

Through Clouded Eyes: Gas Masks and the Canadian Corps in the First World War

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Résumé

Même s'il a fait plus d'un million de victimes, rempli divers rôles tactiques et servi d'arme psychologique, le gaz toxique a été essentiellement relégué à la périphérie des analyses historiques de la Première Guerre mondiale. L'idée acceptée est qu'après l'échec de la première attaque au chlore, qui n'a pas créé de percée sur le front ouest, à la deuxième bataille d'Ypres, en avril 1915, le gaz toxique est devenu quantité négligeable. L'auteur de l'article soutient que, loin d'avoir disparu, la guerre chimique a gagné en ampleur et en intensité, grâce à la mise au point de vecteurs plus efficaces et de gaz plus meurtriers. En conséquence, la nécessité de fournir des dispositifs de protection a stimulé l'évolution d'une série de masques à gaz. Le gaz toxique est néanmoins resté l'arme psychologique puissante et perturbatrice qui rongeaient tous les soldats du front ouest en 1918. Prenant comme exemple le Corps canadien, l'auteur étudie l'évolution du masque à gaz et la guerre technologique qui faisait rage sur le front ouest, dans l'optique de l'histoire de la culture matérielle.

Abstract

Despite causing over a million casualties, being employed in a variety of tactical roles, and acting as a psychological weapon, poison gas has largely been shunt to the periphery in the historical analysis of the First World War. The notion was that once the first chlorine attack at 2nd Ypres in April, 1915, failed to achieve a breakthrough on the Western Front, poison gas became a non-entity. This article argues that chemical warfare did not in fact disappear but continued to expand in scope and intensity, through the introduction of more efficient delivery systems and deadlier gases. As a result, the need to provide protective devices stimulated the evolution of a series of gas masks. Poison gas remained, however, a disruptive and powerful psychological weapon that by 1918 plagued all soldiers on the Western Front. Using the Canadian Corps as an example, this article will examine the evolution of the gas mask and the technological struggle that raged on the Western Front through a material history paradigm.

Ghoul-faced, bug-eyed soldiers emerging out of the haze of battle seem more like science fiction than a historical account of a battle. But such scenes were the reality of the First World War, a conflict where soldiers were forced not only to survive but to fight within the poison gas-drenched battlefields of the Western Front. In doing so, they used and adapted an increasingly sophisticated array of protection devices.

The apocalyptic wasteland of trench warfare was made even more intolerable by the use of poison gas: initially a rare occurrence, gas eventually became a daily event plaguing soldiers before, during and after battles. Despite this abomination of science, as many front-line soldiers saw it, various forms of protection were developed throughout the war. The evolution of the gas mask was a trial-by-error process

carried out in association with the added measure of having to anticipate any new gases the enemy might develop. This see-saw struggle between the offensive and defensive during the war, and more specifically during the gas war, meant that a failure to quickly adapt technologies could result in the death or maiming of hundreds of thousands and the possible loss of the war itself.

The gas mask provided both a functional and a psychological protection that has been ignored in the historiography of the First World War. Using the Canadian Corps as an example to analyze the effects of poison gas and the eventual process by which all soldiers of the Western Front sought to escape its ravages, this article will briefly examine the stages of the gas war, the tactical and operational

problems imposed by gas and the ultimate material solution, the gas mask. The struggle for new weapon systems, with the ultimate hope by both sides of perfecting a breakthrough weapon, was offset by the defensive technologies that were employed to cancel them and thus restore parity to the battlefield.

The life of the *frontsoldaten* was arduous, but their actions were not, as is sometimes expressed, simply zombie-like as they moved through the gas to a grisly death. The soldiers reacted to their deadly environment by continually adapting their survival skills to cope with the reality of the trenches.¹ Yet the gas war was initially seen as somehow different from conventional weapons, and more insidious. Battle skills could be employed to increase the chances of survival in "conventional" warfare in the trenches, but gas was viewed as a silent killer: blinding, scalding, choking and leaving soldiers coughing up bloody sputum until they expired in a horrible fashion.

While these effects were real enough, with the establishment of even the crudest gas masks, soldiers were given a psychological as well as a physical protection from the ravages of gas. The evolution of better gas masks eventually prevented the probable large-scale physical slaughter possible from lethal chlorine and phosgene gas, but the fear of chemical agents was never wholly conquered. The introduction of the gas mask failed to dissipate, as it is wrongly assumed, the threat of gas on the battlefield. Although the gas mask negated poison gas as a breakthrough weapon, and ensured survival for most combatants on the battlefield, it never entirely protected the wearer from the physical, mental or moral disruptions.

Prelude to the Gas War

After the initial mobile stages of the war degenerated into the stalemate of trench warfare, commanders on all sides searched for methods and weapons to break the deadlock. The development and use of machine guns and high explosive shells had exacted a terrible toll on all armies in the first months of the war. As silent testimony to the new weapons, hundreds of thousands of dead were left to rot on the battlefield, while the survivors were forced to dig beneath the earth in order to escape the effects of the new firepower. Two thin strings of trenches wound their way from the North Sea to Switzerland; an empty field of battle where soldiers crouched in their ditches, holding their lines often less than a hundred

yards from their enemy. Barbed wire, fortified defences, machine guns and unseen artillery support in the rear, often annihilated attacking infantry in "no man's land" before they were even able to close with the defender.

The balance of warfare, which had slowly been shifting to the defensive since the American Civil War in the 1860s, made a giant lurch as charging infantry, bayonets leveled, were cut down in swaths by the strengthened fortified defences. The need to cancel the overwhelming power of the defender required a series of new weapons.² Airplanes, tanks and industrial programs to manufacture mountains of high explosive artillery shells all restored the power of the offensive; however, it took months and years before they were fully implemented. The imbalance imposed by the new trench warfare had to be redressed immediately, especially as soldiers were being massacred in the thousands. The reinforced defenders had either to be paralyzed or forced out of their positions.

The notion of chemical warfare was not new; it had been used throughout history to help end sieges and attack an enemy out of reach of conventional weapons.³ In the Hague Conventions of 1899 and 1907, however, the projectile use of gas was banned for its perceived inhumane and unchivalrous nature. Not only was it viewed as diabolical, a weapon that killed without warning, but it was seen as an antithesis to the notion of warfare as a great game.⁴ Yet the destruction wrought in the first months of the war — which numbered over 2.5 million for the Germans alone — required new methods to break the deadlock that was bleeding all armies white. With the most powerful chemical companies in the world, Germany began to prepare for the use of gas as a battlefield weapon.⁵

Responding to complaints from the front that defenders could not be dislodged with conventional explosives, the Germans introduced tear gas shells in the Neuve-Chapelle area of the Western Front on 27 October 1914. The tear gas failed to clear the enemy from their fortified trenches, and the British did not realize they had been the victim of a gas attack until they read about it after the war! The German agent was so impotent that the son of General Erich von Falkenhayn, Chief of the General Staff of the German Armies, was said to have won a case of champagne by remaining in a cloud of the chemicals for five minutes without displaying any signs of discomfort.⁶ The failure of another tear gas shell attack on the Eastern Front motivated Dr. Fritz Jacob Haber, a future Nobel-prize winning scientist

who would effectively run the German gas program, to change the focus of the German chemical production away from lachrymatory (or tear) gases and towards chlorine gas.

Chlorine was a deadly lung irritant, easily compressed into liquid for transport in metal canisters and readily vaporized into gas when released. In addition, some of the brightest German minds were made readily available towards producing more effective gas and delivery systems.⁷ Haber believed that instead of gas shells, which could carry only a small amount of gas, large canisters, weighing close to one hundred and eighty pounds, would be filled with chlorine and then liberated in the face of a strong wind. It was unclear what the effects of such a weapon would produce, and thus, the first use of gas against enemy lines took on a slightly experimental atmosphere. Nonetheless, it was hoped that the chlorine would paralyse the defenders and allow the infantry to scramble across no man's land unhindered.

Although the Germans had quickly produced large quantities of chlorine, General Falkenhayn had a difficult time finding a commander willing to have it employed on his front.⁸ Both the generals of the 6th and 3rd German Armies refused to participate in the use of gas because of its perceived immoral nature. Despite the terrible slaughter already meted out on the Western Front, there remained a notion in many soldiers' minds, from general to private, that war was still a game to be played fairly. Killing a man with noxious gas certainly did not fall in that category. Still, some realized the true nature of a war that would eventually be labeled "total," and the Duke of Württemberg, Commander of the 4th Army, agreed to have gas used on his sector. Despite the prevailing winds of Europe blowing against the German lines more often than not, both Falkenhayn and Haber erroneously believed that the Allied industries were too weak to respond with an effective form of retaliation.

The first gas attack was thus to be used against the British- and French-held Ypres salient in southwest Belgium. The scene of vicious fighting throughout the war, the Ypres salient was a half-moon jutting into the German lines with the city at the centre. The Allied lines were enfiladed by enemy fire from the surrounding high ground, but there was a stubborn desire by the Allies to hold the untenable position at all costs. It was into this "charnel house" that the raw, untried 1st Canadian Division was ordered for its baptism of fire and, as fate would have it, of gas and glory.

Like the young men in Germany and Britain, those who joined the battalions of the 1st Canadian Division in the heady days of August 1914 did so for a myriad of reasons: patriotism, employment, peer pressure, or a search for adventure. Whatever their intentions, few soldiers or politicians expected a war that would last past Christmas. Although the Canadians yearned to get into battle, they were held back in England for all of 1914 for additional training near Salisbury. Realizing that the battle was raging in Europe, the Canadians were overjoyed when they were finally given their orders to embark for France in February 1915. The 1st Division entered the Ypres lines on 14 April, with the 28th British Division on their right and the 45th Algerian (French) Division on their left.

To the southeast of the salient (across from the British-held front), over six thousand gas-filled cylinders had been placed by 10 March. For weeks the Germans desperately waited for a favourable wind, all the while hoping that the Allies would not discover their surprise weapon. A surprise weapon it was not; a misunderstood one it remained. The Allies had been alerted by spies, prisoners and intelligence reports that the Germans were planning on using a new form of gas against their lines.⁹ Yet no defensive action was undertaken, simply because the Allied generals had no concept of what would be used against them. Little if any information was passed down to the soldiers in the trenches and no preparations were made to defend against such an attack.

Discussing the situation with his commanding officer, Lieutenant-Colonel William Hart-McHarg (who would be dead within days), Major Victor Odlum, second-in-command of the 7th Canadian Battalion, remarked that he had not "the faintest idea" of what gas was. "We couldn't visualize an attack with gas, we could not guess where the gas would come from or how we could recognize it when it did come, and we did not know what were the necessary precautions."¹⁰ Their misunderstanding of the nature of gas was reinforced by the French and British High Command's attempt to brush it off as either a hoax or an ineffective weapon that would easily be dispersed like smoke.

On the other side of no man's land, the German infantry quickly became exasperated with a weapon that not only relied on the wind to work, but was also susceptible to British shells that periodically burst open canisters, spewing their deadly contents throughout the

German front lines.¹¹ Accordingly, many of the gas canisters were moved north, across from the French divisions, where the wind was more accommodating. The planned German attack was limited to the capture of Pilckem Ridge, one of the few high points still in Allied hands and one which the Germans had fought for months to capture.¹²

The Birth of a New Warfare

After a furious artillery bombardment during the early part of 22 April 1915, all activity stopped from the German lines and an ominous quiet fell on the battlefield. Then, shortly before four o'clock in the afternoon, the German artillery began to shell the Allied lines rear area and the town of Ypres. As the Allied soldiers kept their heads down, the German gas units, derisively known as *Stinkpioneres* by their own infantry, released 160 tons of chlorine from 5 730 canisters.¹³ A green-yellow cloud, 10 kilometres wide and a kilometre deep, blotted out the sun and quickly passed through the 45th Algerian and 87th French Territorial Divisions. The French troops fled in terror, clutching their necks and screaming "asphyxiate, asphyxiate," as the gas seeped into the crevices and trenches where they were taking cover. Major Andrew McNaughton, an artillery officer who would later command the Canadian Army in the Second World War, remembered the Algerians streaming past him, "their eyeballs showing

white, and coughing their lungs out — they literally were coughing their lungs out; glue was coming out of their mouths. It was a very disturbing, very disturbing sight."¹⁴ Two divisions almost evaporated, leaving little except thousands of dead and dying French in the German path. To the stunned Canadians watching this horrible spectacle on the right, they had only minutes before the outer edges of the cloud enveloped the outer edge of their lines.

Through tearing eyes and hacking coughs, it is no wonder that the Canadians viewed the poor French with apprehension. With lungs ripped raw by chlorine, men turned blue and then green-black, their eyes bulging as they sought air. Behind this horror the German troops cautiously advanced, over the dead vegetation, animal life and French soldiers. A 1.5 kilometre-long gap had been opened in the Allied line from the experimental weapon and the 1st Canadian Division shifted over, along with isolated French outposts, to fill it and block the expected German breakthrough. Buying time for reinforcements to be rushed in, the Canadians fought a series of vicious sacrificial battles.

On the morning of April 24 the battered Canadians were once again pounded by the German artillery and this time it was accompanied by the hissing of gas — the second chlorine gas attack of the war was directly against the Canadian lines. As the wall of gas drifted toward their trenches, officers and men, noticing the green tarnish to their buttons two

Fig. 1
The Second Battle of Ypres, 1915, by Richard Jack, 35.5 cm x 56.5 cm (National Archives of Canada C-014145)



days before, had realized that the Germans were using chlorine against them. Not yet equipped with any sort of protection, men were ordered to rip off pieces of cloth, urinate on them and hold them to their faces. With "invisible death creeping up" on them, as one Canadian later described it, those soldiers that followed the instructions were generally saved as the urine partly neutralized and then crystallized the chlorine.¹⁵ Those that did not, or could not, suffered a terrible fate.

The German infantry once again advanced behind their lethal cloud, but this time expected a routed force and only empty lines to pass through. Instead, they met a fusillade of bullets from Canadian Ross rifles as half-choked and blinded men fired through the still lingering haze of the cloud. The Germans were cut to pieces, but their overwhelming numbers and artillery inevitably pushed the Canadians back. Still, the resilient defence proved that gas was not the war-winning weapon that many called it immediately after the gruesome results of the first battle were publicized. Although it may not have harkened the end of the war, its effects were still potent. When the Canadians were pulled out of the line the next day, they had lost almost half their fighting strength, close to six thousand men in three days of fighting. Thousands had been lost in the immediate aftermath of the gas or to its secondary effects, which caused confused, helpless men to be captured, or to be rendered unconscious and then killed by conventional weapons.

Gas had proved devastating, both physically and psychologically. Before the stalemate of the Western Front had set in, many victorious battles over the centuries had often been decided by which side first gave in and retreated. Most deaths occurred when an army was in retreat and the sight of one's allies fleeing the battlefield could reduce a once-strong army to a rabble also looking to escape from the front.¹⁶ Not only did gas endanger soldiers directly with inescapable horror, but also psychologically as it undercut morale from the bottom up.

Immediately following the German use of gas, the Allies seized upon this event as an effective form of propaganda. Not only did politicians, soldiers and newspapers rage about the new depths to which the barbarous Hun had sunk, but there was also a genuine revulsion against gas among the Allies — and among many Germans as well. It simply did not fall within the accepted confines of how war was viewed or portrayed; soldiers died valiantly

defending their country's honour, fighting to the last, not suffocated ignominiously by some unseen gas, which was controlled and unleashed not by soldiers but by chemists. Lord Kitchener, British war hero and Secretary of State for War, was aghast when he heard the news and thought it "wicked and barbarous," while more junior officers condemned this "dirty gas stuff" and accused the Germans of being "not [willing] to face us in a fair fight."¹⁷ The Germans were eventually reduced to pleading that their gas actions were retaliatory responses to the first use by the French (a primitive tear gas grenade that was all but useless), and that their own gas attacks were not projectile-based and simply a weapon carried by the wind, and therefore within the confines of the Hague Convention.¹⁸ Although this was true, they had broken the spirit of the Convention and were roundly condemned throughout the world.¹⁹ Gas thus became an effective tool of Allied propaganda, especially with the attempt to bring the United States into the war (at least until the Allies responded with like force in September 1915), but, despite the propaganda victory, there still remained the major task of protecting the soldiers against further chemical attacks.

Dubious Protection: The Early Gas Masks

The advent of poison gas threatened to achieve a breakthrough on the Western Front. The notion that the Germans could continue to employ gas against the Allies at will was a frightening one. With little idea of how to counter the threat, Kitchener, after being advised by his army commanders that soldiers in the trenches had used "wetted" cloths to protect themselves, beseeched the women of Britain to reproduce replicas of German cloth masks. Within the first thirty-six hours, 30 000 cotton pad masks were produced.²⁰ But before the gas pads were issued to British troops on May 3, the British were gassed two more times, once on April 26 and a second time on May 2. The gas caused thousands of casualties but failed to exterminate the tenacious British troops. Nonetheless, the effect of the chlorine cloud was tremendous; British Brigadier-General F. Gore-Anley of the 12th Infantry Brigade noted that the gas attack on May 2 "was absolutely overpowering, the officers and men seemed to lose their senses, most of them getting out of the trenches and reeling about under enemy's rifle fire ..."²¹ Although the British held their

trenches, further effects of gas, besides its direct casualty impact, soon became apparent. Gas produced profound confusion, misdirection and disorder among those in its path: soldiers rushed about in terror, looking for cover or help, officers shouted orders, which were muffled by rags over and in their mouths, visibility was reduced, communications cut off, and the whole atmosphere was filled with fear and apprehension. Rarely has nineteenth-century Prussian military theorist Carl von Clausewitz's notion of "friction" — all of the unexpected factors in war that cause constant action and reaction to changing situations — been better illustrated than amongst the chaos of trying to defend a trench in the face of a gas cloud.

To help protect against this intangible terror and the friction it caused, troops were issued with the cotton gas protectors. These were stored in boxes to the rear of the trench and issued to the soldiers who had been quickly instructed to wet them in buckets of chemical solution, and fold the pad of cotton over the mouth and nose during a gas attack. Unfortunately, there was nothing to hold it in place, so the men had to stuff the chemically-dipped rags in their mouths. As one soldier quipped, "These practices were popular for once or twice, but when it began to be realised that the wads were not always used by the same man the novelty waned."²² The cotton wool pad was almost useless as protection, for it dried out too quickly, or more commonly, became a soaked mess when overly saturated with a chemical solution by terrified soldiers who had no faith that these pads might really work, or confidence that the scant training they received would be relevant.²³ On this very point British officer/poet Robert Graves characterized his first gassing in May of 1915:

A soldier came rushing in, his eyes blank with horror and excitement. "Gas, sir, gas! They're using gas!"...Gas had become a nightmare. Nobody believed in the efficacy of our respirators, though advertised as proof against any gas the enemy could send over. Pink army forms marked "Urgent" constantly arrived from headquarters to explain how to use these accessories: all contradictory.²⁴

In attempting to explain the high British gas casualties, one after-battle report issued by Lieutenant-General C. F. H. Macready, Adjutant-General of the British Expeditionary Force (BEF), noted that "very few of them [soldiers] had been properly trained in the use

of respirators."²⁵ Officers with no training in anti-gas matters were simply told to hand out the masks to the men. There was little understanding about creating a doctrine — the method by which soldiers were taught — and the overall effect was haphazard and uncoordinated. Cases were reported of soldiers putting masks over their mouths and leaving their noses exposed to the poisoned air while others were said to be indignant when reproached for not protecting themselves, and opened their coats to show the cotton masks tied around the chest.²⁶ That might sound absurd, but one must remember that most men had never seen or even imagined what gas could do or how it affected a person. Without proper gas training, the common soldier generally had little idea about how to defend against a gas attack.²⁷

Within a week of the first British units being issued their new gas masks, the 1st Canadian Division was issued with the cotton mask, but only after a harsh 26-kilometre march to Bailleul during which several Canadians died from the lingering effects of gas.²⁸ Along with the mask came the first in a long series of instructions from High Command; the Routine Orders informed that "experience shows that the effect [of gas] can be successfully combated if certain simple methods are carefully carried out."²⁹ What these methods were and how they were to be taught to the "poor bloody infantry" was less certain.

Surviving in a gas cloud was a near thing; fighting while wearing a mask was almost impossible. The early masks were only partly adequate in protecting against chlorine, and utterly ineffective for lachrymatory or "weeping" gases, as well as remaining fearful things to keep attached over the nose and throat. Issued on May 20, the Black Veil respirator had a pouch for the pad to sit in and a string to hold the mask in place, and was thus an improvement to the hand-held cloth. Still, its fragile construction virtually immobilized a man for risk of losing his mask — not the most ideal conditions for frantic soldiers trying to defend their trenches.³⁰

Following the German gas attack on 24 May, there was not another canister gas attack on the Western Front until December, 1915. The prevailing winds were blowing against the Germans and they quickly adapted by transporting their gas pioneers to the Eastern Front. Although the Allies were given a natural period of grace, the hapless Russians, many of whom had not been issued any form of gas mask, were killed in the thousands. As the Russians

were being gassed to death, the Canadians struggled with their Black Veil respirators. One Staff Officer report indicated that it was "good against chlorine," but "only gave good protection in the hands of an expert who had plenty of practice."³¹ Such experts the Canadians were not. One of the reasons why the Hypo Helmet, a chemically treated bag that fit over the head, was introduced in the summer of 1915 was its simplicity in comparison to the Black Veil mask.

The idea for a gas mask in the form of a helmet originated from a Canadian sergeant who was gassed at Ypres and had seen some of the German gas pioneers wearing what looked like flour bags over their heads. A Newfoundland medical officer, Captain Cluny Macpherson, experimented with the idea and eventually developed the Hypo Helmet. Some 2.5 million were issued during the war and by 6 July 1915 every soldier in the BEF was equipped with one.³²

Looking like a flour bag, the Hypo or Smoke Helmet was chemically treated, worn over the head and tucked in at the neck. The poison gas was neutralised by the chemicals of the helmet as the man breathed through the fabric. Yet not only did the Hypo smell, as one Canadian soldier lamented, "like last year's bird seed," but it was also cumbersome, stifling and blinding.³³ Because the helmet was impregnated with a chemical solution, the unfortunate effect for soldiers, especially when they sweated, which occurred constantly, was that the forehead was burned and the eyes stung from the chemical irritants.³⁴ Canadian infantryman Owen Bingham of the 78th Battalion remembered how the helmet would give "you burns right across the neck and on your forehead."³⁵ In addition to the nagging pain while wearing the helmet, the mica window through which the soldier was to look clouded up almost immediately, and worse, tended to crack and shatter with the slightest disturbance. Even after the mica window was replaced by a plastic substitute, there remained the disturbing fact that the chemically impregnated helmets lost their ability to filter gas when exposed to air for long periods of time. The Canadian Corps headquarters' response to worried front-line reports about the fragile helmets was to order soldiers to keep their gas helmets clean and away from water.³⁶ This did little to instill faith in the gas helmet, given the muddy, rain-soaked environment of the Western Front.

The alien nature of the gas helmets initially seemed bizarre for soldiers. Lieutenant D. E. Macintyre remarked in his diary how he made his men "practice breathing with our gas

helmets on and the men surely do look a weird sight when they are wearing them. Great goggle-eyed things like a false face."³⁷ The simple inability to communicate and the hearing of one's intake of breath rushing in and out left men feeling isolated from their comrades. Still, it offered some protection, but only if used correctly. One British officer of the 2nd Royal Welch Fusiliers, caught taking a bath during a gas attack alarm, simply "pulled on his gas helmet and stood waiting for the 'all clear,'" forgetting that he was defenceless because he had no garment into which to tuck the free end of the helmet!³⁸ The addled officer was saved by his quick-moving batman, who rushed him some clothing, but such stories highlighted the importance of not just handing out gas helmets, but actually teaching soldiers to use them correctly during gas attacks.

Further instructions were accordingly supplied, and in the summer heat of June 1915, the Canadian Corps ordered that all men had to wear their great coats during gas alerts in order to have something into which to tuck their helmets.³⁹ Because the chemicals in the helmet gave little protection against the various tear gases as opposed to chlorine gas, goggles were issued in June 1915 to be worn underneath the gas helmets. The use of goggles eventually developed into a problem for implementing a good anti-gas defence when it was realized that soldiers tended to keep their hated gas masks in their containers and instead wore only their more comfortable goggles when tear gas was used. This resulted in dozens of casualties in mid-1917, when the Germans introduced a gas that was both lethal and lachrymatory in nature. The Canadian Gas Services recalled all goggles in June 1917 and the British followed suit three months later.⁴⁰ Despite the goggle fiasco, the Hypo Helmet was effective against mild concentrations of chlorine, although it was opposed by physiologists in England, of course without front-line soldiers knowing, on the grounds that the excess buildup of carbon dioxide within the helmet would eventually cause the wearer to lose consciousness, and perhaps even die.⁴¹

British scientists continued to struggle against the spectre of German gas. Their greatest fear was whether the Germans would introduce a new chemical agent that could not be absorbed by the gas helmets. As the epitome of the new scientific warfare, poison gas caught the attention of many. One such man was Charles Aiken of McGill University in Montreal, who, upon hearing of the patriotic response of Britain's women, embarked on his own attempt

to save the boys at the front. Forwarded to Sam Hughes, Canada's Minister of Militia, Aiken's mask was unique in appearance: a long metal pole with perforations at the bottom end of the tube and topped with a rubber mask which covered the mouth, nose and eyes. The metal tube was driven into the ground and the natural oxygen from the soil gave adequate protection against lethal gases, as Aiken proved when he used the mask in a tent full of gases on the university grounds on 2 June 1915. Delighted with the idea of another Canadian contribution to the war, Hughes forwarded the drawings and report to Lord Kitchener and the War Office later that month. Theoretically the apparatus worked, except in mud — a justifiable concern for soldiers in the trenches of Flanders — but it also fixed the wearer to his gas mask, which was stuck in the ground. The idea of soldiers defending their trenches like tethered horses while they waited, immobilized, for the German infantry to come over the top did not even warrant a response from the War Office.⁴²

Along with the impetus for new gas masks, there was also a need for a structure from which an established doctrine could be disseminated. Transferred from the office of the Director General of Medical Services, the British Gas Services were formally established as a distinct entity under Major-General H. F. Thuillier in January 1916.⁴³ Under such a central authority, the British hoped to craft and refine both the offensive and defensive aspects of gas warfare, in which Canada would share as part of the larger BEF structure. Although an organization was in place, there was no effective means for working with lower command units and especially for actively training the soldier at the front in good gas discipline.

As the British worked to revise its gas organizations, the Germans continued to improve their gas tactics on the Eastern Front. In the process they realized the most serious failure of gas as a weapon: the inability to direct it accurately to a desired spot. A new delivery system was needed, but before the Germans perfected that, they introduced a more lethal gas. Eight times more deadly than chlorine, phosgene was almost invisible and without smell. It was a significant advance in making the gas war a major issue for the Allies. The rumours of its use on the Eastern Front provoked the Adjutant General of the BEF to write to the Secretary of State for War: "I desire to call your attention to the very grave situation that may arise if the enemy succeeds in using

this gas before we are provided with some means of neutralising it."⁴⁴ British scientists scrambled to develop a more protective mask as they waited for this new deadly gas. Once again, the scale of technology tipped back in favour of the offensive. Despite the introduction of more effective gas masks, the front-line soldier had little knowledge of how to employ them effectively.

The Russians were the first to be ravaged by phosgene. As their troops were being decimated, their leaders warned the British that the Germans had indeed unleashed a new gas. Deducing that this was the phosgene, the British added the chemical solution of sodium phenate to the new P Helmet in order to protect against it.⁴⁵ Interestingly, the *P* did not stand for phosgene, but rather, phenate, and it was issued to British and Canadian soldiers in November 1915.

The helmet, with its shapeless hood, two eyeholes and a rubber tube hanging down from the mouth, had a bizarre appearance and the snout-like apparatus quickly became known to the trench soldiers as "the goggle-eyed booger with the tit."⁴⁶ A significant improvement on previous gas helmets was the "tit," a special valve that removed the built-up carbon dioxide in the helmet. Unfortunately, it was extremely awkward, cutting corners of the mouth and causing soldiers to drool down their chins; it was not uncommon for soldiers to have their shirts slick with saliva after wearing the helmet for any period of time. In all but the highest concentrations of chlorine (less so for phosgene), the mask would protect the wearer but it remained a terrible burden to wear and one Canadian described it as such:

Most everyone was loath to put on the mask because it was so uncomfortable. The sack kind of material that the mask was made out of had been treated chemically and had a pincher type clamp that clamped over the nose with an elongated mouth piece that fitted in the mouth.⁴⁷

Although protecting the wearer from having his lungs burned out, the P Helmet left anyone wearing it stifled, cloistered and exhausted.

A "Secret" memo by Canadian Headquarters was more frank, reporting that "These men must be warned that they may expect to experience not only slight discomfort but very serious discomfort in some cases almost amounting to a feeling of suffocation." The solution, as espoused by the High Command,

was to "avoid movement."⁴⁸ As rumours of new German gases spread through the Allied armies, the front-line soldier needed more efficient protection rather than cryptic letters from the rear.

Equally detrimental, the user became effectively blind when the helmet was pulled over the head. Gas attacks, like artillery barrages, were often the precursor to large-scale infantry attacks or raids, but when the gas was released, soldiers could barely see five feet in front of them through their murky eyepieces.⁴⁹ The anxiety of peering over trench parapets, hoping to catch glimpses of shadowy figures advancing, left defenders both terrified of gas and of the subsequent friction imposed by it on the battlefield.

Not only was there fear of what was lurking behind the cloud, but also of whether one's gas mask would function properly. There was no method of realistically testing them to full battle conditions and thus soldiers were left to wait fatalistically, isolated and frightful, as the poison death moved towards them:

As I lay there I wondered if my gas mask would protect me. The only tests my mask had was in a building [where] the volume and density of the gas had been controlled. From the colour of this poison gas cloud bearing down on us it looked like it was a very strong mixture....All these thoughts raced through my mind as I lay there waiting for the gas to pass over us. Would



my mask prove to be good or would I die a most horrible death. There was nothing to be done but wait and see. So I took to praying.⁵⁰

Cases of soldiers suffocating with their masks on in high concentrations of gas were uncommon, but their occasional occurrence only added strength to the rumour-mill associated with gas.

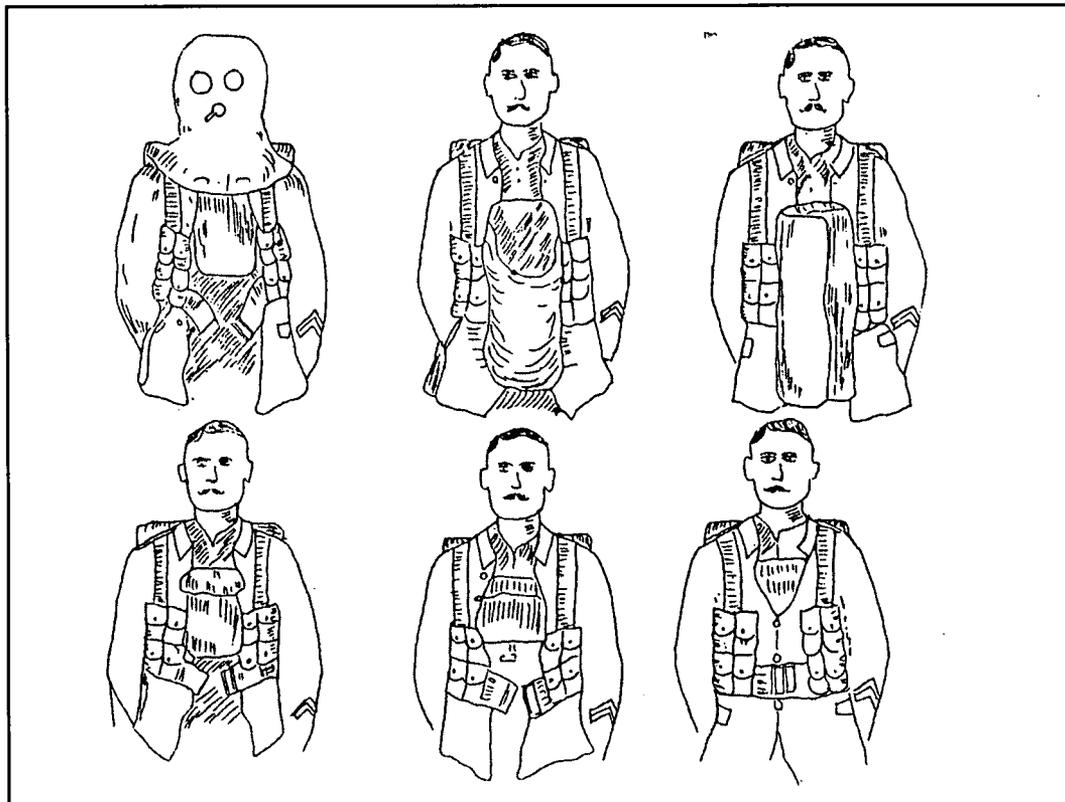
When the winds were again blowing advantageously, the Germans released their new gas against the British at Ypres. On 19 December 1915, a combination of phosgene and chlorine swept over the British lines, inflicting over a thousand casualties. Although some men were reported to have died with their helmets on in the densest concentrations of the gas, most casualties were from men taking their helmets off too soon, not donning them quickly enough or panicking and ripping off their helmets during the attack because they smelled gas. Once again, the issue of gas masks was not enough; soldiers had to be trained in their use.

With the winds once again blowing against the Germans, they did not release another gas cloud attack for months. During this interval, the British issued the PH Helmets (the same design as the P Helmet) during the lapse, with its added protection of the chemical hexamine, in order to better absorb phosgene. The Germans responded by increasing the density of their phosgene gas clouds by adding more canisters in a smaller area and the soldiers suffered accordingly. The Canadian Corps began to receive their new helmets (each man received two) on 4 February 1916, but the only chemical agents they had encountered for months had been tear gas shells.⁵¹ After the disastrous Battle of St Eloi from April 4 to 19, where the 2nd Division suffered almost 1 500 casualties in a confusing action where the location of the Canadian and German front lines were unknown, the Corps fell victim to a surprise gas attack on the night of April 27.⁵²

With the squealing and rush of whirling bodies, thousands of rats scurried over to the Canadian lines, leaping into the frightened soldier's faces and laps, as they instinctively fled from the poison following them. A light chlorine gas cloud moved through the Canadian lines but the men were able to withstand it, having been roused by gas alarms, bells and sirens, the rats and shouts of fear. Beating back a small raiding party of Germans even though they could barely see through their clouded-over plastic eyepieces, the stark terror of a gas attack and the incredible adrenaline rush left the Canadian defenders drained as they slumped to

Fig. 2
Canadian soldier wearing PH Helmet, Shorncliffe, Kent, 1917 (National Archives of Canada PA-056171)

Fig. 3
Alternate method of wearing anti-gas helmets during gas alert (RG9, series III-C-3, vol. 4039, folder 10, file 15)



the ground, smoking cigarettes or sleeping from the combined effects of gas and fighting.⁵³ Within minutes the Germans released a “second gas cloud, which was very thick” and caught many Canadians who had “thrown their helmets away” when they had “thought all was over.”⁵⁴ Some soldiers were gassed due to slowness in getting their gas helmets out of the pouches inside their great coats and others were killed because they no longer had their helmets with them. As well, because the Germans had increased the concentration of the cloud attack, some wearers of the PH Helmet could only take in oxygen if they stayed absolutely still and did not make heavy exertions.⁵⁵

Due to the wind patterns, the gas was most effective against the British units to the north of the Canadians. The British suffered 1 260 casualties, of whom 338 died.⁵⁶ The total Canadian gas casualties were unclear, but among them were twenty cases of gassed new recruits who had only joined their unit three days earlier.⁵⁷ The gas war, like all other aspects of the Great War, required time to learn how to survive. As one artillery officer remarked, “Green troops always hated gas. Our first gas alerts were the worst.”⁵⁸ One sergeant-major was so afraid of gas that “on his first trip into the line [he] slept all night in his gas mask.”⁵⁹

Having a gas helmet generally provided good protection, but knowing when to put it on, how to identify gases and drilling the anti-gas doctrine into soldiers proved that it required more than a quartermaster handing over a gas mask and muttering “best of luck chum,” in order to survive on the chemical battlefield.

Following the chaos of the April gas attack, the First Army ordered the Canadian Corps on 23 May 1916 to appoint a divisional gas officer, the catalyst in the creation of the Canadian Gas Services.⁶⁰ The eventual organization consisted of junior gas officers and non-commissioned officers at the brigade, battalion, and company level, with a Chemical Corps Advisor finally added in March 1917. Throughout the war they prodded and railed against the lack of awareness regarding gas and continually demanded more frequent and realistic training. Although beyond the scope of this article, the Gas Services played an important role in ensuring that the Canadian Corps would not be ravaged by the spiralling gas war, gas masks or not. The development of new technological protective devices was greatly complemented by an effective system of instruction. The Gas Services’ constant diligence provided Canadian soldiers with the skill and knowledge of not only donning their gas respirators quickly, but of learning

when it was safe to remove them, how to identify different variations of gas, and most importantly, how to survive and successfully carry out their operations in the future gas environment of the Western Front.⁶¹

New Delivery Systems and the Small Box Respirator

The chance of encountering gas rose dramatically with the introduction of the lethal gas shell. Before, it had taken weeks to bring gas canisters into the line, set them up under the constant fear of enemy shells puncturing the metal containers, and then finally, waiting for a proper wind to release the cloud from hundreds of these embedded canisters toward enemy lines. The lack of control over the gas, and the subservient role that the infantry played to a weapon that forced them to cancel operations and plans because of the weather, left a bad taste in many commanders' mouths. During the bloodbath at Verdun that raged for almost all of 1916, and where almost seven hundred thousand Germans and French would eventually be killed, lethal gas shells were first used to deadly effect.

Instead of having to be alert when the wind was blowing in the right direction or looking out for unusual activity in the opposite trenches, at any time artillery or mortar gunners could now drop gas shells in and around one's trenches. With gas shells making a deceptively soft 'plop' and easily lost within conventional (and deafeningly loud) high explosive bombardments, soldiers had to be constantly alert to the presence of gas. This was made more difficult by phosgene's lack of smell, night attacks, and the general confusion of attempting to warn large numbers of men quickly. In addition, those men and horses bringing up supplies along the lines of communication leading to and away from the front and the artillery in the rear were susceptible to isolated gas shells falling unseen between the alarms of the front. Soldiers could not wear the PH Helmets all the time, and equally important, the PH Helmet could not be impregnated with any more chemicals unless the solutions that protected against chlorine were to be weakened. If the Germans introduced new gases or higher concentrations of old, it could spell disaster for the Allies.⁶²

To help relieve pressure on the French, General Sir Douglas Haig, Commander of British Expeditionary Force, launched the Battle of the Somme in the summer of 1916. The anticipated breakthrough was smashed when the artillery failed to destroy the German fixed defences; the

initial result was the most disastrous day in British military history — 1 July 1916 — with close to 20 000 dead and another 40 000 as casualties. The Somme was a killing ground on a par with Verdun, and, like there, both sides used gas frequently, in canister and shell. Instead of gas being employed perhaps once a month, it was now being used weekly and sometimes daily. When the Canadians arrived at the Somme front in early September, they were warned that "the enemy now has a very large supply of [lethal gas] shells and uses them extensively against our positions."⁶³ The recorded Canadian gas casualties on the Somme were almost non-existent — around 180 — largely due to the failure of the German artillery to concentrate their gas shell shoots. This would change in the coming months; however, the untold friction and high gas casualty rate among NCOs and officers on the Somme left officials worried.⁶⁴

The questionable protection of the PH Helmet in negating the effects of gas was very much reduced by rushing back and forth. Yet this is exactly what officers and NCOs were forced to do in battle. The friction imposed by the gas — weeping eyes, muffled voices behind gas helmets, the need to order or forcefully help confused or stunned soldiers get their masks on — left those in command, and the most important men in the units, more susceptible to becoming exhausted and gassed. Equally detrimental was the difficult job of ascertaining if gas had sufficiently cleared from the trenches. The common practice was to raise the mask slightly and sniff the air. But the chemical smell of the helmet mixed with the gas fumes arising from clothes left officers with deadened olfactory senses. Realizing the need to get the hated and debilitating gas helmets off as quickly as possible, officers generally removed their helmets completely and were occasionally gassed in the process.⁶⁵ These remained problems throughout the war and were never fully solved, even with the introduction of better gas masks and training.

Following the PH Helmet, two gas masks briefly made their appearance on the battlefield. Shortly after the distribution of the PH Helmet, a rubberized goggle was added to create the PHG Helmet. More difficult to handle than the regular PH Helmet, it was quickly discarded. Experimentation to develop a better mask continued and a newly conceptualised model was introduced. The Large Box Respirator (LBR) — Tarbox Respirator or Harrison's Tower, as the soldiers nicknamed it — was a radical departure from the gas helmets. It worked on the principle of air passing through a canister of

chemicals to strain the impurities. The LBR was reserved for specialist troops like machine gunners and artillery observers, but it too was unwieldy and was discontinued in the summer of 1916.⁶⁶ The concept was sound, however, and a group of scientists, headed by Lieutenant-Colonel E. F. Harrison, continued to refine their respirator mask.⁶⁷

The best gas mask of the war, the Small Box Respirator (SBR), was issued by the British in August 1916, and was used until the end of the

Fig. 4
Two soldiers with Small Box Respirators examine a Lee Enfield rifle, March 1917. (National Archives of Canada PA-001027)



war. Soldiers and gas officers at the front had worked in conjunction with the scientists in the Medical Branch of the War Office to develop a mask that would offer more efficient protection in the growing gas environment of the Western Front. Lighter, at 1.5 kilograms, more comfortable and better able to withstand higher concentrations of gas than the previous gas helmets, the SBR was almost entirely effective in protecting the wearer's lungs from gas.⁶⁸ Carried in a satchel on the chest, charcoal and chemical granules packed in a metal container filtered out the poison gas. From the container a rubber tube led to the mask which covered the mouth and nose. As air entered the valve in the bottom of the satchel, it passed through the chemicals and was taken in through a metal mouthpiece. To ensure the wearer did not breathe through his nose, a nose clip was worn clothes-peg fashion.

Although the device was effective, it was an unnatural method through which to breathe during any period of heavy activity. There were six different sizes of SBRs and each man was fitted with one that offered the most air-tight protection. Unfortunately, any time in the front trenches left men gaunt from lack of sleep, poor food and the stress of being shot at and bombed around the clock. The resulting dilapidated state of the men caused their gas masks to lose air-tightness and required

Gas Services officers to constantly check the men under their command.⁶⁹ But as the War Diary of the 3rd Battalion, Special Brigade remarked after a gas attack on 21 August 1916, "there were practically no cases of slight poisoning. If men put their masks on quickly enough and in the right way they were unharmed. If a mistake was made it cost a man his life."⁷⁰

British units were issued with the SBR between August and December, and the Canadian Corps began to receive their SBRs in late November.⁷¹ W. J. O'Brien of the 1st Battery, 1st Brigade, Canadian Field Artillery did not receive his SBR, which he described "as a dandy," until 11 December 1916.⁷² While the SBR was the first line of defence, PH Helmets were still to be kept in case of damage to the respirator.⁷³ The contrast between the two masks was made clear by soldiers' actions. The Quartermaster General of the British Expeditionary Force complained strongly that soldiers were losing their PH Helmets. Many men did not want the added burden of two gas masks, and especially during large battles they were inclined to drop whatever was not essential. The report condemned all ranks of the BEF for losing some nine million PH Helmets, although it acknowledged that almost no SBRs were lost.⁷⁴

Such actions shed light on the mentality of the Canadian and British soldiers who, although believing in the importance of the gas mask, were not fully convinced that they would need double the protection. Combined with the natural tendency to remove all unimportant equipment, this attitude resulted in the perceived non-essentials (the PH Helmet) being dropped in some hole in the ground during an advance. Unfortunately, in a separate study of 1 082 SBRs, 25 percent were found to be damaged and would have given no or partial protection.⁷⁵ In addition, there were a surprisingly high number of cases like J. I. Chambers of the 7th Battalion, who, after surviving a vicious artillery barrage, realized with horror that both of his gas masks had been punctured!⁷⁶ Thus, it was important to have two gas masks at all times, a lesson only absorbed after vigorous lectures or seeing a companion suffocating to death as he fumbled with a faulty respirator. Most soldiers took their chances, while few took the warnings to heart.

Like all soldiers of the BEF, once the Canadians began to train with the SBR, they realized its advantage over the previous gas helmets. The soldiers were drilled to quickly don their masks and had to be able to accomplish it in under six seconds. Although the SBR could be



Fig. 5
 "Views Taken at Bexhill
 Command School":
 practising with gas
 masks or respirators on
 (National Archives of
 Canada PA-004897)

adjusted in about half the time of the PH Helmet, it was still a difficult process, as George Maxwell of the 49th Battalion described:

Every man hustled to get his mask adjusted. To do this, the steel helmet had to be jerked off; the mask had to be pulled over the head; the clamp had to be fastened on the nose to shut off the breathing with that organ, forcing one to breathe by mouth through the chemically prepared canister attached to the mask. After the beastly mouthpiece was inserted, the helmet had to be readjusted on the head. I forgot to jerk mine off; the chin strap got entangled with the straps of my gas mask. Fortunately, Lieutenant Wyndam was standing beside me and saw my predicament. He came to my aid, but not before I had inhaled some of the abominable gas...⁷⁷

Difficulty in adjusting the SBRs could result in death, so constant practice was needed by both new reinforcements and old hands.

With the introduction of the SBR the soldier gained a much greater degree of physical safety on the battlefield. SBRs gave longer protection against gas — the filters lasted for approximately forty hours of wearing before they had to be replaced — but officers continued to fear that the extended use of gas shells would wear out the respirators.⁷⁸ In contrast to previous gas helmets, however, soldiers did not have to deal with the near suffocation-like experience, but no one ever got over wearing the respirators. The foreign nature of breathing stale air, looking out through goggled eyes (which continued to cloud up until the end of the war), the strange, wheezing intake of air, the sense of isolation from one's companions and, most importantly, the debilitating heat and exhaustion brought on by wearing the mask while engaging in any

form of activity, were all factors in reducing the fighting efficiency of soldiers by an estimated one-half.⁷⁹ With the SBR, the oscillating gas war tipped back in favour of the defensive. Yet while the trench soldier learned to survive in his respirator, the gas war did not end there.

The Gas Environment

The gas war increased in scope and intensity as the war progressed. New delivery systems and deadlier gases were introduced to smother the battlefield. On the night of 12/13 July 1917, the Germans broke the deadlock in the gas war by introducing mustard gas to the already hell's broth of other gases polluting the trenches. Delivered in shells marked with a Yellow Cross on the head, they were surreptitiously dropped into the British lines. After the "all clear" had been given to remove gas masks, the soldiers fell back into their interrupted slumber. By morning, thousands woke up to find they were blind, coughing and covered in suppurating blisters.

Mustard gas, unlike the phosgene and chlorine or the annoying tear gases, was a persistent gas that lurked on the battlefield. No longer were soldiers able to anticipate gas by canisters or gas shells, as mustard gas had a latent potency that could still be deadly to everyone in the vicinity days or weeks after it was first delivered. Not only did mustard gas pollute trenches and shellholes, but it also infected clothing so that when soldiers entered dugouts they contaminated their comrades as well.

No one was safe from this plague. Although the SBR protected soldiers from its effects on the lungs and eyes, it remained a powerful tool for causing blisters and burns that sent hundreds of thousands out of the line by the end of the

Fig. 6
Unidentified Canadian soldier with burns caused by mustard gas (National Archives of Canada C-080027)



Fig. 7
Canadians wearing gas masks bring in wounded, Battle of Amiens, August 1918. (National Archives of Canada PA-002863)

war. While many of the effects of mustard gas wore off after several weeks (the blisters healed and sight returned) and thus did not have the lasting effects of its deadly cousins, phosgene and chlorine, it was highly disruptive to battle plans, and of course also deadly without the SBR. More importantly, because mustard gas could be found or sent anywhere, it required

soldiers to wear their SBRs more often and for longer durations. Aware of the debilitating effects of wearing gas masks continuously, all armies soon made gas an integral component of all their operations: gas in all forms accounted for between 20 and 40 percent of all shells used by 1918.⁸⁰ As the attack gas doctrines were continually refined, chemical agents were used to harass soldiers, cause a steady stream of direct casualties, disrupt the lines of communication, slow logistics, interrupt enemy artillery fire, contaminate forming-up points and front-line trenches, and create general friction and stress during battles.

The British went through seven variations and produced a total of fifty-five million gas masks throughout the war.⁸¹ Without them, the British and Canadian Tommies would have been left to the merciless nature of poison gas, and undoubtedly would have lost the war. The gas mask blunted the possible war-winning nature of poison gas, but it did not negate all of its effects. The evolution of the gas helmet is an aspect of the war ignored in modern historiography and as a result it has been wrongly assumed that, once the first gas masks were introduced, the threat of gas was reduced

to little more than a nuisance. Such views have for too long clouded the true nature of fighting on the Western Front. It was a slow, difficult process by which the *frontsoldaten* received the gas masks, the first being little more than cloths dipped in dubious chemical solutions, the rest, to varying degrees, leaving soldiers feeling stifled, uncomfortable and effectively blinded. Although the SBR gave much better protection against lung gases, it still left the soldier with reduced vision, aggravated fatigue and reduced fighting efficiency. Finally, no mask prevented the deluge of non-lung mustard gas casualties that threatened to reduce whole divisions during the last year and a half of the war.

As the soldier struggled in the ever-increasing gas environment of the Western Front, the gas mask did not become just another component of trench stores, it became the most important piece of equipment owned by a soldier. As an anti-gas lecture read to all men starkly noted, "Your life will often depend upon your respirator."⁸² Notwithstanding such warnings, the Canadian Corps suffered at least 11 572 non-fatal battle gas casualties throughout the war and its soldiers were burdened with countless psychological and physical pressures.⁸³ Despite these losses though, without the development of an effective gas mask there would have been no hope of survival on the Western Front.

NOTES

1. See Bill Rawlings, *Surviving Trench Warfare* (Toronto: University of Toronto Press, 1992), for the best analysis of this struggle.
2. See Hubert C. Johnson, *Break-Through: Tactics, Technology, and the Search for Victory on the Western Front in World War I* (California: Presidio, 1994), for a good discussion of this see-saw struggle.
3. Rudolph Hanslian, "Gas Warfare: A German Apologia," *Canadian Defence Quarterly* 6, no. 1 (October 1928): 96–99; William Moore, *Gas Attack* (London: Leo Cooper, 1987), 2; Martin van Creveld, *Technology and War* (London: The Free Press, 1989), 61.
4. Not all saw this as an inhumane method of warfare and the American representative, the famous Admiral Alfred T. Mahan, asked what the difference was between gassing a man and using a torpedo to blow up a ship without warning and send him to a watery grave. Samuel Hynes, *A War Imagined* (London: Pimlico, 1990), 43–4; Charles H. Foulkes, *Gas: The Story of the Special Brigade* (London: William B. Blackwood & Sons, 1936), 19; Stockholm International Peace Research Institute (SIPRI), *The Problem of Chemical and Biological Warfare*, vol. I, *The Rise of CB Weapons* (Stockholm: Almqvist & Wiksell, 1971), 231–250.
5. By 1913, Germany produced eighty-five percent of the world's chemicals. Jacques J. Bailliu, *Canada and Chemical Warfare* (RMC: Unpublished Master of War Studies Thesis, 1989), 11–21; Robert B. Asprey, *The German High Command at War* (New York: William Morrow and Company, Inc., 1991), 218.
6. Ian Hogg, *Gas* (New York: Ballandean Books, 1975), 20.
7. See Ulrich Trumpener, "The Road to Ypres," *Journal of Modern History* 51 (June 1979), for an excellent analysis of the German production of war gases up until Ypres.
8. Holger H. Herwig, *The First World War: Germany and Austria-Hungary 1914–1918* (London: Arnold, 1997), 170.
9. Sir Basil Liddell Hart, *A History of the World War 1914–1918* (London: Little, Brown & Company, 1935), 245–249; Hugh MacIntyre Urquhart, *Arthur Currie: The Biography of a Great Canadian* (Toronto: J. M. Dent & Sons, 1950), 60.
10. Daniel Dancocks, *Welcome To Flanders Fields* (Toronto: McClelland and Stewart, 1988), 148.
11. At least three men were killed and fifty injured. Ludwig Fritz Haber, *The Poisonous Cloud* (Oxford: Clarendon Press, 1986), 31; Trumpener, "Road to Ypres," 472.
12. There is often discussion with regards to the battle as to the fact that the Germans could have broken through to the Channel ports on the Belgian coast. Most importantly, the gas attack was an experiment and used to cover the movement of several German divisions to the Eastern Front where they were to be involved in an upcoming offensive. The German infantry were given limited objectives and they stuck to them.
13. Lyn Macdonald, 1915: *The Death of Innocence* (London: Headline Book Publishing, 1993), 192.
14. John Swettenham, *McNaughton Volume I* (Toronto: The Ryerson Press, 1968), 44–45.
15. NAC, RG 41, Transcripts from the CBC Radio Program "In Flanders Fields," volume 7, 3rd Battalion, N. Seaman, Tape 2 / Page 12.
16. John Keegan, *The Face of Battle* (London: Pimlico, 1976), 71.
17. J. E. B. Seely, *Adventure* (London: William Heinemann, 1930), 220; Simon Jones, "Under A Green Sea: The British Responses To Gas Warfare, Part 1 & 2," *The Great War*, vol. 1, no. 4 (August 1989): 128.
18. Robert Asprey wrote that "The rape of Belgium, the execution of Edith Cavell [the British nurse executed by the Germans for having helped British soldiers to escape from Belgium], and the introduction of poison gas were all used by Britain in propagandist exercises to invoke the wrath of their people as well as attempt to stir the dormant and isolated United States into action." Asprey, *German High Command*, 214–5; SIPRI, *Chemical and Biological Warfare*, 231–250, for the use of the German gas attack in Allied propaganda.