

Avoiding the Unavoidable: The United States Army's Adaptation to Future Chemical Environments

A Monograph

by

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Abstract

Avoiding the Unavoidable: The United States Army Adaptation to Future Chemical Environments, by MAJ Derek J. Thompson, 50 pages.

In the past two decades the United States Army focused on fighting a counterinsurgency and counterterrorism war while prospective adversaries of the United States have used that time to further their military technological progress. These potential enemies have continued to develop the capability to pursue chemical warfare while finding ways to bypass international conventions and norms. Russia has created fourth generation chemical agents that pose significant threat to the United States. Also, China, North Korea, and Iran each operate in near secrecy with evidence pointing to chemical warfare capabilities. As recently as 2017, Syria employed chemical warfare against its population, with minimal recourse from the international community. The United States Army believes large scale combat operations will be the construct for future conflicts, which is a meaningful change from the operations of the previous two decades. The Army must address doctrinal countering weapons of mass destruction gaps to prevent catastrophic use of chemical weapons. The Army must also invest in significantly in modern chemical defense equipment and training across all components of the Army in chemical operations. The United States is facing an operational environment similar in nature to World War I when major international actors sought any advantage on the battlefield. The American Expeditionary Force found itself unprepared for chemical warfare. The United States Army in 2020 must not find itself unprepared to execute operations in a chemical environment against its opponents.

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Abbreviations

ADP	Army Doctrine Publication
ADRP	Army Doctrine Reference Publication
AEF	American Expeditionary Force (s)
ATP	Army Techniques Publication
CBRN	Chemical, Biological, Radiological, Nuclear
CBRNE	Chemical, Biological, Radiological, Nuclear, and Explosive
CIA	Central Intelligence Agency
CTC	Combat Training Center
CW	Chemical Warfare
CWC	Chemical Warfare Convention
CWMD	Counter/Countering Weapons of Mass Destruction
CWS	Chemical Warfare Service
DOD	Department of Defense
DPRK	Democratic People's Republic of North Korea
FM	Field Manual
JP	Joint Publication
LSCO	Large Scale Combat Operations
OPCW	Organization for the Prohibition of Chemical Weapons
UN	United Nations
VX	Venomous agent X
WMD	Weapon(s) of Mass Destruction/Disruption

Section I: Introduction

On April 4, 2017, the residents of Khan Shaykhun, Syria started their morning by preparing to leave for school and work. This day would take dark turn for these citizens. At approximately 6:30 A.M., locals heard warplanes in the sky. Soon after detecting the Su-22 jets, locals sought shelter as the planes delivered bombs and rockets onto their town.¹ The munitions were not traditional explosive rounds and neighborhoods discovered something was astray. The KhAb-250 aerial bombs caused men, women, and children of all ages to foam at the mouth, faint, suffocate and display pinpoint pupils.² Other victims experienced coldness in their extremities, decreased heart rate, and lowered blood pressure.³ The most concerning aspect involved people perishing in open areas. Residents previously experienced attacks from conventional munitions and even exposure to chlorine which killed people in confined spaces, but this attack differed from previous attacks in that Syrians died in the open.⁴ The symptoms displayed by victims combined with the open-air casualties led to the conclusion that Syrian forces utilized a nerve agent.

In the aftermath of the attack, tissue and soil samples collected for analysis determined what occurred in Khan Shaykhun. Within a week Turkish and British officials declared the nerve

¹ Alison Meuse, “The View from Khan Shaykhun: A Syrian Describes the Attack's Aftermath,” *Conflict Zones*, NPR, April 5, 2017, accessed February 20, 2020, <https://www.npr.org/sections/parallels/2017/04/05/522093672/the-view-from-khan-shaykhun-a-syrian-describes-the-attacks-aftermath>.

² “Syria: New Evidence Shows Pattern of Nerve-Agent Use: Government Enters Realm of Crimes Against Humanity,” *Human Rights Watch*, May 1, 2017, accessed February 19, 2020, <https://www.hrw.org/news/2017/05/01/syria-new-evidence-shows-pattern-nerve-agent-use#>.

³ Raja Abdulrahim and Noam Raydan, “Dozens Dead in Syria Chemical Attack,” *The Wall Street Journal*, April 4, 2017, accessed February 19, 2020, <https://www.wsj.com/articles/syrian-activists-say-dozens-dead-in-idlib-chemical-attack-1491306761>.

⁴ Ellen Francis, “Scores Reported Killed in Gas Attack on Syrian Rebel Area,” *Reuters*, April 4, 2017, accessed February 20, 2020, <https://www.reuters.com/article/us-mideast-crisis-syria-idlib-idUSKBN1760IB>.

agent used in the attack was sarin gas, and that the Syrian government was responsible.⁵ The Organization for the Prohibition of Chemical Weapons (OPCW), later confirmed that sarin or a sarin-like substance combined with the release method, was evidence of chemical weapon employment.⁶ The chemical attack is estimated to have killed at least ninety people including thirty children while wounding over 300.⁷ This tragedy occurred during the Syrian civil war and although American and coalition forces were involved in Syria, fighting Islamic terrorists, this attack received little backlash from the international community.

The international reaction was varied to the Syrian operation, with insignificant impact to the Syrian government. The United Nations (UN) Security Council voted on a draft resolution to condemn the Syrian government and demand a full investigation into the incident, however, Russia vetoed the resolution.⁸ The European Union condemned the attacks and placed blame on the Syrian government.⁹ American response included minimal military and economic actions. The United States launched fifty-nine cruise missiles at the Shayrat Airbase in Syria on April 7, after the UN failed to adopt a resolution.¹⁰ Additionally, the United States imposed sanctions on

⁵ “Theresa May: Syria 'Highly Likely' Behind Attack,” *BBC News*, April 13, 2017, accessed February 20, 2020, <https://www.bbc.com/news/uk-politics-39591476>.

⁶ Organization for the Prohibition of Chemical Weapons (hereafter OPCW), *Report of the OPCW Fact-Finding Mission in Syria Regarding an Alleged Incident in Khan Shaykhun, Syrian Arab Republic April 2017* (The Hague, Netherlands: 2017), 3.

⁷ Ole Solvang, “Death by Chemicals the Syrian Government’s Widespread and Systematic Use of Chemical Weapons,” *Human Rights Watch*, May 1, 2017, accessed February 20, 2020, <https://www.hrw.org/report/2017/05/01/death-chemicals/syrian-governments-widespread-and-systematic-use-chemical-weapons>.

⁸ “Russia Blocks Security Council Action on Reported Use of Chemical Weapons in Syria’s Khan Shaykhun,” *UN News*, April 12, 2017, accessed February 21, 2020, <https://news.un.org/en/story/2017/04/555292-russia-blocks-security-council-action-reported-use-chemical-weapons-syrias-khan>.

⁹ “Statement by President Juncker on the Situation in Syria,” European Commission, last modified April 7, 2017, accessed February 21, 2020, https://ec.europa.eu/commission/presscorner/detail/en/STATEMENT_17_912.

¹⁰ “Syria War: US Launches Missile Strikes in Response to 'Chemical Attack,’” *BBC News* April 7, 2017, accessed February 21, 2020, <https://www.bbc.com/news/world-us-canada-39523654>.

the Syrian Scientific Studies and Research Center for their role in producing chemical weapons.¹¹ Although the United States responded economically and militarily, no major military operations or economic sanctions were imposed on the central government of Syria. The Syrian government exploited the gap in most international treaties, the lack of international enforcement through other than diplomatic means.

The treaty exploited by the Syrian government is the Chemical Weapons Convention (CWC). Syria broke the treaty tenants through offensive application of sarin gas, a chemical weapon. The CWC is the international convention overseen by the OPCW to eliminate global chemical weapons. The CWC requires each signatory “to agree not to develop, produce, acquire, stockpile, retain or use chemical weapons or to assist others in the same.”¹² Syria signed the CWC in October 2013, four years before the Khan Shaykhun sarin attack.¹³ Sarin gas employment is a clear indication of breaking the international treaty and norms against the use of chemical weapons on either civilian populations or military targets. The insignificant American and international response to the violation of the treaty catalyzes other nations to cultivate and employ chemical warfare (CW).

The Problem

The minimal international response to the CWC being disregarded coupled with the rise of peer competitors with historic interest in CW presents a problem for the US Army. If the international community accepts chemical weapons utilization, it will bolster a government’s

¹¹ “Treasury Sanctions 271 Syrian Scientific Studies and Research Center Staff in Response to Sarin Attack on Khan Sheikhoun,” Press Releases, US Department of Treasury, April 24, 2017, accessed February 21, 2020, <https://www.treasury.gov/press-center/press-releases/Pages/sm0056.aspx>.

¹² OPCW, *Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on Their Destruction*, The Hague, Netherlands, UNTS I-33757, 1997, 2.

¹³ “Syria’s Accession to the Chemical Weapons Convention Enters into Force,” *OPCW News*, October 14, 2013, accessed February 21, 2020, <https://www.opcw.org/media-centre/news/2013/10/syrias-accession-chemical-weapons-convention-enters-force>.

usage of these weapons with slight concern of reprisal. The proliferation of nanotechnologies and the production of binary fourth generation chemical agents represent a disparity in existing chemical treaties. Chemical agents offer opponents a strategic and operational capability to achieve the tactical objectives of terrain control and denial, the possible defeat of American forces, and the delay of forces through confusion. Russia, China, Iran, and North Korea may also recognize the operational and the strategic advantages of CW. The use of CW in Large Scale Combat Operations (LSCO) affords opponents opportunities to cause mass casualties, turn public perception against a conflict, and bolster their strategic position as a technologically equipped force capable of inflicting heavy damage. The strategic benefits of CW offset by the lack of CWC enforcement bolsters these countries' probability of CW employment in a potential conflict. Adversaries may pursue leverage through CW to strengthen regional and global influences.

Adding to the problem of enforcement is the transition in the US Army from counterinsurgency and counterterrorism operations to LSCO. LSCO are extensive joint combat operations in terms of scope and size of forces committed, conducted as a campaign aimed at achieving operational and strategic objectives. Complexity, chaos, fear, violence, fatigue, and uncertainty are the characteristics of these operations.¹⁴ These conditions present ideal circumstances for adversarial application of CW to disrupt and delay combat operations. CW affords an adversary strategic, operational, and tactical options to defeat the US. While the US Army adjusts its doctrine, force posture, training, and equipment to execute LSCO, the US Army chemical corps must also continue to adapt for LSCO.

The Army is moving to LSCO after focusing on counterinsurgency and counterterrorism which resulted in a deterioration of capabilities required to fight and win in a chemical environment. Since 2001, shifts occurred to strategic policy and doctrine through the publication

¹⁴ US Department of the Army, Army Doctrine Publication (ADP) 3-0, *Operations* (Washington, DC: Government Printing Office, 2019), 1-5.

of countering weapons of mass destruction (CWMD) policy and doctrine.¹⁵ The Army correspondingly modified force posture by establishing the Chemical, Biological, Radiological, Nuclear, and Explosives (CBRNE) command, realigning decontamination and reconnaissance formations to the strategic reserves, and tasking active component chemical units for multiple purposes. Investments occurred in dismounted reconnaissance resources along with fielding the Stryker Nuclear, Biological, and Chemical vehicle. These revisions aligned the chemical corps against a potential terrorist possession or use of chemical weapons, rather than near peers.

While the Army implemented slight improvements to its operational chemical force, American rivals advanced their CW proficiencies. Several adversaries possess fires superiority that may be combined with chemical employment. This combination enables key terrain denial, isolates friendly forces, and induces battlefield complexity, creating conditions for success. In 2015, Russia realigned its Chemical, Biological, Radiological, and Nuclear (CBRN) forces, with a CBRN brigade supporting every combined arms and tank army.¹⁶ Russia traditionally perceives chemical weapons as an advantageous deterrent to employ on specific terrain and targets to set conditions for force overmatch.¹⁷ North Korea maintains a robust CBRN program that threatens South Korea and the surrounding region.¹⁸ Iran possessing chemical capabilities remains a destabilizing adversary in the Middle East. China maintains a covert CBRN program that

¹⁵ US Department of Defense, *Department of Defense Strategy for Countering Weapons of Mass Destruction* (Washington, DC: Government Printing Office, 2014), 1.

¹⁶ US Department of the Army, Field Manual (FM) 3-11, *Chemical, Biological, Radiological, and Nuclear Operations* (Washington, DC: Government Printing Office, 2019), i.

¹⁷ Joachim Krause and Charles K. Mallory, *Chemical Weapons in Soviet Military Doctrine: Military and Historical Experience, 1915-1991* (Boulder, CO: Westview, 1992), 139-142.

¹⁸ “North Korea's Chemical and Biological Weapons Programs” (International Crisis Group, June 18, 2009), 7, accessed November 14, 2009, <https://d2071andvip0wj.cloudfront.net/167-north-korea-s-chemical-and-biological-weapons-programs.pdf>.

continues to grow and may be employed in future conflicts.¹⁹ These countries present the possibility for CW in a possible LSCO conflict.

The United States is facing potential conflicts where it must account for the possible possession of chemical weapons by American foes. The near peer competitors China and Russia along with the adversarial regimes of North Korea and Iran all possess CW capabilities. The last two decades in Iraq and Afghanistan have atrophied US Army preparedness and understanding of chemical environments. Additionally, the lack of international prosecution for violations of international treaties and norms against countries using chemical weapons enables likely US adversaries' opportunities to employ these weapons with minimal recourse. The US Army will not be prepared for operations against an adversary possessing chemical weapons without revisions to doctrine, force posture, training, and equipment.

Methodology

This monograph explores the threat, doctrine, organization, training, and equipment necessary for LSCO chemical operations. A key aspect to the strategic framework is insights to the current and historic international treaties and norms that govern CW. Chemical operations in World War I furnishes a context of the fundamental challenges of CW that persist to drive doctrine, force posture, training, and equipment in the US Army. An analysis of the feasible enemy capabilities affords an appreciation of the hazards against which to implement changes in the Army. Current strategic frameworks along with joint and Army chemical doctrine is necessary to identify gaps thereby informing recommended modifications to force posture, equipment, and training.

Research focused on an understanding and synthesis of primary and secondary sources relating to history, doctrine, threats, and chemical force posture. The findings omit certain sources

¹⁹ "Strategic Weapons Systems," Jane's Sentinel Security Assessment - China and Northeast Asia, last updated October 2, 2019, accessed November 14, 2019, <https://janes-ihs-com.lumen.cgsccarl.com/Janes/Display/CNAA015-CNA#Chemical%20capabilities>.

related to specific information and risks due to material classification levels. In instances of classification, secondary sources bridged the material. Primary source material on World War I consisted primarily of the reports *Gas in Attack and Gas in Defense* along with *The Chemical Warfare Service in France*, written by BG Amos Fries, who was the commander of the Gas Service Section of the American Expeditionary Force and second commandment of the Chemical Warfare Service (CWS). Primary sources for chemical threats consist of Central Intelligence Agency (CIA) and Defense Intelligence Agency reports on dangers during the Cold War. Strategic frameworks and current doctrine provide the primary sources on current chemical doctrine, capabilities, and organization.

Secondary sources offered material on perceived threats, trends, and relevant chemical equipment and resources existing across the globe. Publications by Al Mauroni, the Department of Defense (DOD) foremost expert on CWMD, delivers historic foundations of America's history in CBRN operations. Publications by the Combat Studies Institute and the US Army chemical corps granted technical and tactical information required to understand current chemical operations and future implications. *War of Nerves*, *Hellfire Boys*, and *Avoiding the Abyss* are each anthologies of CW and the implications of chemical operations.

The sources utilized enable a robust technical understanding of CW which presents potential problems due to its complex nature. Although CW is a complex subject that involves various chemical agents, simple characteristics allow for a cursory understanding. Chemical agents are liquid or gaseous agents categorized into four groups. Blood agents block the transport of oxygen by red blood cells from the lungs to the tissues that causes respiratory failure. The common type of blood agent is hydrogen cyanide. Blistering agents, including mustard gas, phosgene and lewisite penetrate the skin and produce chemical burns, blindness, and muscle pain. Chlorine and phosgene are choking agents that cause pulmonary edema or dry land drowning. Nerve agents such as sarin, tabun, and VX disrupt the transmission of nerve impulses in humans

resulting in death usually.²⁰ Another way to classify CW agents is by their persistency or ability to stay in an area. Persistent agents accomplish terrain denial as they stay in areas for longer periods. Persistent agents include mustard and VX. Non-persistent agents dissipate faster and are employed to produce favorable fighting conditions and inflict heavy casualties. Non-persistent agents include phosgene, chlorine, and sarin.²¹ Chlorine, phosgene, and mustard are the agents that forces encountered most frequently in World War I.

Section II: Historical Case Study

Although modern chemical agents are classified and understood, CW has history from the fifth century BC through the twenty-first century. The first recorded use of CW was in 423 BC when the Spartans created sulfur dioxide by burning sulfur and pitch during the siege of Plataea.²² The Spartans produced a gas that forced defenders to abandon their posts and allowed Sparta to occupy the area. Following Sparta's application of sulfur dioxide, militaries throughout the world experimented with sulfur but never employed it on a large scale. In 1854, during the Crimean War, Sir Lyon Playfair, the British Secretary of the Department of Science, advocated utilizing cyanide filled shells during the Siege of Sebastopol.²³ In the American Civil War, Union and Confederate supporters advocated for CW, including cyanide, sulfur, and chlorine.²⁴ The international community understood the ramifications of CW and took steps to limit its employment. In 1874, the Brussels Convention on the Law and Customs of War prohibited the

²⁰ Joseph Cirincione, Jon B. Wolfsthal, and Miriam Rajkumar, *Deadly Arsenals: Nuclear, Biological, and Chemical Threats*, 2nd ed. (Washington, DC: Carnegie Endowment for International Peace, 2014), 63.

²¹ Albert J. Mauroni, *Chemical and Biological Warfare: A Reference Handbook* (Santa Barbara, CA: ABC-CLIO, Inc., 2007), 157.

²² Eric R. Taylor, *Lethal Mists: An Introduction to the Natural and Military Sciences of Chemical, Biological Warfare and Terrorism* (Huntington, NY: Nova Science, 2001), 5.

²³ *Ibid.*, 5.

²⁴ Guy R. Hasegawa, "Proposals for Chemical Weapons during the American Civil War," *Military Medicine* 173, no. 5 (2008): 499.

employment of poisoned weapons, and the use of arms, projectiles, or material to cause unnecessary suffering. Additionally, in 1899 at the Hague Convention, countries agreed to abstain from utilizing projectiles whose only objective is the diffusion of asphyxiating or damaging gases. A second Hague Convention, in 1907, reiterated earlier bans on employing poison or poisoned weapons.²⁵ All the major actors of World War I, except the United States, ratified these agreements, however in 1915 these international norms were broken. World War I presented chemical threats that required the US Army to adapt its doctrine, force posture, training, and equipment to operate on the battlefield.

Although international CW norms existed, the stalemate on the western front, trench warfare, and a yearning to end the conflict expeditiously created an ideal environment for CW. When the allies blocked Germany on their advance to Paris in 1914, the German army desired a way to surprise the allies and regain the initiative.²⁶ The answer lay within the German scientific and industrial community. At the onset of World War I, Germany possessed a robust industrial base and retained the world's foremost chemists. In 1915, Dr. Fritz Haber, a scientist and consultant to the German War Office, recommended the use of chlorine gas as a weapon.²⁷ Chlorine is deadly in concentrated form, produced a surprise advantage, and would disrupt allied command and control nodes. The first chlorine attack during the second battle of Ypres on April 22, 1915 failed to break the stalemate due to extreme cold temperatures freezing the gas thereby making it less effective. Additionally, German forces failed to seize the tactical initiative created by the confusion of the new gas.²⁸ While Germany initially did not achieve a tactical or

²⁵ Edward M. Spiers, *A History of Chemical and Biological Weapons* (London: Reaktion, 2010), 29-31.

²⁶ Amos A. Fries, *History of Chemical Warfare Service in France* (Washington, DC: War Department, 1919), 15.

²⁷ Mauroni, *Chemical and Biological Warfare*, 7.

²⁸ *Ibid.*, 8.

operational advantage using CW, the innovative technology surprised the enemy and offered evidence for the potential benefits of CW.

Following Ypres in April 1915, the introduction of new chemical munitions changed the operational environment. In December 1915, Germany utilized phosgene gas in an attack on British troops at Wieltje near Ypres, Belgium. While chlorine produced rapid casualties and effects, phosgene remained at ground level and filled the trenches. Phosgene forced defenders to abandon their trenches and bestowed a tactical advantage to the Germans.²⁹ Mustard gas, first introduced in 1917 at the third battle of Ypres, was arguably the most effective chemical agent in World War I. The agent affects exposed skin and eyes while producing burns on the body, eyes, and respiratory system. Mustard gas supplied a tactical advantage by forcing defenders to abandon their trenches due to the nature of liquid agent touching the skin and contaminating the trench for extended periods of time.³⁰ The temperature did not affect mustard agents drastically, so it could be applied in colder conditions without freezing. The persistency of mustard gas offered another tactical advantage as the agent may be employed against flanks, strong points, or any areas that the attacker wished to make inaccessible. Battlefields characterized by heavy employment of chlorine, phosgene, and mustard gas presented problems to the US Army as they entered the war in April 1917.

American forces in World War I recognized the realities of chemical trench warfare and developed nominal doctrine for chemical defense. The Army Gas Service Section created the first four training pamphlets, and eventually published them together as *Document 705, Gas Warfare* in October 1917 to ensure leaders and soldiers understood the nature of CW. The pamphlets covered methods of training in defensive warfare, defensive measures against gas attacks,

²⁹ Charles E. Heller, *Chemical Warfare in World War I: The American Experience, 1917-1918* (Honolulu, HI: University Press of the Pacific, 2005), 22.

³⁰ *Ibid.*, 151.

German methods of offense, and Allied methods of offense.³¹ During the war, chemical agents had four primary purposes: to produce deaths and casualties before an attack, to produce deaths and casualties among support and reserve personnel followed by a delayed attack, to produce deaths and casualties among lines of communication with no imminent attack likely, and to produce casualties at locations out of reach of line of sight weapons.³² The published doctrine delivered leaders at all levels an understanding of CW from both an offensive and defensive perspective. The pamphlets did not link chemical offensive and defensive tactics into a combined theory of CW.

While the Army published doctrine, World War I necessitated a new technical branch of the Army as CW subject matter experts. An Army organization tasked as CW subject matter experts did not exist until July 5, 1917. General Order 8, published in July 1917, established the organization of the American Expeditionary Forces (AEF) general headquarters and created the position of Chief of the Gas Service. The Gas Service Chief's responsibilities included procurement of gas personnel and supplies, the conduct of both offensive and defensive CW, the supervision of training for gas officers and troops, and experimentation with new gases, delivery systems, and protective devices. On August 17, 1917 GEN John J. Pershing appointed LTC Amos A. Fries as the chief of the gas service. LTC Fries, through General Order 79, created unit gas officers at every level from corps to battalion. The division and higher echelon gas officers were to instruct and supervise the gas officers and soldiers within their command, supervise all defensive training and drill, collect enemy CW material for submission to AEF laboratories, inspect defensive measures, and advise the commander and staff regarding all aspects of CW. The division gas officer had the responsibility of reporting to the commander all gas casualties and

³¹ William L. Siebert, *History of the Training Division Chemical Warfare Service* (n.p.: Washington, DC, 1920), 4. (MG Siebert was the commandment of CWS from 1918-1920 and this book was unpublished and compiled by MG Siebert).

³² Amos A. Fries, "Gas in the Attack and Gas in the Defense," Reprinted from the *National Services Magazine* (June and July 1919): 8.

actions taken to prevent recurrences. The division commander forwarded this report, together with a list of the actions he had taken to correct the deficiencies, to the Chief of the Gas Service. At lower echelons, gas officers and soldiers supervised training in the employment of gas masks, gas proof shelters, alarm systems, and related defensive measures. They reported weather, terrain conditions, all new enemy gas tactics and material, and any noted deficiencies.³³ The creation of the gas service produced subject matter experts on CW, but the gas service officers and soldiers formal training.

Gas service troops attended formal training on chemical operations in the United States and France. The Gas Defense Department at Fort Sill was created on August 15, 1917 to train gas recruits for deployment to Europe but was moved and reopened as the Army Gas School, at Camp Humphrey's, Virginia, in May 1918.³⁴ The AEF Gas Defense School in Chaumont, France was established in May 1918.³⁵ Training at all three courses included instruction on the nature of chemical operations including personal protection, types of agents, climatology, chemical offensive capabilities, and battle drills in a simulated chemical environment.³⁶ These courses were instrumental in providing shared understanding across the force on active defense against chemical threats. The graduates of these courses were responsible for CW training for all AEF forces. The training afforded soldiers the knowledge required to survive and fight effectively in a chemical environment.

Although training saved lives through shared understanding, proper equipment is instrumental in any chemical environment. The priority for equipment was personal protection that included an appropriate mask that protected soldiers' faces and lungs. Chemical protective protection is always a concern in chemical environments as the equipment mitigates the

³³ Heller, *Chemical Warfare in World War I*, 47-54.

³⁴ Siebert, *History of the Training Division Chemical Warfare Service*, 4.

³⁵ Heller, *Chemical Warfare in World War I*, 50.

³⁶ Sibert, *History of the Training Division Chemical Warfare Service*, 21.

extraordinary threats presented by chemical agents. At Cantigny in 1918, medical officers determined that gas casualties were a direct result of three primary issues. The issues were a lack of discipline operating in a gas environment, a lack of protected dugouts and areas to escape the gas, and finally troops disregarding gas orders from officers during the attack.³⁷ LTC Fries decided American protective masks must give protection, offer clear vision, be comfortable, and not become dislodged during wear.³⁸ The key to operating and winning in the environment was the employment of a proper mask combined with soldier discipline. Although soldiers occasionally disobeyed orders and displayed a lack of discipline, improvements to protective masks were developed that helped shield forces from effects by utilizing the French M-2 mask combined with a small box respirator.³⁹ Ensuring that soldiers could fight wearing protective masks required training with assigned masks. Recruits before arriving in Europe were drilled in the wear and care of their assigned mask and executed battle drills while wearing their mask.⁴⁰ Personal equipment was key to protecting American forces during the war however, the CWS recognized a need to detect chemical agents prior to the contamination of soldiers.

The US Army in World War I desired detectors to understand contamination in an area. Every effort was made to create a mechanical detection system, but no reliable system was produced.⁴¹ Detection relied on using captured chemical agents and exposing soldiers to the smell in small concentrations to help service members identify the unique smells of chemical agents.⁴² Medical research of gas casualties revealed that the aromas of a gas shell burst were recognized

³⁷ Rexmond C. Cochrane, *US Army Chemical Corps Historical Studies, Gas Warfare in World War I: The 1st Division at Cantigny May 1918* (Washington, DC: US Army Chemical Corps Historical Office, 1953), 17.

³⁸ Fries, *History of Chemical Warfare Service in France*, 17.

³⁹ Fries, "Gas in the Attack and Gas in the Defense," 46.

⁴⁰ *Ibid.*, 48.

⁴¹ *Ibid.*, 50.

⁴² Fries, *History of the Chemical Warfare Service in France*, 19-22.

by a large proportion of the force.⁴³ Soldiers received instruction in the persistency and the properties of each unique chemical agent to determine how soon after an attack the air would clear. Reliance on human smell was not always a good detector. On February 26, 1918, in the Ansauville sector, the Germany army attacked the 1st Division with 250 bombs containing phosgene. This was the first deployment of CW against the Americans. Gas troops did not recognize the smells and over thirty percent of the force became casualties.⁴⁴ During the Battle of the Marne in May 1918, an entire platoon from the 28th Infantry Regiment stopped to rest in a hole on the road, but rain had diluted the smell of mustard gas filling the hole and the entire platoon was contaminated.⁴⁵

The Americans lacking proper detection equipment needed a way to prevent long term exposure to chemical agents to preserve operational strength. To mitigate chemical exposure required decontamination. Leaders below the division level understood the need to relieve soldiers from a chemical environment to reduce battlefield stress and maintain operational strength, but initially no decontamination capability existed. The initial response was to move units from contaminated areas.⁴⁶ On July 18, 1918 northwest of Chateau Thierry, the Germans heavily shelled the woods sheltering the 42nd Division with mustard gas. Gas officers understood the need to remove troops from a mustard gas infected area. A 42nd Division regimental gas officer discovered that a portion of the woods was free from the gas, and the regimental commander, promptly following the gas officer's advice, moved his troops into the unexposed area.⁴⁷ Rotation and movement was not an adequate response as limited uncontaminated areas

⁴³ H.L. Gilchrist, *A Comparative Study of World War Casualties from Gas and Other Weapons* (Washington, DC: Government Printing Office, 1928), 27.

⁴⁴ Heller, *Chemical Warfare in World War I*, 76.

⁴⁵ *Ibid.*, 76.

⁴⁶ Fries, "Gas in the Attack and Gas in the Defense," 53.

⁴⁷ *Ibid.*, 52.

existed to move troops. The US Army developed and implemented a new response for soldier protection to overcome this shortcoming.

Contamination neutralization became a priority for CWS and the first attempt was the use of fire for trench ventilation as fires produced a large circulation of air.⁴⁸ Employing fire did not work on mustard gas as the substance maintained a high boiling point and a slow evaporation rate.⁴⁹ The solution was lime chloride as it neutralized liquid agents.⁵⁰ Along with decontaminating trenches with lime chloride, a priority emerged to also decontaminate formations. The AEF authorized the creation of mobile decontamination teams on August 29, 1918 under the medical department. These teams consisted of eleven men with a five-ton truck and 1200 gallons of water to rapidly wash soldiers and issue fresh uniforms to avoid chemical burns and long-term exposure to agents.⁵¹ The decontamination rinsed any possible liquid agents and prevented mustard burns. Decontamination equipment gave relief to troops from the horrors of CW that were existent throughout World War I and would exist beyond the war.

The stalemate of World War I generated a tragic opportunity for CW use. World War I is the baseline for chemical fundamentals that still exists in the Army. The Army requires a trained subject matter force prepared to operate in any chemical environment guided by doctrine and supported by proper resources. The confidence of division and regimental commanders in gas officers in World War I is the same confidence that must exist in LSCO through commander's protection cells and unit chemical officers from battalion to corps. The chemical officers and soldiers in World War I utilized their specific training to train soldiers in every career field and advise their commander on CW issues. The training gas officers received in World War I was

⁴⁸ Fries, "Gas in the Attack and Gas in the Defense," 53.

⁴⁹ Cirincione, *Deadly Arsenals*, 62.

⁵⁰ Fries, "Gas in the Attack and Gas in the Defense," 53.

⁵¹ *Ibid.*, 54.

relevant to the operational environment and incorporated known enemy tactics and weapons. The knowledge of the European chemical environment informed the creation of the first chemical doctrine. The doctrine adapted to specific threats posed by adversaries and the methods to mitigate those risks while also addressing offensive operations required to win a conflict. The Army must learn from World War I to prepare for potential chemical operations during LSCO. The Army requires a force grounded in relevant chemical doctrine that supports offensive operations, has the proper force posture to combat CW threats, is trained for contemporary dangers, and is properly equipped. The lack of proper equipment in World War I was responsible for a considerable number of chemical casualties that shocked the world and would be a baseline for international norms regarding CW.

The end of World War I set the stage for world leaders to address chemical weapons through international treaties and norms. In the aftermath of World War I, the Geneva Protocol of 1925 called for nations to abstain from chemical and biological weapons in future conflicts. The Protocol prohibits first use of CW, but not the development and storage of chemical weapons. While the 1925 Geneva Protocol was the first step in creating international agreement on CW, the next major discussion of international norms did not occur until 1968. The 1968 Disarmament Conference in Geneva began discussions between countries on the possession of chemical and biological weapons.⁵² The discussions initiated in 1968 would eventually lead to the convention that currently regulates global chemical weapons. In 1993, the CWC opened for signatures and entered into force on April 29, 1997. The CWC requires each signatory to not develop, produce, otherwise acquire, stockpile, use, transfer, or retain chemical weapons or their components.⁵³ Although the CWC is clear on the purpose of the convention, as seen in Syria, the CWC does not

⁵² United States Arms Control and Disarmament Agency, *Documents on Disarmament 1968* (Washington, DC: Government Printing Office, 1968), 30.

⁵³ OPCW, *Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on Their Destruction*, 1.

contain an enforcement mechanism and therefore opportunities exist for potential American competitors to break the CWC.

Section III: The Environment

Current Chemical Threats

The prospect of CW during LSCO increases with the precedent for a lack of enforcement of international norms under the CWC. Globally, there is an increase in the transfer of technical information and pathways required for weaponizing chemicals. Russia, China, and Iran have all signed and ratified the CWC.⁵⁴ The 2017 National Security Strategy (NSS) identified the revisionist powers of Russia and China, and the rogue regimes of Iran and North Korea as major threats.⁵⁵ Each of these countries likely possesses CW capabilities and may employ them in a LSCO environment. The advent of fourth-generation agents also offers American enemies with a distinct advantage on a chemical battlefield. To understand a conceivable chemical battlefield, an exploration of America's adversaries is critical.

The greatest CW threat to the US exists from Russia that has a history of CW ambitions. During the Cold War, the Soviet Union (USSR) was the second-largest producer of chemical weapons. Estimates indicate Russian possession of between 50,000 to 70,000 metric tons of various chemical agents.⁵⁶ The USSR produced blood agents, choking agents, nerve agents, and fourth generation novichok agents. The most sophisticated Russian CW agents engineered are novichok agents. Novichok agents, created in the 1980s by Soviet scientists, are binary agents rendered from common industrial and agricultural chemicals. The CWC schedule of chemicals

⁵⁴ Daryl G. Kimball, "The Chemical Weapons Convention (CWC) at a Glance," Arms Control Association, last modified June 2018, accessed February 2, 2020, <https://www.armscontrol.org/factsheets/cwcglance>.

⁵⁵ Donald. J. Trump, *National Security Strategy of the United States of America* (Washington, DC: White House, 2017), 1.

⁵⁶ Amy E. Smithson, *Toxic Archipelago: Preventing Proliferation from the Former Soviet Chemical and Biological Weapons Complexes* (Washington, DC: Henry L. Stimson Center, 1999), 11-13.

does not prohibit these industrial chemicals.⁵⁷ These chemical weapon precursors are stored separately and only mixed prior to their employment. The utilization of the precursors allows Russia to circumvent the CWC. Novichok agents possess the deadly toxicity of VX agents and the aging effects of soman. The aging effect describes a nearly irreversible process in which the agent-enzyme forms a refractory complex that reduces the effectiveness of an antidote.⁵⁸ In addition to novichok agents circumventing the CWC, Russia may also possess traditional CW agents.

Although Russia signed the CWC in December 1997, intelligence indicates they may not be following the international convention. During the 1990s and early 2000s, Russia destroyed a significant amount of the 39,000 metric tons of chemical agents declared under the CWC.⁵⁹ However, information from Russian defectors, who worked on the chemical program combined with intelligence estimates from the CIA reveal that Russia possessed between 50,000 to 70,000 metric tons of chemical agents, and failed to reveal novichok agents.⁶⁰ While the destruction of declared agents is on schedule, the remaining 10,000 to 20,000 metric tons of undeclared agent is a possible sign of continued Russian interests in CW. The Nuclear Threat Initiative, founded in 2001 and created to prevent catastrophic incidents with weapons of mass destruction and disruption, estimates that Russia currently maintains 20,000-30,000 metric tons of binary novichok agents and 20,000-25,000 tons of the precursors for the manufacture of more binary agents.⁶¹ These agents may be weaponized on a variety of delivery systems including ballistic missiles, artillery, rockets, cruises missiles, and unmanned aerial systems. In 2015, Russia

⁵⁷ Smithson, *Toxic Archipelago*, 9.

⁵⁸ Mauroni, *Chemical and Biological Warfare*, 153.

⁵⁹ Director of Central Intelligence, "Accuracy of Russia's Report on Chemical Weapons" (Washington, DC: Government Printing Office, 1994), 2.

⁶⁰ Smithson, *Toxic Archipelago*, 13.

⁶¹ Amy E. Smithson, *Chemical Weapons Disarmament in Russia: Problems and Prospects* (Washington, DC: Henry L. Stimson Center, 1995), 25.

signified intentions of pursuing CW when it assigned a chemical brigade to each of its combined arms and tank armies.⁶² An understanding of Russian doctrine combined with specific agent threats enables an understanding of a future operational environment.

Soviet doctrine and current Russian operations render insight into Russian likelihood of CW in LSCO. Russian strategic objectives include extending its sphere of influence which is possible through the threat of CW. Russian operations in Crimea demonstrate utilization of long-range unobserved fires followed by maneuver forces to occupy areas.⁶³ Russians would likely deploy non-persistent agents against enemy troop positions, terrain, and installations that Russian forces want to occupy. To protect maneuver flanks, Russians will potentially employ persistent agents including novichok agents to deny maneuver corridors for American forces. Russian forces may employ persistent CW in conjunction with conventional strikes to neutralize American nuclear capabilities, command and control nodes, logistical nodes, and aviation support areas. The combination of chemical and conventional armaments is intended to inflict large casualties and to force combatants to conduct operations in cumbersome environments, which degrades morale and efficiency.⁶⁴ Combat operations are probable in regions where Russia possesses an operational advantage of layered aerial and access denial platforms and resources. Anti-access defenses combined with CW affords Russians a maneuver advantage in occupying critical areas of interest and influence. An understanding of the strategic framework, threats, and doctrine provide opportunities for the US Army to understand a possible LSCO environment against Russia.

While a signatory to the CWC, Russia shows indications that CW is still a viable option. Following the Khan Shaykhun sarin strike Russia vetoed all Security Council resolutions relating

⁶² US Army, FM 3-11, i.

⁶³ Jeremy W. Lamoreaux, "The Three Motivations for an Assertive Russian Grand Strategy," in *Russian Strategic Intentions A Strategic Multilayer Assessment (SMA) White Paper*, ed. Nicole Peterson (Washington, DC: The Joint Staff, 2019), 2.

⁶⁴ Krause and Mallory, *Chemical Weapons in Soviet Military Doctrine*, 134.

to the attack. Russia has additionally cultivated weapons intended to bypass the CWC using industrial and agricultural chemicals. Russia enhances its strategic aims of expanding their sphere of influence through the employment of CW. These factors combined point to likely Russian possession and application of chemical agents in a conflict. The major CW menace facing the US is Russian fourth generation binary agents. American detection equipment is currently unable to detect these agents. Until the US Army is issued proper equipment, it will be reliant on chemical officers at every echelon to advise their commander on the adversarial threat and the conditions that have to be set for Russian use of these weapons. The US is aware of the dangers posed by Russia as a byproduct of the binary Cold War era, however, another rising peer competitor may possess chemical weapons.

Like Russia, China is a rising global competitor who has ratified the CWC but maintains military capabilities that the US must prepare to encounter. China signed the CWC in April 1997 however compliance with the treaty has been mixed. The 2003 State Department compliance report on disarmament concluded that "China maintains an active offensive research and development chemical weapons program, a possible undeclared CW stockpile, and CW related facilities that were not declared."⁶⁵ However, in 2005, the compliance report downgraded the earlier assessment stating that China "maintains a CW production mobilization capability, although there is insufficient information available to determine whether it maintains an active offensive CW research and development program."⁶⁶ While past US government assessments have accused China of not declaring the full extent of its chemical program, the State Department report on disarmament in March 2012 does not list China as a country with compliance issues. Although China appears compliant with the CWC, the secular nature of the Chinese government

⁶⁵ "The Chemical Weapons Convention," in *Adherence to and Compliance with Arms Control, Nonproliferation, and Disarmament Agreements and Commitments* (Washington, DC: Department of State, 2003), 32.

⁶⁶ "The Chemical Weapons Convention," in *Adherence to and Compliance with Arms Control, Nonproliferation, and Disarmament Agreements and Commitments* (2005), 54-55.

and the increased tensions between the US and China requires that the US still maintain focus on Chinese chemical capabilities. China is self-sufficient in the production of all precursor chemicals for blister and nerve agents. It is also believed that China generated a range of incapacitants, which serve to temporarily inhibit human defensive responses to enable military operations with fewer casualties.⁶⁷ While China has no historical precedent for chemical operations, an understanding of possible Chinese chemical doctrine and tactics is necessary.

The proliferation of chemical technologies and knowledge enables the US to synthesize the perceived Chinese threat. China sold chemical manufacturing equipment and precursors to Iran.⁶⁸ Due to proliferation of chemical resources, correlation indicates that China maintains an active CW capability. China can equip modern artillery, rockets, missiles, and bombs with chemical warheads.⁶⁹ Kinetic operations are likely to occur in the Chinese homeland, so non-persistent agents will be the weapon of choice. The benefits for Chinese non-persistent agents are easy deniability due to the low stability of the agent, prevention of long-term contamination of homeland, and the ability of non-persistent agents to produce mass casualties on opponents. The agents could be employed against large exposed troop formations, command and control nodes, and support areas. With the capacity to produce both precursors and actual CW agents, China is not reliant on outside sources to produce additional chemical agents. The geography of China makes CWMD operations difficult due to the potential number of dispersed sites required for elimination. China previously transferred chemical capabilities to another American adversary.

⁶⁷ “Strategic Weapons Systems,” in Jane's Sentinel Security Assessment - China and Northeast Asia, last updated October 2, 2019, accessed October 27, 2019, <https://janes-ihs-com.lumen.cgsccarl.com/Janes/Display/CNAA015-CNA#Chemical%20capabilities>.

⁶⁸ Bill Gertz, "China Sold Iran Missile Technology," *Washington Times*, November 21, 1996, p. 1, accessed October 22, 2019, <https://www.nti.org/learn/countries/iran/chemical/>.

⁶⁹ “Strategic Weapons Systems,” in Jane's Sentinel Security Assessment - China and Northeast Asia.

The Chinese government sold chemical technology to Iran, a rogue regime consistently attempting to achieve regional influence in the Middle East while challenging American involvement in the region. Iran is one nation to experience CW since the end of World War I. Iran utilized sarin gas and mustard agents in the Iran-Iraq War. When the war ended in 1988, Iranian Speaker of Parliament Hashemi Rafsanjani stated,

With regards to chemical, biological, and radiological weapons training it was made very clear during the war that these weapons are very decisive. It was also made very clear that the moral teachings of the world are not very effective when war reaches a serious stage, the world does not respect its own resolutions, and closes its eyes to the violations and all the aggressions which are committed on the battlefield. We should fully equip ourselves in the defensive and offensive use of chemical biological and radiological weapons.⁷⁰

Rafsanjani's declaration is indicative of the perceived weakness of international conventions and norms. Although this Rafsanjani made this statement five years prior to the draft CWC, he clearly saw the disparity between perceived international norms and the reality of CW use. The international community simply condemns CW but does not enforce the norms.

Iran appears to maintain an offensive CW program and is continually seeking modern technologies. Since 1988, Iran has imported thiodiglycol and thionyl chloride. These chemicals have legitimate purposes such as dyes, textiles, and pesticides or can be easily diverted towards a CW program.⁷¹ In the 1990s, Iran imported several tons of phosphorus pentasulfide, which are chemical precursors, but do not appear on the CWC list of banned substances.⁷² The

⁷⁰ Peter R. Lavoy, Scott D. Sagan, and James J. Wirtz, *Planning the Unthinkable: How New Powers Will Use Nuclear, Biological, and Chemical Weapons* (London: Cornell University Press, 2000), 84.

⁷¹ Sanjoy Hazarika, "India Says It Sold Iran a Chemical Used in Poison Gas," *The New York Times*, July 1, 1989, 1, accessed November 4, 2019, <https://lumen.cgscarl.com/login?url=https://search-proquest-com.lumen.cgscarl.com/docview/427296908?accountid=28992>.

⁷² The Australia Group, *Australia Group Common Control List Handbook Volume I: Chemical Weapons-Related Common Control Lists* (Washington, DC: Government Printing Agency, 2018), 12, accessed November 4, 2019, <https://australiagroup.net/en/documents/Australia-Group-Common-Control-List-Handbook-Volume-I.pdf>.

precursors are a starting point for the production of V-group nerve agents.⁷³ In 2002, a CIA unclassified report claimed that Iran's stockpile of CW agents reportedly included blister, blood, and choking agents, and possibly nerve agents.⁷⁴ A 2011 CIA report of a similar nature assessed that "Tehran continues to seek dual-use technologies that could advance its capability to produce CW agents."⁷⁵ The collection of intelligence reports and links to the international transfer of technology establishes the conclusion that Iran likely maintains a secretive but active CW capacity. The premier formation of the Iranian military is likely to employ these varied agents.

The Iranian Republican Guard spearheads Iranian CW and presents the specific threat to the US Army. The Republican Guard maintains separate chemical brigades in each of its corps and has been observed cross-training with maneuver elements in simulated chemical conditions.⁷⁶ In 1996, *Jane's* cited various reports that Iran had "developed 155mm artillery shells, mortar rounds, aerial bombs for chemical fill, and possibly chemical warheads for Scuds."⁷⁷ Iran's Shahab missile is also believed to be capable of carrying chemical warheads. Iranian forces could employ persistent and non-persistent agents in LSCO from multiple delivery systems. Iran will utilize persistent agents to block key terrain and force maneuvering elements into a position of disadvantage. The objective of Iranian CW is counterforce missions to kill, delay, and impede advancing forces. Due to Iranian geography, elements in the support area present opportune targets to offset any opponents advantage in speed and operational reach. While LSCO in a

⁷³ US Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction*, OTA-BP-ISC-115 (Washington, DC: US Government Printing Office, December 1993), 29.

⁷⁴ Director of Central Intelligence, "Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions, 1 January through 30 June 2002" (Washington, DC: Government Printing Office, 2002), 2.

⁷⁵ Director of National Intelligence, "Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions, 1 January - 31 December 2011" (Washington, DC: Government Printing Office, 2011), 4.

⁷⁶ Lavoy, *Planning the Unthinkable*, 89.

⁷⁷ Barbara Starr, "Iran Has Vast Stockpiles of CW Agents, Says CIA," *Jane's Defence Weekly*, August 14, 1996, 3, accessed November 4, 2019, <https://www.nti.org/learn/countries/iran/chemical/>.

chemical environment with Iran could occur in a large and disperse area, another American enemy is likely to deploy chemical arms in a geographically condensed and populated region.

Like Iran, North Korea (DPRK) is a potential adversary of the United States with a high probability of possessing chemical weapons. Operations against DPRK would likely occur on the Korean peninsula with the US protecting South Korea. The DPRK is among the world's largest possessors of chemical armaments and is not a signatory to the CWC. In 2012, the South Korean Ministry of National Defense estimated that DPRK possesses between 2,500 and 5,000 metric tons of CW.⁷⁸ At maximum capacity, DPRK can produce up to 12,000 tons of CW. Nerve agents such as sarin and VX are thought to be the focus of DPRK production.⁷⁹ In 2017, Kim Jong-nam, the half-brother of North Korean leader Kim Jong-un, was attacked by two women at the Kuala Lumpur airport, who wiped his face with a cloth; he died on the way to the hospital, after complaining of pain in his face and having a seizure. Following an investigation, Malaysian authorities announced that Kim had been killed using the chemical nerve agent VX.⁸⁰ Employment of chemical weapons by North Korea is a concern for the US Army due to DPRK CW facilities and the geography of the region.

The infrastructure required to engineer, and store chemical weapons is substantial and North Korea may have this foundation in place. The Korea Research Institute of Chemical Technology in South Korea alleges North Korea has four military bases equipped with CW, eleven facilities where chemical munitions are stored, and thirteen research and development

⁷⁸ Kwan Jin Kim, 2012 *Defense White Paper* (Seoul, SK: Republic of Korea Ministry of National Defense, 2012), 36.

⁷⁹ "North Korea's Chemical and Biological Weapons Programs" (International Crisis Group, June 18, 2009), 7, accessed November 14, 2019, <https://d2071andvip0wj.cloudfront.net/167-north-korea-s-chemical-and-biological-weapons-programs.pdf>.

⁸⁰ David Bradley, "VX Nerve Agent in North Korean's Murder: How Does It Work?" *Scientific American*, February 24, 2017, accessed November 5, 2019, <https://www.scientificamerican.com/article/vx-nerve-agent-in-north-koreans-murder-how-does-it-work/>.

facilities.⁸¹ North Korea could employ artillery, multiple-launch rockets, missiles, aircraft, and unconventional means to deploy chemical munitions. South Korea's concentrated urban areas make a rich target for chemicals as the response required for attacks on unprotected populations is resource intensive. Non-persistent chemical agents could be deployed in the opening stages of combat to inflict casualties, while persistent agents may be combined with mountainous terrain to accord the DPRK a maneuver advantage and delay possible counter-offensives by American and South Korea forces.

The four main opponents of the US possess a range of chemical weapons with multiple means of employment. At the strategic level each of the potential foes has shown indications of ignoring or bypassing the agreements of the CWC, which is a sign of their desire to use chemical weapons in a conflict. Due to the perceived lack of enforcement of the CWC, adversaries may expand their CW capabilities and threaten regional actors. The risk of CW against US forces may turn American sentiment negatively in a conflict, as CW by its nature is ugly and unforgiving. Russian possession of fourth generation chemical agents present challenges to the US Army as current detection equipment, a key factor of chemical defense, are unable to identify the presence of these agents. Additionally, possible conflicts against each adversary will involve LSCO with tempo and operational reach as key elements of these operations and the Army must update its decontamination equipment to address specific hazards. Decontamination of large areas will be key to prevent secondary contamination and casualties. The Army must study and amend the force posture of decontamination units tasked with executing this technical mission. To fight in a chemically contaminated environment against these specific challengers, training should reflect the specific chemical threats each possesses. CWMD missions executed by combined arms formations require extensive training and resourcing and each adversary presents imaginable

⁸¹ Tim Bonds, *Strategy-Policy Mismatch: How the U.S. Army Can Help Close Gaps in Countering Weapons of Mass Destruction* (Santa Monica: RAND Corporation, 2014), 63.

targets for CWMD operations. The doctrine for combined arms operations and CWMD must be linked. Leaders need to understand core chemical and CWMD doctrine in addition to implementing the tenets of this doctrine across the force to mitigate the hazards from prospective rivals.

United States Army Doctrine

Global threats indicate that adversaries will likely pursue CW and requires the US Army to follow appropriate doctrine. The main doctrines for reference in a chemical LSCO environment are CWMD doctrine and chemical defense doctrine. These doctrines are not nested, or related, to one another. Additionally, CWMD doctrine and US Army core doctrine are not linked. An examination of CWMD doctrine, chemical defense doctrine, and core Army doctrine provide an understanding of the gaps that exist and the present risk to the US Army.

The DOD recognizes CW as a battlefield hazard but seeks ways to avoid the employment of chemical weapons by likely adversaries. The 2014 *Department of Defense Strategy for Countering Weapons of Mass Destruction* is the DOD response to threats posed by WMD.⁸² The strategic framework provides the ends, ways and means for CWMD policy. The ends include no new WMD use or possession and to minimize the effects of WMDs. The objectives to these ends are managing risks, increasing barriers to possession, reducing incentives for possession, and denying the effects of these weapons. The ways to achieve the framework are containing and reducing the threats, preventing acquisition, and responding to crises. The means are all the associated CWMD activities and tasks.⁸³ The strategic framework for CWMD informs joint and US Army CWMD doctrine.

⁸² Martin E. Dempsey, *Department of Defense Strategy for Countering Weapons of Mass Destruction* (Washington, DC: Government Printing Office, 2014), i.

⁸³ *Ibid.*, 12.

Joint force and US Army CWMD doctrine guide potential operations across the force against actors possessing WMDs. Joint Publication (JP) 3-40, *Countering Weapons of Mass Destruction* and Army Techniques Publication (ATP) 3-90.40, *Countering Weapons of Mass Destruction* are the doctrine the US Army must follow for CWMD operations. The execution of CWMD operations prevents adversaries from obtaining, storing, acquiring technologies, and eliminating the capability to employ chemical weapons.⁸⁴ ATP 3-90.40 gives specific doctrine on the conduct of CWMD missions as a combined arms team.⁸⁵ The Army published ATP 3-90.40 to support joint CWMD doctrine, but the ATP is not nested with foundational Army doctrine.

An effective ATP must be nested and integrated into FMs and ADPs, however ATP 3-90.40 presents gaps. The proponent for ATP 3-90.40, the organization responsible for the writing and implementation of the doctrine, is the US Army Chemical School.⁸⁶ ATP 3-90.40 is a techniques publication that should be nested with ADP 3-90 and FM 3-90, *Offense and Defense*, but the proponent for each is the US Army Combined Arms Center. CWMD, with its own technique publication, should receive attention in ADP 3-90 and FM 3-90, however, CWMD only is discussed as potential operations when presented the opportunity, rather than detailed operations for execution.⁸⁷ A gap occurs for execution, training, resources, and focus on CWMD since maneuver and CWMD doctrine are produced by separate service proponents. As the US Army Chemical School is the proponent for CWMD doctrine, chemical doctrine offers further detail on CWMD operations.

⁸⁴ US Department of Defense, Joint Staff, Joint Publication (JP) 3-40, *Countering Weapons of Mass Destruction* (Washington, DC: Government Printing Office, 2014), V-2 – V-4.

⁸⁵ US Department of the Army, Army Techniques Publications (ATP) 3-90.40, *Combined Arms Countering Weapons of Mass Destruction* (Washington, DC: Government Printing Office, 2011), 1-1.

⁸⁶ US Army, ATP 3-90.40, iii.

⁸⁷ US Department of the Army, Army Doctrinal Publication (ADP) 3-90, *Offense and Defense* (Washington, DC: Government Printing Office, 2019), iii-3-17.

In addition to CWMD doctrine, the chemical corps produce FM 3-11, *CBRN Operations*, the capstone doctrine on chemical operations for the Army. FM 3-11 identifies three core activities and one integrating activity for chemical operations.⁸⁸ CWMD is not a core or integrating activity for the chemical corps. FM 3-11 describes the chemical corps role as supporting CWMD. According to FM 3-11, CWMD operations are a combined arms mission, with support from chemical expertise, to control, defeat, disable, and dispose of WMDs.⁸⁹ The key is the reliance on combined arms teams with support from chemical experts. Additionally, CWMD cannot be a chemical corps mission due force structure and resourcing, but must remain a directed mission of combined arms formations, informed by FM 3-0 and FM 3-90. The chemical corps provides technical expertise to CWMD but culturally the Army views the chemical corps as the subject matter experts on CWMD. The Army should consider how it nests CWMD to ensure shared understanding and resourcing across the force. The chemical corps generates the subject matter expertise for the technical aspects of CWMD through its formations.

Chemical Corps Force Structure

The Army maintains chemical units across all components to respond with technical and tactical expertise in chemical operations. The 20th CBRNE Command, constituted in 2004, supports chemical operations including CWMD, supports homeland response missions, and develops and exercises doctrine and procedures.⁹⁰ The current mission of the 20th CBRNE Command is to exercise mission command over assigned CBRN and explosive ordnance disposal forces and to deploy a headquarters in support of combatant commander requirements for

⁸⁸ US Army, FM 3-11, 1-3.

⁸⁹ *Ibid.*, 1-7.

⁹⁰ J.B. Burton, F. John Burpo, and Elmore F. Smoak, "CBRNE Task Forces," *Army Chemical Review* (Summer 2015): 9.

CWMD and chemical operations.⁹¹ The vision of the command is to deliver highly trained CBRNE forces that are ready to enable the Army to conduct LSCO. Doctrinally, the command is responsible to integrate, coordinate, deploy, and provide chemical forces.⁹² In LSCO, the Army also requires chemical brigades and its subordinate battalions to execute chemical operations in a LSCO environment.

The brigades and battalions required to execute chemical operations reside in the active, national guard, and reserve components. In LSCO, a chemical brigade will support a corps and echelons above corps.⁹³ The chemical brigades command two to five subordinate chemical battalions and the brigade commander determines the appropriate chemical unit requirements. Within each brigade are subordinate chemical battalions that are responsible for two to five chemical companies. Chemical battalions support divisions and echelons above division.⁹⁴ If a battalion is required to support a corps, then the corps chemical staff must take a greater role in the planning and coordination of chemical activities within the area of responsibility. Although brigades and battalions supply headquarters of subject matter experts, the companies subordinate to chemical battalions provide the array of technical skills required in a chemical environment.

The Army retains four chemical company compositions, with certain formations found solely in the strategic reserves. These four types of formations will likely deliver CWMD technical expertise and execute chemical defense missions in LSCO. The four company structures are hazard response, area response, CBRNE, and biosurveillance.⁹⁵ A hazard response company is a dual capabilities company capable of both reconnaissance and decontamination. The subordinate platoons execute chemical reconnaissance and surveillance, operational and thorough

⁹¹ "Mission," 20th CBRNE Command, accessed February 15, 2019, <https://www.army.mil/20thcbrne#org-about>.

⁹² US Army, FM 3-11, 2-5.

⁹³ *Ibid.*, 2-6.

⁹⁴ *Ibid.*, 2-7.

⁹⁵ *Ibid.*, 2-8.

decontamination, and site assessment and characterization. Area response companies support corps sized organizations with chemical reconnaissance, surveillance, and decontamination support in support areas and consolidation areas. An area support company has the means of executing terrain and fixed-site decontamination. Their subordinate platoons conduct chemical reconnaissance and surveillance, operational and thorough decontamination support and terrain, fixed site, and aircraft decontamination. Area support companies exist only in the strategic reserves. A biological detection company executes biological surveillance and monitoring of key areas and critical nodes. The company and its platoons can monitor, sample, detect, identify, and report biological agents. The Army retains these companies in the reserve component and deploy them in suspected biologically contaminated environments. A CBRNE company consists of specialized teams to provide the advice, assessment, sampling, detection, verification, render-safe, packaging, and escort of chemical hazards. When supported by security from maneuver elements, CBRNE companies enable combined arms CWMD operations.

The Army has made substantial progress in the doctrine and organizations to conduct chemical operations in LSCO. The development of Army doctrine to support the strategic framework of CWMD provides the Army a foundation to conduct this critical mission. The Army culturally views the chemical corps as the subject matter experts on CWMD, but the chemical corps lacks the internal resources and formations required to execute CWMD as stand-alone elements. The chemical corps should stay focused on chemical defense while combined arms formations must be the subject matter experts on CWMD supported by chemical technical support. The lack of nesting between proponents responsible for doctrine presents a gap in a LSCO environment. The chemical corps is currently postured to fight LSCO but only in a one peer scenario. If the Army executes LSCO chemical operations in potential future conflicts, the chemical corps will require a force realignment.

Section IV: Recommendations and Conclusion

The Army faces critical gaps that need addressing for enhanced success in chemical environments and must align its doctrine internally. The realignment of area support companies between components ensures formations are prepared and trained for LSCO. Training for CW remains a relic of the Cold War and the Army must update training to reflect the contemporary environment. The Army should field material solutions that enhance core chemical functions to close disparities between capabilities and threats. The framework for all changes must be rooted in doctrine.

Current Army doctrine must close gaps to operate across the chemical spectrum. The National Security Strategy, the DOD guidance in *CWMD*, and JP 3-40 all emphasize the requirement to conduct activities that prevent adversaries from acquiring and employing WMD. While ADP 3-90.40 provides a framework for conducting these operations, a large chasm exists for rectification. FM 3-0 and FM 3-90 make little mention of CWMD or their role in LSCO. The Army should make the Army Combined Arms Center the proponent for CWMD. As the proponent for offensive and defensive operations already, CWMD doctrine under the Combined Arms Center is likely to be well nested from the ADP through the ATP. Additionally, FM 3-90 and FM 3-0 must make CWMD a priority in the doctrine to expand the focus, training, and resourcing for CWMD. FM 3-0 refers to active defense as activities to destroy or mitigate CW before employment, however, there is no doctrinal reference for CWMD as an active defense measure. The inclusion of the activity within FM 3-0 and FM 3-90 ensures that combined arms forces train to proficiency on the CWMD task. CWMD can take place at any point in conflict continuum and therefore is not a niche chemical activity but an operation executed anytime by combined arms formations. Units in World War I were unfamiliar with proper doctrine and techniques to fight and win in a chemical environment and soldiers today face the same dilemma due to the gap in doctrine and the lack of CWMD training. CWMD is a key aspect of LSCO as

adversaries will maintain facilities and weapons that need seized and destroyed before utilization on the battlefield. Although a hole exists in doctrine for a key strategic concept, current gaps exist in the Army to conduct chemical operations in LSCO.

The Army must realign chemical corps formations for a potential LSCO conflict. The Army places all area support companies in the strategic reserves and these companies are employed during LSCO for decontamination of terrain, rear areas, and corps support areas. The deployment of these companies for LSCO depletes the strategic reserve and relies on capabilities from forces that have no historic command relationships or familiarity with the supported forces. The Army should realign a portion of area support companies to the active component to ensure mission readiness and command relationships while maintaining the strategic reserve. In one theater LSCO conflict, it is probable that two corps level task forces will execute operations. During Operation Desert Storm each corps required twelve chemical companies to conduct chemical defense.⁹⁶

In a CWMD mission, each corps would likely require further chemical support. A RAND study suggests CWMD operations require one chemical company per large fixed site.⁹⁷ In Iran, North Korea, and Russia it is likely that the corps will have multiple large fixed sites to exploit. Therefore, in a two corps operation, the Army requires a minimum of thirty-four total chemical companies with the ten additional companies executing the CWMD mission. The additional CWMD companies will be CBRNE companies due to their capacity to conduct exploitation of suspected weapon sites. A total of thirty-four companies constitute forty-four percent of available chemical companies across all components. If a two-theater conflict occurs, then nearly all chemical companies across the entire force are employed, thereby annihilating the strategic chemical reserves. A recommendation is to add one CBRNE or hazardous response and one area

⁹⁶ Albert J. Mauroni, *Chemical-Biological Defense: U.S. Military Policies and Decisions in the Gulf War* (Westport, CT: Praeger, 1999), 45-74.

⁹⁷ Bonds, *Strategy-Policy Mismatch*, 62.

support company to each chemical battalion. Area support companies decontaminate fixed sites and large areas. This capability did not exist successfully in World War I and soldiers found themselves contaminated long after initial chemical employment due to the persistent nature of the agents. The Army can decontaminate in the present conflict, but the units need to realign for future threats. The Army also needs to explore force sizing constructs across combined arms formations to determine capabilities to conduct CWMD missions. Whether the Army shifts force posture or not, the entire Army needs to focus on stressing the training system to prepare for chemical environments.

Individual and collective chemical training at every echelon must be a priority. Operations throughout LSCO will require tactical units to battle through contaminated environments while maintaining tempo. To maintain tempo, soldiers and units must understand and be proficient at individual decontamination techniques, unmasking procedures, familiarity with detection systems, CWMD combined arms tasks, and proficient at hasty and operational decontamination. Observations at the four combat training centers (CTC) indicate troops struggle to execute these basic chemical skills.⁹⁸ Commanders at all levels must ensure plans, directives, and techniques consider chemical defense as a priority. The staff must understand its responsibilities and relationships with supported commanders for proper chemical defense. Each echelon of an organization must accomplish its core mission in a chemical environment. Commanders must carefully consider courses of action and permit additional measures and time requirements associated with operating under chemical conditions.⁹⁹ The CTCs must also improve their antiquated chemical training to deliver more realistic training opportunities. The battle management system currently utilized at the National Training Center does reflect cross-contamination and contamination times. A “contaminated” area is only contaminated for a

⁹⁸ Kurt Ebaugh, *Unit CBRN Readiness Training-A Way* (Fort Leavenworth, KS: Center for Army Lessons Learned, 2019), 1.

⁹⁹ Center for Army Lessons Learned, “Ten Fundamental Brigade Combat Team Skills,” *CALL Newsletter* no. 17-19 (Fort Leavenworth, KS: Center for Army Lessons Learned, 2017), 66.

notional set time and the system that records units' actions and engagements. The system is not capable of determining the extent of area contamination from units maneuvering through a contaminated area. The CTCs need to incorporate area decontamination into training environments, as large site and fixed site decontamination will be a primary mission during LSCO. Finally, battalion task forces and CTCs need to incorporate CWMD training. It is feasible that the Army will task multiple infantry battalions with executing CWMD missions during LSCO, and therefore CWMD training is vital to mission training. To enable this training, leaders at all levels and CTCs must design training for CWMD adhering to ATP 3-90.40 and Army Doctrine Reference Publication (ADRP) 1-03, *The Army Universal Task List (AUTL)*.¹⁰⁰ The AUTL directs training criteria for executing CWMD operations and should be incorporated into combined arms training.

Although training can fix certain gaps, the Army must seek material solutions to threats. The Army employs technology and equipment that is outdated and presents potential obstacles during LSCO. The Army individual protective suit can protect soldiers, but the Army should look to invest in nanotechnologies that save units time and money on individual decontamination and gear exchange. The Uniform Integrated Protection Ensemble can provide individual percutaneous protection with the ability to operate in a contaminated environment with no or minimal degradation in performance against traditional, non-traditional, advanced agents, and toxic industrial materials.¹⁰¹ The uniform will sense the presence of adverse substances, initiate countermeasures regardless of the origin or type of hazard, and offer real-time battlefield awareness to the wearer and to command nodes, with minimal burden on the individual soldier

¹⁰⁰ US Department of the Army, Army Doctrine Reference Publication (ADRP) 1-03, *The Army Universal Task List* (Washington, DC: Government Printing Office, 2015), 6-59 – 6-63.

¹⁰¹ US Department of Defense, *Department of Defense Fiscal Year (FY) 2019 Budget Estimates: Chemical and Biological Defense Program* (Washington, DC: Government Printing Office, 2018) 109.

and the logistical infrastructure.¹⁰² The new suit must be able to protect against all perceived chemical threats including novichok agents. Soldiers found themselves unable to protect their skin against mustard agents in World War I, and troops now must be able to protect themselves against advanced agents. Just as soldiers could not protect their skin in World War I because they lacked mechanical detection for chemical agents, now the Army must invest in updated detection equipment.

The fourth-generation chemical agents present unique challenges to Army capabilities. Common Army detection equipment is not capable of detecting novichok agents, which are a primary threat from Russia.¹⁰³ Certain chemical detectors are available commercially off the shelf, however, the price tag is nearly eight times the cost per unit compared to current joint chemical agent detectors.¹⁰⁴ The difference in price results from ion mass spectrometry in JCADs and high-pressure mass spectrometry. Spectrometry refers to the measurement of the interactions between light and matter, and the reactions and measurements of radiation intensity and wavelength. The difference in detectors is the pressure at which agents are analyzed, providing for more accurate results. Investments in a field mass spectrometer under the next-generation detector program will bridge the current gap.¹⁰⁵ The Army must link early warning and detection equipment outside the effective radius of the hazard. Integration of unmanned aerial chemical surveillance systems, detectors for fourth-generation agents, and modeling software ensure a

¹⁰² Fred S. Celec, *2009 Annual Report to Congress, Department of Defense Chemical and Biological Defense Program* (Washington, DC: Government Printing Office, 2009), 25.

¹⁰³ "Fourth Generation Agents: Reference Guide," Chemical Hazards Emergency Medical Management, last modified January 18, 2019, accessed January 21, 2020, <https://chemm.nlm.nih.gov/nerveagents/FGAReferenceGuide.htm>.

¹⁰⁴ "LCD 3.2 E" CBRNE Tech Index, accessed January 24, 2019, <https://www.cbrnetechindex.com/Print/3518/smiths-detection-inc/lcd-32e->.

¹⁰⁵ US Department of Defense, *2015 Annual Report to Congress, Department of Defense Chemical and Biological Defense Program* (Washington, DC: Government Printing Office, 2015), 7.

complete understanding of the operational environment.¹⁰⁶ Due to the highly toxic nature of VX and novichok agents, the Army should invest in new decontamination solutions to ensure quick and effective decontamination in LSCO.

A significant investment in decontamination technology will save units time and resources in a kinetic atmosphere. A new sprayable slurry can decontaminate an entire vehicle quicker with minimal water. The slurry works by employing a blend of hydrolytic and oxidative chemistries with a small amount of water, solvent, and binder. The decontamination can occur while the vehicle is in use, as the decontamination slurry bonds to the vehicle.¹⁰⁷ This new decontaminant will ensure units can continue to fight on and maintain tempo in LSCO. Decontamination capabilities lacked in World War I and caused significant casualties, however the ability to decontaminate currently exists, so the Army must ensure the most efficient solution is available. In addition to decontamination, the Army must research medical capabilities for chemical casualties.

The proliferation of chemical knowledge and technology provides adversaries opportunities that the US must counter. A step in CW mitigation involves medical decontamination and treatment. Due to technological advancements, opponents may possess the capacity to produce multiple variants of chemical agents and new generations of chemical agents.¹⁰⁸ The Army must invest significantly in medical research to develop counters for chemical agents that work against multiple variations of chemical agents. An example is civilian vaccines that work against multiple strains of influenza. In World War I, medical providers and patients often found themselves contaminated or untreated in the field hospitals. The Army

¹⁰⁶ US Department of the Army, Training and Doctrine (TRADOC) Pamphlet 525-3-5, *The US Army Functional Concept for Maneuver Support 2020-2040* (Washington, DC: Government Printing Office, 2017), 9.

¹⁰⁷ Gay Pinder, "Sprayable Decontaminant Slurry Could be in Warfighters Hands Soon," *ECBC Solutions Newsletter* (Q1, 2020): 5-6.

¹⁰⁸ Thomas C. Westen, "Are U.S. Army Capabilities for Countering Weapons of Mass Destruction at Risk?," *The Land Warfare Papers*, no.10 (September, 2015): 9.

should ensure soldiers injured in chemical attacks receive the proper treatment through efficient application of countermeasures. A solution needs to exist to ensure units can avoid contamination and thereby avoid the need for decontamination.

Information management and hazard understanding is a requirement for the Army. Software exists that allows units to model potentially contaminated areas, and technology that allows for early warning for fixed sites and maneuver elements, however, these technologies remain unlinked to mission command systems. In LSCO, units will rely on information sharing about hazards and threats to predict and understand the extent of contamination in the event of a chemical release. Planners can utilize the modeling software to fuse intelligence and operational planning of the battlefield. During World War I, units were unable to predict the extent of contamination and therefore would likely face more casualties after the initial chemical attack. Modeling software through mission command systems will ensure the prevention of accidental contamination and deliver operational options to maneuver commanders while reducing risk. The Army needs to invest in chemical hazard planning software that links to other mission command systems.

The Army and the chemical corps can anticipate the future by observing trends and making alterations to the organization based on trends. The Syrian use of sarin delivers contemporary evidence that CW is not a relic of the past but will continue to present potential dangers on any battlefield. As the CWC currently does not contain an enforcement mechanism, countries will continue to pursue these technologies to provide them with a strategic option to counter the US. The US Army must prepare its forces to neutralize these threats prior to their deployment through CWMD and if CWMD fails, then it must ensure soldiers receive proper equipment and training to continue fighting in a chemically contaminated environment.

Chemical soldiers in the Army will continue to push realistic training opportunities, but the training effectiveness is reliant on all commanders to take chemical threats and environments seriously. The Army was unprepared for CW in World War I due to the new and unique nature of

the hazard, but the current chemical danger is mature, and leaders must take the threat seriously. The physical and psychological strains presented in a chemical environment are the same stresses encountered 100 years ago, but they cannot be simulated without extensive training in the equipment and techniques required to succeed in such an environment. Leaders at all levels must understand the uniqueness of CWMD missions to prevent adversarial use of chemical agents. An initiative-taking approach to eliminating CW ensures a reduced amount of chemical dangers on the battlefield. Although doctrinal gaps exist, chemical leaders must further their expertise in current doctrine and understand their role in the planning process and the capabilities supplied by the unique technical expertise of chemical units. Cross-functional training between maneuver elements and technical enablers will ensure seamless effort in any potential LSCO conflict. It has been 105 years since the introduction of CW on a large scale but the lessons from that war still apply. Soldiers need to train to operate and survive in the conditions, they must manage the psychological pressures, and the Army must decontaminate them as soon as possible to ensure they continue to fight and engage America's enemies. The threat of CW presents risks to the US Army but through proper doctrine, force structure, training, and resourcing the US Army will find itself prepared to win America's battle in any chemical environment.

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