] Second, the Cabinet's

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[47] Letter from Asquith to the King, 5 May 1915, referring to the meeting on 4 May, TNA: PRO CAB 41/36/20.
[48] TNA: PRO AIR 1/2656.
[49] Undated, unsigned reply to Crewe's letter, TNA: PRO WO 24/40. The WO classification indicates that this letter originated in the War Office, possibly even written by Kitchener.
[50] TNA: PRO WO 159/21, emphases original.
[51] Scott (1920), p. 266.

extensive discussions indicate that the decision to retaliate was not easily made and that it is highly likely that ethical and moral considerations figured in these discussions. Kitchener had made no secret of his disdain for the use of gas in his appeal to the government, saying that "these methods show to what depths of infamy our enemies will go in order to supplement their want of courage in facing our troops".[52] Feelings that gas was "downright unsporting" were also common. The indiscriminate nature of gas injuries, which were considered to affect soldiers without regard to their courage, experience or fighting skill, offended the British sense of fair play.[53] As William Moore points out, "Britain was then still a country where it mattered very much just how you 'played the game'."[54]

The historian Richard Price argues that questions of legality were the primary concern for the British in these discussions, moral and ethical considerations occupying a subsidiary position. Asquith's report of the 27 April Cabinet meeting showed that the British government was unclear whether Germany had violated the Hague Convention. Price suggests that the absence of moral outrage in the early press response to the German use of gas at Ypres supports his claim.[55] However, as we have seen, the press did condemn the German action very shortly afterwards. When the use of gas was first reported, very little information would have been available concerning the effects of that attack on individual soldiers. As eyewitness descriptions of the painful and terrifying deaths suffered by unprotected troops exposed to chlorine at Ypres were published, they were indeed accompanied by outrage.

When the decision to use gas was finally taken, it appears to have been driven by the overwhelming military need to maintain the morale of British troops and to ensure parity in fighting forces. The British chose to retaliate with cylinder attacks using chlorine, exactly the method already employed by the Germans. In this way, whatever the eventual decision regarding the legal status of these attacks, the worst the British could be accused of was retaliation in kind. Charles Foulkes, who was later placed in charge of the British Special Brigade for the use of gas, was highly

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[52] Palazzo (2000), p. 43.
[53] Richter (1994), p. 16. See Sir John French's view along these lines, which we discuss in Chapter 8, Section 3.2.
[54] Moore (1987), p. 44.
[55] Price (1999), pp. 53–54.

critical of the decision not to employ deadlier weapons than those used by the Germans.[56] But it is worth bearing in mind that the options for British response were also limited by practical factors in addition to the restraining effect of legal and moral considerations; chlorine was the most readily available chemical suitable for use in chemical weapons in Britain.

Even in the case of chlorine, only one factory, the Castner Kellner plant in Merseyside, was capable of mass production in 1915. Despite considerable pressure from the War Office, this factory only managed to produce one-tenth of the chlorine demanded of it. The rate of production of chlorine in Spring 1915 was one ton per day, and at that rate it would have taken the British six months to manufacture the amount of chlorine released in a few minutes at Ypres.[57] To respond in kind would require a massive mobilization of British manufacturing industry, diverting money, physical resources and manpower from other vital spheres, including a conventional munitions industry that was already failing to meet demand for shells.[58] Thus the British decision to enter into chemical warfare was not without risk, especially given that the efficacy of gas as a weapon had yet to be established. In these circumstances, it was by no means a foregone conclusion that the development and deployment of chemical weapons was the best available option, and the Cabinet decision is best viewed as a complex balancing of a large number of competing factors.

3.3. The British use of gas at Loos

In June 1915, the War Office created four Special Companies (which later became the Special Brigade) to develop British gas warfare. Major Charles Foulkes was made the commanding officer. Foulkes admitted that when he was given this assignment, he knew nothing about gas.[59] The British military on the whole was equally unprepared, as he explained in his 1918 Report: "nothing was known of the enemy's system of discharge and no experimental ground was available; nor was there time for experimental work to be undertaken before the machinery of the

[56] Foulkes (1934), p. 177, cited in Richter (1994), p. 23, and Price (1999), p. 53.
[57] Moore (1987), p. 44.
[58] Strachan (2001), pp. 1067–1068, describes the British shell shortage.
[59] Foulkes (1934), p. 17, contains recollections of his meeting with General Robertson, who was French's Chief of Staff.

new Department had to be put into motion".[60] Foulkes understood the need for a rapid response, commenting: "We must not wait for further experiments, but must . . . organise a gas attack on a large scale at the earliest possible moment".[61] He was quick to learn in his new job. By July, his companies were capable of using 90lb cylinders of chlorine gas, and by September they were prepared for the new method of warfare.[62]

The Battle of Loos was a two-pronged attack coordinated by the French under General Joseph Joffre, and assisted by the British forces under General Haig. Joffre was determined to follow up on French successes at Vimy ridge, using a pincer movement with the aim of causing a rout in the central Artois region.[63] The first prong of the attack was mounted by the French 1st and 10th armies in the Lens–Arras area, while the British 1st and 4th corps attacked between La-Bassée and Loos. Sir John French faced two major problems when planning the British part of the offensive. There was a severe shortage of artillery shells. The flat, unbroken terrain in the La-Bassée–Loos area was also unsuitable for an infantry assault, offering little cover and being overlooked at the furthermost northern flank by the large German hill fort known as the Hohenzollern Redoubt.[64] The British and French general staffs met at Boulougne on 19–20 June to discuss these difficulties. The British argued that since their current shell production was only 5,000 per month, they would not be ready for an offensive of that nature until early 1916.[65] Joffre objected. France had been occupied for over a year and launching a decisive attack was imperative for the French High Command. Despite the lack of adequate cover available to the advancing infantry, Haig agreed to the offensive. The result, as Philip Warner comments, was that British troops were "simply men being fed into a killing ground" as they advanced into enemy machine-gun fire.[66]

Acts like this earned for the British infantry their reputation as "lions led by donkeys". But was Haig's decision simply irresponsible?[67]

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[60] Foulkes (1918), p. 1.
[61] Foulkes (1934), p. 40.
[62] Harris and Paxman (1983), p. 11; and Richter (1992).
[63] Johnson (1997), p. 33.
[64] Ibid., p. 36.
[65] Rawson (2003), p. 18.
[66] Warner [1976] (2000), p. 9.
[67] There is little consensus in histories of WWI concerning the responsibilities of the generals for massive casualty rates, although Haig in particular has been the subject of

Haig had been sufficiently impressed by gas trials in August 1915 to believe that gas could compensate for the lack of artillery, causing enough confusion to protect British troops as they advanced.[68] The Special Companies started shipping gas cylinders to the front in great secrecy. There was not a sufficient amount of gas to attack the whole length of the line, but the plan was to use the gas economically, with large numbers of smoke-creating candles to "thicken out the cloud".[69] A strict timetable was set for the release of gas by Haig and Foulkes. Zero hour was 05:45, when gas cylinders were to be opened and mortar fire was to begin. At 06:30 the first wave of infantry would leave their trenches, heading into no man's land. Meteorological reports on the morning of 24 September had predicted the southerly and south-westerly winds needed to spread gas towards the enemy lines, leading Haig to authorize the gas attack.

By 04:30 the following morning, however, Haig noticed that there was a dead calm: the cigarette smoke of orderlies on his observation tower hardly dispersed. At 05:00 he tried to countermand the order for the gas attack, but poor communications with the front meant that zero hour passed and the attack went ahead despite the unfavourable wind conditions.[70] Some officers, noticing the still air, refused to open gas cylinders at zero hour, but such resistance was not tolerated. When Captain Percy of the Black Watch sent the message, "The gas officer refuses to open the cylinders", the response from General Hove was clear: "Then shoot the bastard".[71] Further up the line still, Lieutenant Graves, who had noticed the lack of wind to move the gas, messaged headquarters saying: "Dead calm impossible to discharge accessory [the gas]". He received the reply, "Accessory to be discharged at all costs".[72] The cost of that decision was high. In the south of the line near the village of Loos, discharged chlorine hung in the windless air. When soldiers of the Black

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severe criticism by historians including Gary Sheffield. The military historian John Keegan is much more sympathetic to the difficulties faced by generals such as Haig in WWI.

[68] See Spiers (1986), p. 19, and Johnson (1997), p. 33, on the decision to use gas at Loos, which was substantially due to Kitchener.

[69] Warner [1976] (2000), p. 40; Richter (1992), p. 81. See also Interview with Lawrence Grover, IWM Sound Archive, 46/8.

[70] Johnson (1997), p. 37, and Rawson (2003), p. 40.

[71] See Richter (1992), p. 67 for this exchange.

[72] Graves [1929] (1985), p. 129.

Watch and Caledonian regiments began their assault at 06:30, they immediately ran into clouds of chlorine. Men fell back into their trench, grabbing their throats as they were poisoned by British gas. Even where troops wore gas masks, such prolonged exposure to dense clouds of chlorine left many dead or incapacitated.[73]

By all accounts, the Battle of Loos was a failure for the British. They lost 8,000 men on the first day alone, while failing to gain even one mile of German territory. Some reports spoke of parts of the German front line being piled high with corpses and machine gun crews lying dead at their weapons, but in other parts of the line the gas simply hung over no man's land, or blew back into the British trenches. A second attack on 27 September fared little better, since the Germans were prepared and had lit braziers around their machine-gun posts, creating an up-current of air to disperse the gas.[74] Only a smaller-scale attack on the fortress at Hohenzollern was more successful. The Special Brigade mounted another cylinder assault, with more flexible timing and better communication between Foulkes and the gas officers allowing them to wait for favourable weather conditions.[75] The attack, which took place on 13 October, was a last-ditch attempt to destroy the northern flank as the assault floundered. In a battle lasting just over three weeks, 16,000 British troops were killed and 25,000 wounded to gain a stretch of land just over two miles wide.

The analysis of whether and why gas failed at Loos is complex but very revealing.[76] At Loos the British were deploying gas partly to compensate for the short supply of artillery shells, with the result that the initial artillery attack was severely curtailed and failed to meet its military objectives. But it is not satisfactory to attribute the British losses at Loos simply to a failure of gas. More informative is an attention to the suitability of the specific gas technology used by the British. The use of cylinders made the success of gas attacks highly dependent on wind conditions. The construction of large cylinder emplacements took days and this, combined with inflexible battle planning, meant that the British were generally unable to deploy gas at the most effective time and

[73] TNA: PRO WO 32/5163.
[74] Richter (1992), p. 85.
[75] Ibid., pp. 95–96, and Horne (1963), pp. 285–287.
[76] See Groom (2002), pp. 133–135, and Sheffield (2001), p. 107, for standard accounts of the Battle of Loos.

place.[77] In the days before satellite reconnaissance and radio communication, it was difficult to coordinate such an assault.[78] While the Germans had switched to the use of gas-filled shells by the summer of 1915, the British continued to rely on cylinders, partly because of the continued shortage of shells and partly because of Foulkes's unexplained commitment to cylinders.[79] The British were locked into an inferior technology for gas delivery until relatively late in the war, and Haig continued to use gas as a method of compensating for shortages of conventional munitions. As we shall see, these factors prevented Britain from developing strategies that made the most effective use of the special features of gas as a weapon.

4. The strategic and tactical functions of gas

Although gas failed to gain either side the kind of decisive strategic advantage that its most ardent advocates had hoped for, it was not abandoned. Quite the contrary, during the course of the war there was a progressive escalation in the toxicity and damaging effects of the chemical agents employed. Germany was ready for the first use of phosgene at the Second Battle of Ypres in December 1915, eight months after the First Battle of Ypres and within a few months of the British retaliation with chlorine at Loos. Phosgene has similar effects to chlorine, acting on lung tissue in very much the same way and with equally lethal consequences. The difference is that phosgene is invisible and odourless, and causes no spasm on inhalation. Many phosgene casualties were unaware that they had inhaled a lethal dose.[80] Men often continued as normal for up to 24 hours after inhaling phosgene, as the following medical report on an officer who reported to a dressing station shows:

> He said he didn't feel very well, but he did not look very bad. I gave him a cup of tea which he drank and we talked for a little while. Suddenly he collapsed in the chair he was sitting on. I gave him some oxygen but he died an hour afterwards.[81]

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[77] Richter (1992), p. 72, shows a diagram of cylinder employment. See p. 184 for a description of the work involved in mounting a cylinder attack and the persistent problems with this technology.
[78] See Sheffield (2001), pp. 99–102, on communications problems during WWI.
[79] Richter (1992), p. 185.
[80] Harris and Paxman (1983), pp. 18–19, and Spiers (1986), p. 22.
[81] Quoted in Harris and Paxman (1983), p. 18.

Phosgene's lethal qualities earned it the nickname "killer" among some troops.[82] Phosgene (code-named Blue Cross) was followed by diphosgene (Green Cross), and mustard gas (dichlorodiethylsulphide, Yellow Cross) by July 1917. Unlike its predecessors, mustard gas did not immediately incapacitate its victims. Its early symptoms, which were generally not fatal if a respirator was worn, included acute conjunctivitis, temporary blindness, sneezing, nausea and vomiting, as well as blisters and burns. Mustard gas was extremely persistent, remaining toxic long after its use in an attack.[83]

There were also developments in the technology of delivery, and the most notable of these were in fact British inventions: the Livens projector and the Stokes mortar, for launching gas-filled projectiles.[84] The Livens projector was difficult to install and load, but it was cheap and could be used in massive numbers. The Stokes mortar, when operated by a well-trained crew, could fire fifteen canisters before the first of them hit its target, each canister containing more gas than any equivalent shell.[85] The supply of these canisters was also not dependent on munitions supply, as shells would have been. The Stokes mortar may have been the first weapon to break the letter of the 1899 Hague Convention, by carrying chlorine gas unaccompanied by explosives (see Chapter 8, Section 2 for further discussion of this issue). In 1918, after the British started using mustard gas, Livens projectors were mounted on trains that moved parallel to the German lines, enabling a volley of tremendous force.

After Loos, the British Special Brigade trained for six months to overcome some of the problems they had experienced in the handling of cylinders. Most of May and June 1916 were spent practising carrying cylinders to the front, checking their installation and training more men in their use. Haig took over from French as Commander of the BEF, with important consequences for gas warfare. French had become increasingly strained, taking long tours of hospital wards where he lingered over shell and gas casualties with tears in his eyes, wondering what had become of the "gentlemanly" wars he had fought against the Boers (see Chapter 8,

[82] Interview with Lawrence Grover, IWM Sound Archive, 46/8.
[83] Spiers (1986), p. 25.
[84] Ibid., p. 24.
[85] Harris and Paxman (1983), p. 23.

Section 3.2. for further discussion of French).[86] One of Haig's first acts was to reorganize the Special Companies. He increased their numbers to Brigade strength, splitting the organization into offensive and defensive parts under a Director of Gas Services, Brigadier H. T. Thuilliver. While Foulkes remained in charge of offensive operations, Major S. L. Cummins was appointed to head anti-gas operations.

The summer of 1916 saw the British mount a large number of small-scale gas attacks at the Somme, beginning in June at Monchy-au-Bois and continuing with a series of diversionary attacks at Ancre in July 1916. Between July 1916 and May 1917 the British used gas, principally chlorine and phosgene, in over 100 operations, employing nearly 40,000 cylinders.[87] Haig's plan at the Somme was to rout the Germans by breaking their front line in two. He believed that a sustained artillery assault could flatten German dugouts and barbed wire, rendering German machine-gun posts ineffective. Gas was to be used in a largely diversionary role at the periphery of the designated battle area, although most machine-gun crews were issued with gas masks in the event of a German counter-attack using gas. The Somme offensive was a disaster. The British artillery barrage went on for ten days, at the end of which inexperienced troops of Kitchener's "pals" regiments were ordered out of the trenches and into no man's land. The Germans, who had been sheltering in their concrete dugouts, noticed a lull in the shellfire and emerged to open fire on the advancing enemy. The British troops were hopelessly exposed. After that single day of combat on 1 July 1916, 21,000 British soldiers were dead or missing.[88]

Many historians agree that Haig relied unduly on artillery in planning the Somme offensive. It is tempting to speculate that more extensive use of gas would have provided cover for advancing British troops, while lessening the Germans' ability to defend their positions. However, there was never any concerted effort in Britain to develop gas warfare in its own right, despite the additional resources that Haig committed to the Special Brigade. British battle plans were largely limited to the use of gas to substitute for conventional shells, or as a diversionary measure. The shortage of cylinders, shells and gas left military strategists unable to

[86] Editors' note: We have not been able to confirm the source of this description of French's behaviour.
[87] Haber (1986), pp. 90–91.
[88] Howard (2002), p. 78.

formulate effective battle plans incorporating gas.[89] These supply problems, which had their roots in the underdeveloped state of the British chemical and munitions industries at the outbreak of WWI, were only solved by the entry of the United States into the war in 1917.[90]

Overall, 1915–16 can be seen as the crucial period for gas warfare. During this period, when the tank was in its infancy and the airplane had little direct impact on the ground, gas was the only weapon with the potential to break trench deadlock and solve "the problem of the Western Front". In fact, neither side realized the full potential of gas, relegating it to the status of a nuisance weapon whose effects were countered by increasingly effective gas masks. In the German case, the military put up a resistance to gas warfare, which was seen as a suspect innovation introduced by civilian chemists headed by Fritz Haber (1868–1934).[91] Therefore the early opportunities for advance that were gained by the use of gas on an unprepared and unprotected enemy were not exploited fully.[92] Once both sides were in possession of effective gas masks, gas became more effective in small-scale, attritional offensives. Whereas the Germans exploited this capacity well, the British neither resolved the supply problems, nor developed successful strategies for gas warfare.

Let us now take a closer look at the factors contributing to the British failure to use gas successfully. Many historians have argued that the problem was technological: the British were technically less adept at using gas, and they introduced new gas weapons far more slowly than the Germans. The British continued to use weather-dependent cylinder attacks long after the Germans had switched to gas-filled shells. This was partly due to an extreme shortage of shells. In May 1915, only 5% of the shells requested were delivered.[93] This problem inevitably delayed the development of gas-filled shells in Britain. The British were also short of chlorine and, later, phosgene and mustard gases. For example, poor mobilization of industrial resources left Britain (and France) largely

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[89] Haber (1986), p. 90.
[90] Ibid., Chapter 11.
[91] For details on Haber's work on chemical warfare, see Stoltzenberg (2004), chapter 7.
[92] Moore (1987, p. 16) describes Falkenhayn's difficulty in finding a commander who was prepared to experiment with the new weapon. Haber (1986, p. 7) explains that his father (Fritz Haber) had to lobby hard for an opportunity to test gas.
[93] Strachan (2001), p. 1068.

dependent on a single manufacturer for the supply of phosgene. A French contractor named De Lair promised to build a plant capable of supplying both armies with all the phosgene they needed, but his plant failed to produce anything like the required amount. British stocks of the gas fell drastically low.[94] The shortages were not limited to gas-related supplies. Gary Sheffield describes how "trench mortars had to be improvised from jam tins and water pipes" during the early years of the war.[95] Even when new weapons were introduced, the problems of production and the difficulty of obtaining replacement parts restricted battlefield effectiveness. Malcolm Brown notes: "Field commanders and staff officers had little scope for trying out new ideas since they lacked the material to do much more than sit and wait".[96]

British technological disadvantage is perceived to have been a direct result of its industrial inferiority, particularly in the crucial chemical sector. The problem was not only a shortage of materials, but also a shortage of knowledge and skills. L. F. Haber believes that the highly developed state of the German industry in general and the German chemical industry in particular was crucial to its success in chemical warfare:

> In 1915 such specialists [chemical engineers and experienced craftsmen] were even rarer in Britain and France than academic chemists, and the lack of pipe fitters, welders, workers in lead and competent charge hands caused delays at all times. What had taken German dye makers many years to learn and improve had now to be acquired in months.[97]

In such a situation, Britain suffered from technological immobility, unable to utilize new developments to the full due to lack of resources and inadequate technical support.

This comparative industrial argument is supported by Hew Strachan, who notes that the British were highly dependent on simply increasing orders to private firms to meet their needs. He claims that most of Britain's munitions industry was geared up for equipping the Royal Navy rather than providing for the modern Army.[98] Germany, by contrast, rarely suffered from munitions shortages after 1915, largely due

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[94] Haber (1986), Chapter 6.
[95] Sheffield (2001), p. 126.
[96] Brown, I. M. (1998), p. 102.
[97] Haber (1976), pp. 8–9; see also Spiers (1986), p. 27.
[98] Strachan (2001), p. 1067.

to its better-mobilized industrial facilities.[99] Germany was also able to call upon existing scientific facilities for development of military science and technology, including the Kaiser Wilhelm Institute for chemistry in Berlin where Haber and others investigated the use of chemicals as offensive weapons and the best means of defence against those agents.[100]

Another important aspect of the comparison between the British and the German uses of gas is connected to the very different ways in which the two sides conducted their offensives in the crucial early parts of the war. The Germans realized much more quickly the potential of gas as a nuisance weapon, used to "bleed their enemies white". One well-known illustration of this was the German attack on the French fort at Souville during the Verdun offensive. The German assault was floundering because of artillery fire from the fort. Crown Prince Ruprecht, commander of the assault forces, gave the order for phosgene shells to be fired at the fort as the French were eating their evening meal. Caught off guard, the French soldiers were for the most part unaware that they were inhaling phosgene. Their primitive respirators proved unable to withstand the seven hours of phosgene shelling. Horses went wild and bolted, carrying supplies and ammunition with them. When the gas attack was followed by a fierce artillery barrage and dawn infantry assault, the fort was overrun. Small-scale gas attacks like this could be devastatingly effective and the Germans learnt this lesson well.[101] In contrast, there were continued expectations among the leading figures of British gas warfare, including Foulkes, that gas would revolutionize warfare, which met with disappointment. That outcome was not a necessary one, as we have already argued, but resulted from lack of investment and understanding in gas technologies and their effective deployment.

An interesting comparison can be drawn with another major technological innovation introduced in WWI, namely the tank. Tanks were first used by the British at the Somme in 1916, but all 30 became bogged down only a few hundred yards into German front lines. Undeterred by this failure, Britain continued to develop tanks and methods of their use. At the Battle of Cambrai in November 1917, more than 300 tanks supported by close formations of infantry achieved a dramatic breakthrough, gaining a section of line a mile deep with only a

[99] Strachan (2001), p. 1070.
[100] Stoltzenberg (2004), pp. 138ff; Harris and Paxman (1983), pp. 9–11.
[101] Horne (1963), pp. 285–287.

fraction of the casualties that usually occurred from comparable operations. As the tanks overran machine-gun posts, British military strategy evolved around them. By late summer 1918 huge tank formations were combined with airplanes and artillery to break the German front line at the Battle of Amiens, a victory that eventually led to the collapse of the Hindenburg line.[102] The introduction of the tank was pursued despite early problems until the new weapon acquired sufficient "technological momentum" to shape military institutions, while itself being shaped by them in return.[103]

How can we explain the different fates of gas and the tank? One crucial factor is the difference in the attitude of the British military establishment to the two technologies. Whereas the military was originally resistant to the use of gas, the tank was perceived from an early stage to be a useful addition to the technologies of combat. After the failure of gas at the Battle of Loos, Britain did not deploy gas on a large scale until 1917. Even after the invention of the Livens projector and the introduction of mustard gas into the British arsenal, gas continued to be "the accessory". Throughout WWI, Britain was almost entirely reactive to German developments in gas warfare, mainly using gas as a substitute for conventional weapons. Although large volumes of mustard gas shells were used by both Britain and Germany during the later stages of the war, this fact does not in itself suggest a strategically significant role for gas, if we consider the general escalation in the use of all weapons. At no time during WWI did Britain undertake a thorough and systematic examination of gas warfare technologies and the military strategies necessary for their successful implementation.

5. British soldiers' experience of gas

Whether or not gas had much effect on the outcome of the war, it has often been portrayed as a uniquely horrific weapon which completely altered the way in which war was fought. The negative image of gas warfare clearly survives to this day. But was chemical warfare in WWI

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[102] Keegan (1999); Childs (1999), p. 174.

[103] The concept of "technological momentum" from the historian of technology Thomas Hughes reflects the view that "technology and society drive each other". See http://www.msu.edu/~kirkman/Courses/LBS_332_Summer_2001/notes/momentum.htm (most recently accessed on 18 January 2007).

such a uniquely terrible experience? We are not able to give a comprehensive answer to that question, but we would at least like to examine the experience of British soldiers, on which we have some accessible sources. We shall argue that it was not gas warfare itself but the ways in which Britain managed gas warfare that resulted in some exceptionally painful experiences. It seems that gas eventually became simply another routine horror of trench warfare which existed alongside the dangers from high explosives, sniper fire, mud, and disease. In anthologies of personal recollections after 1915 there is only scant mention of gas, while photographic evidence shows that the wearing of gas masks became routine by the end of the war.[104] Gas merely made a bad situation worse, rather than completely altering it. In the earlier phases of the war, however, it seems that gas did constitute a special horror for the soldiers.

One important aspect of the less-than-ideal management of British gas warfare was the slowness and inadequacy in the provision of gas masks. The first official British gas mask was the "tube helmet" which was issued to troops from late August to early September 1915. It was a long canvas bag dipped in sodium phenate, with two eye-holes protected by plate glass. It was similar in design to the hypo helmet which was issued later in 1915 for use by artillery regiments and machine gunners, rather than front-line infantry. Both masks worked on the same principle: the chemically treated canvas prevented the wearer from inhaling chlorine, provided that the loose bottom of the bag was tucked into the tunic collar or another item of clothing at the neck. These masks proved inadequate during prolonged exposure to gas because the treated fabric actually prevented the passage of oxygen and carbon dioxide as well. Unable to breathe properly, soldiers were suffocating and fainting. In desperation they sometimes undid their collars to allow some circulation of air, and took in the poison gas. Luther Mitchell, a member of the Special Companies at Loos, reported that he and his mates found themselves "half suffocating with our own gas. We all had gas helmets on, but they got so stuffy that the temptation is to remove them for a breath of air**,** which proves to be a breath of chlorine".[105] In addition, the

[104] For example, in Arthur (2002), a collection of transcripts of personal accounts from the Imperial War Museum's Sound Archive, gas does not figure prominently, except at Ypres. For the photographic evidence, see the Imperial War Museum Photograph Archive, Q.2999. See Ashworth (2000) on the trials of trench life.
[105] Quoted in Richter (1992), p. 73.

glass eyepieces were prone to crack or shatter in action and, due to the enveloping nature of the bag-like design, vision was extremely restricted while wearing these masks. Not only did the skull-like appearance of these helmets contribute to the nightmarish quality of a gas attack, but wearing them significantly reduced the soldiers' fighting capability.[106]

This was in sharp contrast to the German provision of gas masks, which was based upon extensive research carried out alongside the development of new chemical agents. The German masks were more complex than the British ones, incorporating a respirator attached to the face which contained chemical filters including charcoal. By January 1916 such respirators were standard kit for all German infantry troops, and their design was so effective that they remained the standard issue in Germany even in the Second World War. The British experience did improve finally, as a respirator based on the use of charcoal filters was developed. The Standard Box Respirator (SBR) was issued to many troops in time for the Battle of the Somme in 1916 and became part of standard kit by January 1917. It was highly effective in reducing the number of gas casualties. According to War Office statistics, of the 4,587 gas casualties between July 1916 and May 1917, only 319 died, while 80% returned to active service within three months. Official directions issued to commanding officers stated that "box respirators afford complete protection against all gas"; they "should be worn as soon as shelling commences and even when used continuously will provide complete protection for forty hours".[107] Only with the introduction of mustard gas did this "complete protection" fail, as a result of the extreme persistence of mustard gas.

Medical treatments available for gas casualties were also initially very inadequate, and improved only gradually. Early gas attacks caused mass casualties, overwhelming the casualty-clearing stations, which were only equipped for basic surgery, pain relief and the treatment of minor injuries. Many minor gas casualties were simply given liberal doses of brandy to ease their pain and dressings for their burnt eyes. More severe cases were left to stabilize or die. According to autopsy reports between April and June of 1915, the men exposed to a fatal amount of gas died within 14–48 hours, usually after coughing several pints of "bloody bile"

[106] Dunn (1938), p. 211.
[107] TNA: PRO WO 142/101.

from their irreparably damaged lungs into the bowls left by their side. With less severe exposure, the wounded coughed up yellow bile from the damaged walls of the trachea and, although many with such injuries survived, their respiratory systems were permanently damaged.[108] The two major treatments for chlorine and, later, phosgene, were ammonia capsules and therapeutic oxygen.[109] A medical officer's report from May 1915 describes the use of ammonia to relieve milder cases of gas at dressing stations.[110] Oxygen treatment (discussed further in Chapter 10, Section 2), developed by the physiologists Joseph Bancroft and Leonard Hill in 1915, was used for more severe gas casualties. Gentle doses of pure oxygen were administered to calm the swelling of inflamed lungs. By the end of 1916, it was common practice for field hospitals and ambulances to have oxygen equipment.[111]

Another important aspect of the soldiers' experience of gas warfare was the way the military authorities treated the victims of gas attacks. As effective protective helmets and masks began to afford soldiers better protection from the effects of gas, an official perception arose that gas casualties were the fault of the individual. In a report which concluded that gas masks were highly effective in reducing the casualty rate, the Medical Officer of the Royal Irish also described a frustrating incident:

> Two men of the RIF suffering badly from gas came to my dressing station[.] I saw they did not have on their masks and when asked why they replied "we have them round our necks" — evidently they had been too stupid to wear them over their mouths and noses.[112]

Tim Cook argues, in his study of Canadian troops in WWI, that simply providing protective clothing was not enough to protect soldiers, who needed extensive training in the correct wearing of gas masks.[113] As gas-mask drills were incorporated into routine training, this also resulted in a harsh regime of discipline surrounding gas injuries. Official reports in September 1915 recommended that courts of inquiry be set up to ascertain whether gas injuries did not result from carelessness or delib-

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[108] Medical Research Committee (1918).
[109] TNA: PRO WO 142/101.
[110] TNA: PRO WO 32/5169.
[111] Sturdy (1998).
[112] TNA: PRO WO 32/5169.
[113] Cook (1998).

erate exposure.[114] Anyone found guilty of carelessness had to wear a wound stripe to show others how inept they had been in allowing themselves to inhale gas.

According to Ian Whitehead, officials were also concerned in late 1915 by growing numbers of men who seemed to be using the presence of gas as "an excuse for malingering either by feigning or exaggerating the symptoms of gas poisoning".[115] The offence of "gas malingering" was created in early 1916 in response to these concerns. Dressing stations were also ordered to make it a priority to return gas casualties to active duty as soon as possible, in an attempt to discourage soldiers from believing that fake or self-inflicted gas injuries would provide them with a means of escaping from the trenches. In case this sounds extreme, it is worth pointing out that tales of "golden" or "lucky" wounds were rife along the Western Front. Large numbers of men were court-marshalled on cowardice charges after receiving gunshot wounds to the foot or leg prior to or early in a battle. In a particularly striking case, one medical officer recalled seeing a group of Sikh soldiers with self-inflicted wounds: "They all had wounds through the palms of their hands . . . . we came to the conclusion they must have held their hands up above the trench so that they could be shot through the palms and invalided home."[116] It is unclear how many men were taken to courts of inquiry and punished for their gas wounds. The number of courts of enquiry declined after the introduction of mustard gas in the later stages of the war. Given the persistence of mustard gas leaving the trenches and landscape poisonous long after its use, it became much more difficult to treat injuries as the fault of the individual.

The British drive to reduce gas casualties was also reflected in ambitious targets for reductions in admissions to clearing stations, and shorter turn-around times for hospital treatment. Casualty figures were often over a thousand per week and gas attacks could double those figures. At a time of stalemate on the Western Front, with few ways of measuring success, this offered a way of showing tangible progress: reducing the number of gas casualties meant that the impact of gas

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[114] Harris and Paxman (1983), p. 16. A court of inquiry, created under the Army Act, had more limited sanctions at their disposal than a court martial.
[115] Whitehead (1999, p. 242) describes gas malingering and the improvement of treatment, citing TNA: PRO WO 95/90, DDGMS diary, 4 October 1915.
[116] Captain Maberly Esler, RAMC, in Arthur (2002), p. 88.

warfare had been reduced. This approach was connected with the system of discipline surrounding gas injuries in which gas injuries were perceived as being preventable and therefore the result of carelessness or deliberate self-injury.

To summarize: despite believing gas injuries to be preventable, the British authorities were slow to develop effective gas protection. The early gas helmets were poorly designed and uncomfortable to wear, and during 1915 there was little serious effort made to develop an improved gas mask. This slow response makes a stark contrast with the German gas research programme, which right from the start had placed equal emphasis on protection and attack. The British gas drills tended to emphasize discipline and courage rather than imparting knowledge and skill. As the use of gas became more frequent, soldiers adjusted to it and the fear of gas became part of the routine. Gas injuries in themselves were no more horrifying than those caused by conventional weapons.[117] Thus, while gas added to the horror of warfare and intensified the strain of surviving in the trenches, it did not constitute a danger of an entirely different magnitude. What contributed most to the monstrous "unfairness of gas" was the thought that gas injuries could be taken as evidence of incompetence or cowardice, for which the British Army exacted the most severe punishments.[118]

6. Conclusion

Although the rapid development of gas defences rendered gas attacks less devastating, gas remained a weapon with considerable tactical power. Following their initial use of gas at Ypres, the Germans continued to make effective use of gas in attaining military objectives. We have explored the reasons why Germany was consistently able to exploit gas as a tactical weapon in far superior ways to Britain. This superiority resulted from two main factors. First, as Germany had a significantly better industrial, scientific and technological infrastructure,[119] German use of gas was not hampered by supply and technical difficulties to the same extent as British attempts. Second, with a greater military commitment to

[117] See Prentiss (1937), p. 680, for the main statistical analysis of gas casualties and fatalities.
[118] Harris and Paxman (1983), p. 16; Winter (1978), p. 125.
[119] Moore (1987), pp. 16–19.

using gas, Germany developed a better understanding of how to use gas effectively. We believe that the use of chemical weapons in WWI warrants more serious consideration within the context of military strategy and effectiveness than it has so far received.

The British decision to enter into offensive chemical warfare was driven principally by principally military concerns, moderated by legal scruples. Moral considerations did not provide a real deterrent to the British use of gas. The widespread emphasis on the horrors of gas warfare in Britain had more to do with the public demonization of the enemy than the substance of policy debates surrounding the use of gas. Gas as a weapon did not induce absolute terror amongst soldiers for long. From the soldier's perspective, gas was increasingly perceived as only one of the many hazards of trench warfare. Certainly by the later stages of WWI, increasingly effective gas masks and gas drills considerably reduced the number of gas casualties and fatalities. Popular and literary accounts of the horrors of gas are not reliable indicators of soldiers' experiences of gas warfare, especially after the introduction of adequate gas masks.

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