CHEMICAL and BIOLOGICAL WARFARE OVERVIEW

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SECTION 1

Introduction

The potential use of chemical or biological weapons against the United States (U.S.) military and U.S. national security interests is a disturbing threat for our defense policy makers. Both chemical and biological weapons are considered "weapons of mass destruction," or WMD. WMD are those unconventional weapons that are capable of a high order of destruction and/or of being used in such a manner to kill large numbers of people. While the term "WMD" typically includes nuclear weapons along with chemical and biological weapons, this overview focuses on the chemical and biological warfare (CBW) threat since the potential threat from these weapons is generally considered to be more likely than the threat of nuclear weapons.

> *The gravest danger to the American people and global security continues to come from weapons of mass destruction.*
>
> --*National Security Strategy*, 2010

With this in mind, this introduction to CBW agents and munitions offers the reader a basic level of understanding of what can be a very technologically challenging and confusing topic.

The U.S. development of CBW programs was considered necessary as a strategic deterrent during World War II, much in the way that nuclear weapons were considered necessary as a strategic deterrent during the Cold War. Although CBW attacks were considered unconventional, U.S. and Soviet Union military planners anticipated their use in total war scenarios. As the Cold War ended, other nations developed CBW programs, primarily as a way to either threaten their neighbors with a large area, mass casualty weapon or as a deterrent against a neighbor's WMD program. As a result, U.S. combat troops or American installations in foreign countries faced a greater threat of CBW attacks.

Today, the use of CBW agents against domestic U.S. targets is also considered a viable threat. Although transnational terrorist groups have not yet carried out CBW attacks against the U.S. homeland, some believe that CBW capabilities are rapidly expanding due to the availability of technology and information in today's information age. Others believe that terrorists lack the desire or capability to develop military-grade CBW agents and have instead turned to industrial chemicals and crude toxins to use in small-scale, single events.

> *Several terrorist groups, particularly al-Qa'ida and al-Qa'ida in the Arabian Peninsula, probably remain interested in … low-level chemicals and toxins. Some terrorist groups see employing chemical, biological, radiological and nuclear (CBRN) materials as a high-impact option for achieving their goals, as even if they do not produce many casualties they would have a psychological impact.*
>
> *--Office of the Director of National Intelligence,*
> *Unclassified Report to Congress*, 2012

Dual-use technologies relating to chemical manufacturing and biotechnology continue to advance rapidly. The National Defense University's Center for the Study of WMD assesses that it is likely that U.S. forces will encounter unknown agents in the future and must prepare accordingly. The Center believes that CBW agents will be:

- more accessible to both nation-states and sub-state groups due to the easy access to acquisition of current and emerging CBW-related technologies;
- more capable, particularly in their ability to defeat current or emerging defensive countermeasures;

- more discriminant – that is, more precisely targeted and more reliably low- or non-lethal; and
- harder to attribute with traditional forensic methods known today.[1]

In summary, chemical and biological weapons do not represent a Cold War threat that can be put behind us. Despite the relative success of current non-proliferation regimes, as long as there is warfare, there will be nation-states seeking to defeat their adversaries quickly and efficiently. As long as the U.S. military has superior conventional capabilities, there will be active adversaries seeking asymmetric means to defeat U.S. national security objectives. Accordingly, policy makers from all areas of Government must continue to place a high priority on this threat to our nation and to our warfighters.

[1] John P. Caves, Jr. and W. Seth Carus, *The Future of Weapons of Mass Destruction: Their Nature and Role in 2030.* (National Defense University: Occasional Paper 10, June 2014), 4.

SECTION 2

Chemical Warfare Threats and Chemical Hazards

Chemical warfare (CW) agents can be used to inflict immediate casualties or to deny access to areas or physical assets through surface contamination. In some situations, the lethality, persistence, and psychological effects of CW agents may make them attractive options compared to conventional weapons. Also, many CW agents or their precursors are readily available due to their industrial uses. Chemical warfare agents are relatively fast-acting, and some agents are very difficult to defend against. As better methods of detection, protection, and decontamination have evolved, adversaries have developed new CW agents to defeat these improved defensive measures.

Chemical Hazard Symbol

Over the past hundred years, CW agents have been used many times, often during wartime but also to quell insurrections or commit acts of terrorism. As governments have continued to regulate the conduct of war through various diplomatic vehicles, a growing global consensus has emerged that these weapons should be banned from traditional combat operations.

Chemical Weapons, Chemical Agents, and Toxic Industrial Chemicals

The Department of Defense (DoD) defines a "chemical weapon" as:

> *Together or separately, (a) a toxic chemical and its precursors, except when intended for a purpose not prohibited under the Chemical Weapons Convention; (b) a munition or device, specifically designed to cause death or other harm through toxic properties of those chemicals specified in (a), above, which would be released as a result of the employment of such munition or device; (c) any equipment specifically designed for use directly in connection with the employment of munitions or devices specified in (b), above.*[2]

This definition encompasses not only the chemical agent used, but the delivery device and support equipment, as long as these are inseparable from the weapon system itself.

Mustard Agent Shells

The Chemical Weapons Convention (or CWC)[3] is an international treaty that seeks to eliminate and prohibit the production, stockpiling, and use of all chemical weapons. It similarly defines a "chemical weapon" as any toxic chemical or its precursor that can cause death, injury, temporary incapacitation, or sensory irritation through its chemical action. The CWC also considers munitions or other devices designed to deliver chemical agents to be chemical weapons, even if the munitions or devices are not filled with CW agents. Additionally, the CWC prohibits the use of riot control agents (RCAs) as a method of warfare. Long-standing U.S. government policy states that RCAs and herbicides are not considered to be chemical weapons; however, only the President may authorize

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[2] Joint Chiefs of Staff (JCS), Joint Publication (JP) 1-02, *Department of Defense Dictionary of Military and Associated Terms*, November 8, 2010 (as amended through June 15, 2015), 31.

[3] The full name of the CWC is The Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction.

their use during wartime.[4] **Figure 2-1** provides further detail regarding some of the policy considerations surrounding the use of RCAs during wartime.

Riot Control Agents – Policy Considerations

CWC:

- Article I.5 of the CWC prohibits the use of riot control agents as a method of warfare. Article II.7 defines "Riot Control Agent" as, "Any chemical not listed in a Schedule, which can produce rapidly in humans sensory irritation or disabling physical effects which disappear within a short time following termination of exposure."

Executive Order 11850:

- In April 1975, President Ford issued Executive Order 11850, Renunciation of certain uses in war of chemical herbicides and riot control agents. Under this policy, the use of RCAs by U.S. military forces during wartime is prohibited, unless authorized in advance by the President.

Joint Publications 1-02, 3-11, and 3-40:

- Riot control agents, along with herbicides, are chemicals but are not chemical warfare agents.

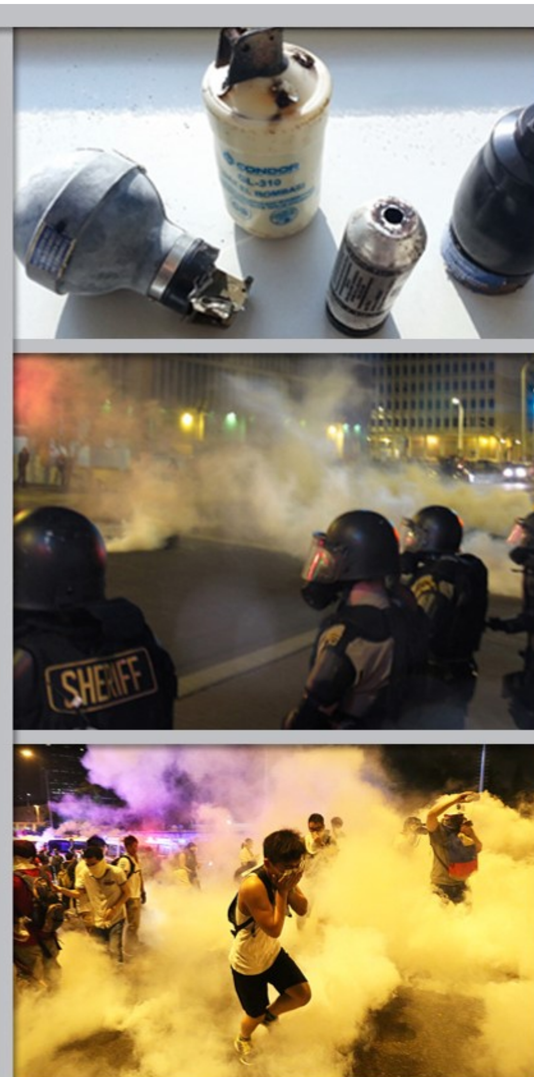

Figure 2-1. Policies Governing RCA Use in Wartime
(Photo Credits: Top Image, Birhanb, https://en.wikipedia.org/wiki/File:Tear_gas_shells_used_in_istanbul_in_2013.jpg; Middle Image, Russell Contreras / AP; Bottom Image, Sam Tsang)

Chemical munitions may be unitary, in which only one chemical agent is present, or binary. Binary weapons typically have two component chemicals that are stored

[4] The White House, Executive Order 11850, *Renunciation of Certain Uses in War of Chemicals, Herbicides, and Riot Control Agents*, April 8, 1975. The Secretary of Defense can authorize the use of RCAs during the recovery of a nuclear weapon.

separately and then mixed just prior to or during delivery. For example, the United States produced the M687 155-millimeter artillery shell, which contained two components of sarin separated by a partition. During flight, the partition would burst, and rotation of the shell would mix the component chemicals together.

CW Agent Group	Persistency	Rate of Action
Blister Agents		
Sulfur mustard (H, HD)	Very high	Delayed
Nitrogen mustard (HN)	High	Delayed
Phosgene oxime (CX)	Low	Immediate
Lewisite (L)	High	Rapid
Blood Agents		
Hydrogen cyanide (AC)	Low	Rapid
Cyanogen chloride (CK)	Low	Rapid
Arsine (SA)	Low	Delayed
Choking Agents		
Chlorine (Cl)	Low	Variable
Phosgene (PG)	Low	Delayed
Diphosgene (DP)	Low	Delayed
Chloropicrin (PS)	Low	Delayed
Nerve Agents		
Tabun (GA)	High	Very rapid
Sarin (GB)	Low	Very rapid
Soman (GD)	Moderate	Very rapid
Cyclosarin (GE, GF)	Moderate	Very rapid
VX	Very high	Rapid

Figure 2-2. Traditional Chemical Warfare Agents.[5]

A "chemical agent" is a "chemical substance that is intended for use in military operations to kill, seriously injure, or incapacitate mainly through its physiological effects."[6] In other words, chemical agents are toxic chemicals that have been used as weapons or were developed specifically to be used as weapons. As previously mentioned, this does not include RCAs, herbicides, or incendiary devices (e.g., white phosphorus, napalm, smoke, or obscurants). Because the CWC uses the general term of "toxic chemical," this pamphlet uses the term "chemical warfare agents" to distinguish a particular group of agents designed for military combat operations, **Figure 2-2** provides a more detailed list of CW agents and their general characteristics.

Chemical warfare agents can be categorized into groups based on the effects that they create:

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[5] "What is a Chemical Weapon?, Organisation for the Prohibition of Chemical Weapons, http://www.opcw.org/about-chemical-weapons/what-is-a-chemical-weapon (accessed July 24, 2015).

[6] JCS, JP 1-02, 30.

Blistering agents such as “mustard” agents and lewisite cause the eyes, skin, and respiratory system to develop debilitating blisters.[7] Blistering agents and choking agents were among the first chemical agents to be used in modern warfare.

Blood agents such as hydrogen cyanide and cyanogen chloride prevent blood from carrying oxygen, which in turn causes damage to tissues throughout the body.

Choking agents irritate and damage the respiratory system, causing fluid to fill the lungs. Chlorine and phosgene are common examples of choking agents.

Nerve agents prevent the nervous system from transmitting neural signals effectively, and exposure can result in convulsions and death. Nerve agents are chemically related to organophosphate insecticides and include “G-series” agents such as sarin and tabun, as well as VX.

Incapacitating agents are chemical compounds designed to have temporary debilitating effects. In general, they were not specifically designed to be used in warfare, and they are typically non-lethal unless administered in very high doses. Agents of this type include RCAs, other sensory irritants, such as strong-smelling “malodorants;” and psychoactive agents, such as *3-Quinuclidinyl benzilate* (BZ).

Toxic Industrial Chemicals. A toxic industrial chemical (TIC) is a “chemical developed or manufactured for use in industrial operations or research by industry, government, or academia that poses a hazard.”[8] These chemicals can be inhalation hazards, corrosive agents, carcinogens, flammables, explosives, or chemically-reactive substances. While there are tens of thousands of industrial chemicals that have toxic properties, only a small number represent a significant operational risk to unprotected military personnel, notably the toxic inhalation hazards. Some chemicals may not pose much threat under normal storage conditions but may become dangerous when exposed to heat, fire, other extreme environmental conditions, or other chemicals. Some toxic chemicals used in industry have in fact been developed or used as CW agents or CW agent precursors. For example, chlorine is widely used as a sanitizing agent, but–as discussed

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[7] Mustard agents are so-named due to their pungent odor.

[8] JCS, JP 1-02, 247.

below–its use as a weapon dates back to World War I. **Figure 2-3** provides a list of common highly-hazardous TICs and their common applications.

Chemical	Applications
Ammonia	Fertilizers; cleaning and sanitization
Arsine	Microelectronics
Boron trichloride	Metal refining
Boron trifluoride	Chemical production
Carbon disulfide	Fumigation; solvents; manufacturing
Chlorine	Industrial and consumer products; sanitization
Diborane	Chemical production
Ethylene oxide	Chemical production
Fluorine	Uranium enrichment; electronics; medical applications
Formaldehyde	Manufacturing; industrial and consumer products; disinfectants
Hydrogen bromide	Chemical production
Hydrogen chloride	Chemical production; microelectronics
Hydrogen cyanide	Chemical production
Hydrogen fluoride	Chemical production; oil refining
Hydrogen sulfide	Chemical production; metal refining
Nitric acid	Fertilizers; explosives; propellants
Phosgene	Chemical production
Phosphorus trichloride	Chemical production
Sulfur dioxide	Chemical production; disinfectants
Sulfuric acid	Chemical production; industrial and consumer products
Tungsten hexafluoride	Microelectronics; metal refining

Figure 2-3. Highly-Hazardous TICs and Their Uses

Delivery Devices

CW agents can be weaponized by loading them into delivery systems such as spray tanks or munitions. Munitions range in complexity from crude explosive devices attached to storage canisters to precision-guided ballistic or cruise missiles with binary warheads or submunitions.

Improvised devices. The simplest method of delivering a chemical agent is venting a toxic gas from a storage tank or detonating a conventional explosive attached to a storage tank of toxic chemicals. In 1995, members of the Aum Shinrikyo cult used the former method on a small scale when they released sarin from small packages in the Tokyo subway system. Insurgents in Iraq and Syria have been accused of using the latter method by detonating explosives attached to tanks of chlorine. The effectiveness of both methods can be severely limited by environmental factors, such as temperature, wind, and precipitation. Also, the heat from an explosive detonation can neutralize some of the chemical agent.

Inspecting Chemical Munitions
(Photo Credit: OPCW)

Munitions. In the 20th century, chemically-armed countries developed various munitions for delivering CW. These munitions included aerial bombs, artillery projectiles, artillery rockets, mortars, and landmines. Artillery projectiles included the U.S. M687 155-millimeter shell, described above, and the M-55 artillery rocket that was designed to carry sarin or VX in unitary form.

Aerial spraying. Another delivery method is spraying chemical agents from storage tanks mounted in aircraft. Airborne dissemination negates the need for an explosive detonation that might not function properly (dud) or might neutralize some of the chemical agent. However, spraying chemicals from aircraft entails other hazards, such as variable weather conditions and the endangerment of air crews working in confined spaces near the chemicals.

TMU-28 Spray Tank

In addition to the complexity of the munition, other factors in the selection of the means of delivery include the properties of the chemical agent being delivered, environmental factors, and the desired effects. Chemical agents are categorized as persistent or non-persistent, largely based on their viscosity. **Figure 2-4** provides an overview of these considerations. In general, vapors (gases) and aerosols are less persistent than liquids and solids. Also, the dissemination of vapors and aerosols is more susceptible to disruption by environmental factors such as temperature, humidity, wind, and precipitation.

Persistency	Target of Choice	Target Effect
Non-persistent		
• Nerve • Blood • Choking	• Personnel	• Immediate • Lethal
Persistent		
• Nerve • Blister	• Terrain • Materiel	• Reduced operations tempo or mission degradation • Lethal or casualty producing

Figure 2-4. Chemical Agent Effects[9]

Effects can range from short-term or reversible to long-term or permanent. Also, chemical agents delivered by aerial spraying or aerial bombs may affect broad areas (resulting in mass casualties or area denial), but agents delivered by landmines, artillery, or other short-range weapons may result in targeted effects over smaller areas. Other factors that CW planners may consider include:

Adversary's defensive capability. General purpose troops may not be trained to respond quickly to chemical attacks, while other modern militaries have specialists who operate throughout the force to detect and decontaminate CW agents.

Operational considerations. As discussed earlier, changing weather conditions may work against a military force using CW munitions, once an agent is released. Also, a persistent agent that is difficult to decontaminate will deny friendly access to an adversary's territory or materiel for a long period of time. This is especially true if large areas or a large number of items require decontamination.

Terrain. Liquids and heavy vapors tend to concentrate in low-lying areas and areas with limited ventilation.

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[9] JCS, JP 3-11, *Operations in Chemical, Biological, Radiological, and Nuclear Environments*, October 4, 2013, A-2.

Development and Use of Chemical Warfare Agents and Munitions, 1915–1945

Modern CW munitions were first used on a large scale during World War I. Chlorine, phosgene, and mustard were the most widely used agents. In the first major use of CW agents in combat, German troops released chlorine gas against French and Algerian troops at the Second Battle of Ypres in April 1915. Within months, French and British troops responded in kind. It is estimated that more than 120,000 tons of chemical agents were expended during the war, resulting in approximately 90,000 deaths and more than one million casualties.

Blistering Agent Use in World War I

German, French, and British military planners quickly realized that releasing poison gas from cylinders carries many risks, including fratricide due to shifting winds. By the end of the war, both sides used artillery shells to deliver mustard agent, which had the advantage of increasing the distance between friendly troops and the point of release of the agent. Also, mustard proved to be more persistent and more difficult to defend against than either chlorine or phosgene. However, phosgene killed far more people than mustard.

In 1925, sixteen world powers, including the United States, signed the Geneva Protocol banning the use of poison gas in warfare. However, the U.S. Senate did not take up ratification of the Protocol immediately, and it was not ratified by the United States until 1975. Also, although the Protocol banned the use of poison gas, there was no explicit prohibition against producing or storing such agents.

In the interwar period, there were isolated deployments of CW agents around the world, including in Russia, Morocco, and Ethiopia. Often, the CW agents were used by occupying powers to put down rebellions. In the 1930s, Nazi Germany began developing nerve agents and nerve agent delivery systems. German scientists quickly realized that nerve agents were more persistent than blood or choking agents and produced effects more quickly than blistering agents.

During World War II, the United States produced more than 146,000 tons of chemical agents for retaliatory use should the Axis powers attack with CW agents.

Also, the United Kingdom developed CW agents for use in the event of an invasion by Germany. However, the Allies did not employ CW munitions during the war. There was also no significant use of CW agents by the Axis powers against the Allies, although Japan used them extensively in China. Many of Japan's abandoned CW munitions remain in China today.

Development and Use of Chemical Warfare Agents and Munitions, 1945–present

State Programs

By 1960, the United States and the Soviet Union had extensive stocks of CW agents and munitions and robust production capabilities. These capabilities included the production of nerve agents and nerve agent delivery systems. Nearly half of all U.S. stocks were stored at Tooele Army Depot, Utah. Most of the rest were kept in seven other domestic locations. The U.S. military developed and tested these systems for operational use, storing some stocks in Germany and Okinawa during the Cold War.

CW Munition Destruction at Johnston Atoll

The CW agents and munitions in Okinawa were moved to Johnston Atoll in 1973. Those stored in Germany were also moved to Johnston Atoll in 1991.

Prior to 1985, all of the U.S. CW munitions were unitary rounds. Congress authorized the development of binary weapons in 1985, but the modernization program ceased in 1991 when the U.S. government unilaterally declared it would no longer maintain an offensive chemical attack capability. When the United States and Soviet Union ratified the CWC in 1997, they declared stockpiles of more than 30,000 tons and 40,000 tons of chemical agents, respectively. The United States and Russia are now working to eliminate their stockpiles of chemical agents, delivery systems, and production facilities.

On numerous occasions, Iraq used mustard and tabun in its 1980-1988 war against Iran. Approximately 20,000 Iranians were killed, and nearly 90,000 more survived but sustained injuries from the attacks. Also, in 1988, Iraq used CW munitions as well as conventional munitions against unprotected civilians in the Iraqi city of Halabja in a sustained campaign of genocide, killing thousands of civilian Kurds and injuring as many as 10,000 more.

In 2013, Syrian forces allegedly fired rockets filled with sarin at rebel-held neighborhoods around Damascus, killing hundreds of civilians and injuring thousands more. The Syrian government denied that it had used chemical weapons, but United Nations (UN) investigators determined that high-quality sarin had been used, probably by Syrian military forces with the access and expertise necessary to carry out the attacks. In response to the CW attacks, President Barack Obama stated that international norms had been violated and threatened to strike Syrian military targets. Syria narrowly avoided these strikes by hastily agreeing to give up its chemical weapons program and to accede to the CWC, which it did in 2014.

Organisation for the Prohibition of Chemical Weapons (OPCW) Logo
(Photo Credit: OPCW)

Other countries that have had chemical weapon programs or are suspected of having former or current programs include India, Israel, Japan, Albania, Libya, and South and North Korea. India and South Korea declared chemical stockpiles in 1997 and, in 2009, India declared that its stockpile had been eliminated. Japan carried out chemical attacks in China during World War II and is now attempting to locate and eliminate the munitions and agents left behind. In 2004, Libya joined the CWC and began eliminating its stockpiles of agents and munitions and its production facilities. Albania destroyed its small stockpile in 2007. North Korea has not signed the CWC and is suspected of having an active CW program.

Sub-state Programs

In addition to state-sponsored CW programs, there have been a number of instances of individuals or small groups acquiring and using chemical agents. Members of the Aum Shinrikyo doomsday cult released sarin agent in Matsumoto, Japan, in 1994 and again in the Tokyo subway system in 1995. More than 20 people were killed in the two attacks, and more than 1,000 were injured. Aum Shinrikyo members also used sarin and VX in targeted assassinations in the years leading up to the Tokyo attack.

In Iraq and Syria, insurgents are suspected of using chlorine and mustard agents, but attribution has proven difficult. The Syrian opposition has counter-claimed that Syrian government forces are behind the continued CW attacks. In Iraq, there have been reports of members of the Islamic State using chlorine and mustard agent against Kurdish forces in 2015.

Conclusion

Chemical agents have been used in warfare and against civilians many times since 1915, and their effects and properties—such as persistence, lethality, and rate of action—have been studied extensively. In many cases of CW agent use, especially in earlier incidents, chemical agents were simply released from large cylinders. However, some countries developed sophisticated delivery systems, such as mines, rockets, aerial spray systems, and aerial bombs with chemical submunitions. Today, there are few countries with an active CW program due primarily to the effective results of the non-proliferation regime. Concerns remain that a legitimate civilian chemical industry could be the basis for a state's or sub-state group's development of chemical weapons.

In recent history, the Syrian government used chemical agents in an attempt to gain a military advantage in its long-running civil war. Despite formally ending its CW program, Syrian troops continue to face accusations of using chemical agents indiscriminately. Also, insurgents in Iraq and Syria have been accused of carrying out CW attacks, but it is difficult to get inspectors into active war zones to verify these claims. Because of the continued and active interest in CW agents by adversarial states and terrorist groups, this particular form of unconventional weapons will continue to be a concern into the future.

SECTION 3

Biological Warfare Threats and Biological Hazards

Biological agents can cause disease in human, animal and plant populations. If used by a state or non-state adversary, biological warfare (BW) agents and munitions can be used to kill, incapacitate, disrupt, or cause economic or psychological injury to the intended target. While there are a range of targets and impacts of BW agents, the military is mainly concerned about anti-personnel BW agents since they are most likely to be used in a battlefield context. Biological hazards are denoted by the symbol shown here.

Biohazard Symbol

Biological warfare agents present unique complexities that create special challenges. Although BW, like CW agents and munitions, are considered WMD, they are distinctive. For example, unlike with most CW agents, exposed personnel are not likely to become symptomatic immediately. As a result, the use of BW agents can be very difficult to detect until after people become sick. Indeed, the first sign of BW agent use might be reports from medical clinics. Another distinction is that generally the quantities of biological agent required to cause harm are not as great as with CW agents. This makes it easier for adversaries to develop operationally-significant quantities of BW agents and munitions clandestinely and in dual-use facilities that appear to be legitimate commercial or research enterprises. The small quantities required for effects (tens of kilograms) also makes it easier to hide and transport these agents. Moreover, some BW agents can be disseminated by a greater variety of means and vectors to include food, water, animal, human, or a mechanized delivery device.

Another major distinction is that unlike CW agents, some BW agents can be contagious. These agents, such as smallpox, can be transmitted by human-to-human contact. Other agents can be transmissible between animal populations or plant species. Much less common, some agents—such as viruses that cause avian influenza—have been known to be transmitted between animals and humans. The fact that some BW agents are contagious means that an adversary could create a ripple impact after release. That is, they could infect a much larger group than initially attacked as the disease spreads across a population. Given all of the complexities and the highly destructive potential of these weapons, it is critical to understand what they are, what they can do, and what measures the U.S. government has in place to help counter their use. **Figure 3-1** provides some distinctions between BW and CW weapons.

CW Agents and Munitions	BW Agents and Munitions
Symptoms generally immediate	Incubation and disease periods often longer
Man-made	Can be naturally occurring and then weaponized for use
Generally larger scale production	Can be produced small scale
Not contagious	Can be contagious
Easier to detect due to color, odor	Can be odorless, colorless
Delivered as aerosols or liquid	Can be delivered in air, water, or food via multiple vectors or delivery devices, to include humans and animals
Attacks likely to be overt (due to immediate effects, ability to detect, and amount required)	Covert dissemination more likely (due to often delayed effects, difficulty detecting, and smaller amounts required)

Figure 3-1. Chemical Compared to Biological Warfare Agents and Munitions

Please note that the distinctions characterize the majority of, but not all, BW agents. Some agents blur the line between chemical and biological and the rules are not hard and fast. For example, ricin is considered a biological agent but, as a toxin, has some properties more in common with chemical agents. In addition, while it is more likely that BW agents would be delivered covertly—because the effects are not necessarily immediate and the amount required to create an impact is generally smaller—certain CW agents can also be delivered covertly. Or, adversaries might choose to attack with BW agents overtly, using munitions or sprayers during or immediately prior to combat operations.

Biological Warfare Agents

A common definition of biological warfare is "the use of biological toxins or infectious agents such as bacteria, viruses, and fungi with the intent to kill or incapacitate humans, animals or plants as an act of war."[10] Although there are hundreds of biological agents, not all are suitable to be weaponized for biological warfare. A number of variables come into play when assessing which agents have the potential to be weaponized, particularly to a militarily significant level. One factor is stability of the agent—can it withstand temperature changes or ultraviolet light without deteriorating? For example, *Francisella tularensis* can deteriorate at the rate of 50% for every twenty minutes when exposed to bright light or sunshine.[11] On the other hand, an agent such as anthrax is more resilient to ultraviolet light, but degrades in bright light over time.

Another consideration is the agent's potential effects. While not all adversaries have the same objectives, many will take into account the agent's lethality; whether it is transmissible or contagious (potentially inflicting more casualties); and what available preventative or treatment options exist. *(See Section 4, "Defensive Countermeasures.")* For example, anthrax might not be an effective weapon if the majority of the population being targeted has received vaccinations to prevent infection. On the other hand, if the intent is to cause long-term economic loss or even area denial, an agent such as anthrax that is persistent, requiring expensive and time-consuming decontamination measures, might be preferred. While the anthrax letter attacks in 2001 (also known as Amerithrax) were not militarily significant, they did cause mass panic and cost a great deal of money and time to clean up. Analysts estimate that decontamination and remediation costs for the

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[10] Wikipedia, *Biological Warfare,* last modified October 8, 2015*, https://en.wikipedia.org/wiki/Biological_ warfare.*

[11] Bruce W. Bennett and Jim A. Davis, *Needed Now: The "85% Quick-Fix" in Bio-Defense,* (Maxwell Air Force Base: Air University, 2004), 10.

Amerithrax incidents ran up to $320 million; cost estimates for larger attacks run into the billions.[12]

Another factor is the adversary's ability to acquire and use the agent as a weapon. Some biological agents are extremely hard to produce or require larger quantities or doses to create an impact. While these agents might work for small-scale BW terrorism or assassinations, they have limited use for wide-spread or militarily significant BW agent attacks.

The adversary must also assess whether they can protect their own population from infection once the weapon is released. They must also consider the detectability of the agent—can the attack be traced and attributed to the perpetrator? For example, an adversary may want to contaminate a food supply since it is not likely to be immediately apparent that the resulting outbreak was caused by a BW agent attack. Similarly, an adversary may want to choose an agent with a short incubation period—particularly for a transmissible illness—so more people are infected before the BW event is discovered and treatment options can begin.

Based on all of these factors, there are five broad categories of agents that might be weaponized—with the first three being the primary focus of military BW attention.

Bacteria. These are single-cell organisms that cause diseases such as anthrax, brucellosis, tularemia, and plague. Bacteria exist naturally in a variety of places, to include in living animals, plants, and in decaying and even dead matter, as well as in soil and the air. Thus, they tend to be environmentally hardy; do not require a living host to reproduce; and can be more easily cultivated. They are well suited to be weaponized. On the other hand, many bacteria are susceptible to antibiotic treatment, depending on the agent and the timing of the prophylaxis treatment.

Bacillus anthracis

[12] Ketra Schmitt and Nicholas A. Zacchia, "Total Decontamination Cost of the Anthrax Letter Attacks," *Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science*. Vol 10, No. 1 (March 2012), 106.

One example of a bacteria is *Bacillus anthracis*, the agent that causes anthrax. It is relatively stable and resistant to drying, heat, and some disinfectants. Although there is a vaccination, it is not generally available to the public and antibiotic treatment after attack requires dosing before an individual becomes symptomatic. As a result, this bacteria has been developed as an offensive BW agent by both states and individuals. In 2001, the Amerithrax attacks left five persons dead and seventeen infected when anthrax spores were mailed in letters.

Examples of other potential bacterial agents and diseases are included in **Figure 3-2**.

Agent	Diseases
Bacillus anthracis	Anthrax
Francisella tularensis	Tularemia
Brucella	Brucellosis
Burkholderia mallei	Glanders
Vibrio cholera	Cholera
Salmonella	Salmonellosis, typhoid gastroenteritis
Yersinia pestis	Plague
Shigella	Shigellosis, gastroenteritis
Burkholderia pseudomallei	Melliodosis

Figure 3-2. Examples of Bacterial Agents and Diseases

Viruses. These are extremely small intracellular parasites or micro-organisms. They are about one percent the size of bacteria. Although they generally require a living host to reproduce and can be vulnerable to environmental degradation, they are still a viable candidate for weaponization. Viruses cause diseases such as Venezuelan Equine Encephalitis (VEE), smallpox, or hemorrhagic fevers such as Ebola and Marburg.

Toxins. Toxins are derived from organisms, although they can be synthetically produced. Toxins can be weaponized, for example, by extracting poisons from venomous animals or plants or microorganisms. They cannot reproduce and thus are not contagious. In general, toxins impact their targets by interfering with cell and tissue functions, causing inability to control breathing or muscle function. Toxins blur the distinction between biological and chemical agents. In early negotiations of the Biological Weapons Convention[13], there was debate as to how

[13] The full name of the BWC is the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction.

to categorize toxins since unlike many biological agents, "they are inanimate and not capable or reproducing themselves."[14] Ricin, which is extracted from the seed of the castor bean in particular blurs the line between CW and BW.

In addition to these three major agents of DoD focus, there are two other categories of biological agent that have the potential to be weaponized:

Rickettsiae. Rickettsiae are similar to both bacteria and viruses. They resemble bacteria but are actually parasites that reproduce inside cells. While rickettsiae are small, relatively stable, and could be spread as an aerosol, they are also difficult to produce in any quantity and effective treatments exist to counter their effects. They also are not easily transmissible and thus are not generally considered a threat for BW agent production. Typhus and Q fever are examples of diseases caused by rickettsia organisms.

Fungi. These are pathogens that have some potential to be weaponized. For example, mycotoxin-producing fungi could possibly be used against humans since they are relatively environmentally hardy and could be released in aerosol form. More likely would be weaponizing fungi for use to destroy crops and create economic and other materiel damage to an adversary, such as cereal rust.

Biological Warfare versus Biological Hazards and Naturally-Occurring Diseases

Not all injurious biological outbreaks are the result of deliberate use. While the initial outbreak may be similar, there is a clear distinction between BW caused by deliberate use and illness caused by biological hazards or naturally-occurring or endemic diseases. While both can cause great harm—and the procedures to detect and treat may be similar—the distinction is in whether the agent existed naturally, as a byproduct of common human activity, or was intentionally used to inflict harm. **Figure 3-3** provides some examples of historical BW agent attacks versus naturally-occurring disease outbreaks.

[14] Jozef Goldblat, "The Biological Weapons Convention: An Overview," *International Review of the Red Cross*, No. 318 (June 1997).

Distinction Between Biological Warfare and Naturally Occurring Diseases/Biological Hazards

Biological warfare examples:

- In 1763, the British allegedly gave smallpox-infected blankets at Fort Pitt to American Indians. While there is no conclusive evidence that the blankets infected their targets, there was a smallpox outbreak in the Ohio Valley following the supposed exchange.
- The Viet Cong, during the Vietnam War, occasionally sharpened swords and sticks and dipped them in feces so enemies would be infected when stabbed.
- In 2001, the anthrax attacks through the U.S. mail infected 17 persons, of which 5 died.

Naturally occurring disease and biological hazards examples:

- In the Spring of 2009, a novel flu virus spread. The first case of H1N1 (swine flu) was diagnosed in April of that year. Within two weeks, the U.S. government declared a public health emergency. The Centers for Disease Control and Prevention (CDC) estimate that between April 2009 and April 2010, there were over 60 million people infected and approximately 12,000 deaths from H1N1.
- In the 1992 outbreak of bovine spongiform encephalopathy ("mad cow" disease), approximately 180,000 cattle were infected and 4.4 million slaughtered to eradicate the outbreak.

Figure 3-3. Biological Warfare Agent and Munition Attacks and Naturally-Occurring Disease Outbreaks
(Photo Credits: Bottom Photo, Animal and Plant Health Inspection Service (APHIS) by Dr. Art Davis)

As mentioned above, the definition of BW agents includes intent—i.e., an adversary intends to cause harm. On the other hand, biological hazards are defined as "organisms, or substances derived from an organism that pose a threat to human, plant, or animal health. These hazards include medical wastes, microorganisms, viruses, or toxins (from a biological source)."[15] For example, drawing blood from a

[15] JP 3-40, p. B-2.

patient infected with HIV/AIDS could pose a hazard to others if the blood is not properly protected, stored, and disposed.

The Centers for Disease Control developed biosafety levels (BSL) for laboratories researching disease hazards to ensure specific containment controls for microbes and biological agents. The BSLs range from Level 1 to Level 4 and take into account the severity of the disease, the likelihood of someone contracting it, and the availability of treatment options. For example, Biohazard Level 1 includes diseases such as varicella (chicken pox) and canine hepatitis. Handling these wastes requires less protection than Biohazard Level 4 agents which include Marburg virus and Ebola virus. In addition to biological hazards from laboratories, medical or other activity, there are agents and diseases that exist in nature that can cause disease through a variety of means. For example, the common cold is caused by viruses, most commonly the coronavirus or rhinovirus. A cold can spread across a population since humans cannot build up enough resistance to such viruses because strains can frequently mutate. However, unless deliberately spread by an adversary, these viruses and the resulting disease are not considered biological warfare.

It is possible for sub-state actors or individual terrorists to steal or even purchase biological hazardous material on the open market to launch a covert biological attack. One of the complexities related to BW, particularly in these types of cases is the difficulty in discerning whether a biological event was deliberate or the result of an endemic or naturally occurring disease. For example, if a number of personnel get food poisoning or there is a diarrheal outbreak, it is not immediately evident whether an adversary contaminated the food or water supply or there was an endemic reason for the problem. In cases where the disease is contagious, it is even more critical to rapidly identify whether an attack has occurred and address it to prevent the secondary wave of casualties.

Biological Warfare Threats

Beyond classifying biological agents by different agent and hazards, they can also be classified by where they lie on the biological threat spectrum. This classification, largely used by the Department of Health and Human Services (DHHS) looks at BW agents through the lens of where the agents are in the course of their development, as well as what are the potential countermeasures available. This scheme assigns agents to four categories—Traditional, Enhanced, Emerging and Advanced, particularly as a focus for developing medical countermeasures. The Homeland Security Presidential Directive/HSPD-18 released in January 2007, titled "Medical Countermeasures against WMD" provides the general categorization below.

Traditional agents. These are naturally occurring microorganisms or toxins. They have not been modified but they can be relatively easily disseminated or are contagious. These types of agents have the potential to create mass casualties or social disruption. Examples include *Yersinia pestis* (plague) or *Bacillus anthracis* (anthrax).

Enhanced agents. These are modified traditional agents or agents that an adversary has selected or developed to increase their ability to inflict harm or to make them less susceptible to countermeasures. Examples include bacterial agents that are resistant to antibiotics, agents modified for a longer viability, or certain types of weaponized anthrax.

Emerging agents. This category of agents focuses on pathogens that are not previously known or recognized. These agents might be naturally occurring or manipulated. Because they are not previously recognized, they have the potential to inflict mass causalities since countermeasures have not yet been developed. Moreover, existing detector technology might not be able to detect these novel, unrecognized agents.

Advanced agents. These "advanced agents are novel pathogens or other materials of biological nature that have been artificially engineered in the laboratory to bypass traditional countermeasures or produce a more severe or otherwise enhanced spectrum of disease." For example, they may be modified to allow them to be ingested easier, inhaled more easily, or to amplify the impact. [16]

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[16] White House, *Medical Countermeasures against WMD,* Homeland Security Presidential Directive/HSPD-18, January 2007.

Dispersing Biological Warfare Agents

Critical to BW agent use is determining how to weaponize, disperse, and deliver the BW agents to the target. Agent delivery can be extremely challenging. Indeed, an important factor in assessing which agents present the highest threat is how easily they can be disseminated and what form they can be dispersed in. Agents can be transmitted as liquid, powder, or aerosol, depending on the type of agent and other factors. While there are a variety of means for agent delivery, not all are practical or effective. For example, while it would be possible to disperse agent through water supplies it would take an unrealistically large amount of agent to create many casualties and the water supply is often treated before use. Similarly, delivering ricin toxin via a spring-loaded umbrella—as happened in 1978 to Bulgarian dissident Georgi Markov—might be effective for a single target or assassination, but it is not a militarily-significant means to deliver BW.

The following discusses potential dispersion and delivery means and the challenges adversaries face with each. **Figure 3-4** provides historical examples of various agent delivery means.

Aerosol dispersion is one of the most effective means to spread biological agents. An adversary could deliver aerosolized agent through a sprayer in a populated area, a ventilation system, or via a cruise missile or improvised device. Depending on the wind patterns, it would be possible to cover a wide area with infectious material and impact a large population. However, to be effective, the agent needs to be dispersed in fine enough particles to pass into the lungs while maintaining its stability and ability to cause infection. To produce weapons-grade agent, such as anthrax, requires relatively sophisticated culturing and processing. Moreover, the impact of an outdoor release might be mitigated if the population is indoors and protected, or if the agent is spread by prevailing winds or degraded by ultraviolet light or other environmental factors. Releasing aerosol in an enclosed space tends to concentrate and focus the attack. Other delivery platforms for aerosolized agent include drones, ground vehicles, cruise missiles, helicopters, aircraft with spray tanks, bomblets, and others.[17]

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[17] GlobalSecurity.org, "Biological Weapons," last modified July 24, 2011, http://www.globalsecurity.org/wmd/systems/bw.htm.

Examples of Biological Warfare Programs or Attacks Using Different Dissemination/Delivery Means

Aerosol:

- Aum Shinrikyo tried multiple times to release different biological agents in aerosol form. Their attempts to use BW failed, in part due to weak or inactive strains of agent, as well as inappropriate sprayer mechanisms.
- In 1979, there was an inadvertent release of anthrax spores in Sverdlovsk in the former Soviet Union, which killed over sixty individuals and injured many others.

Explosives:

- State-sponsored offensive BW programs, such as the Soviet and Iraq programs included multiple explosive delivery options.
- North Korea has stated that it still considers BW as a military option and allegedly has multiple explosive delivery means.

Food or Water:

- In 1984, the Rajneeshee Cult used *Salmonella enterica* in Oregon to contaminate salad bars. Over 750 persons contracted food poisoning and dozens were hospitalized.

Human, Animal or Object:

- During WWII, Japanese's Unit 731 program dropped bombs containing plague infested fleas on Chinese cities. Although the attack caused casualties, it seemed to have no significant strategic impact.

Figure 3-4. Dispersing Biological Warfare Agents
(Photo Credits: Second Image from Bottom, National Institute of Allergy and Infectious Diseases)

Explosives can also be used to deliver BW agents. However, this method tends to be less effective than aerosol, non-explosive means because much of the agent is likely to be destroyed by the blast and heat from the explosion. According to experts, efficiency for "delivery of biological agents by explosive devices is .... ~1-5 percent."[18] Nevertheless, depending on the quantity and desired targets, perpetrators can use bombs, missiles, artillery, improvised devices, or other explosive delivery. This method allows longer-range and stand-off delivery options for military use.

[18] GlobalSecurity.org, "Biological Weapons."

Water or food. Another means of agent delivery is to deliberately introduce pathogens or toxins into food or water supplies to contaminate or induce poisoning. Water-borne delivery is feasible but presents practical challenges for large attacks. An adversary would need to introduce the agent after the water is treated and the quantities required to impact large populations could be significant. For both food and water dissemination, BW agents may not remain stable. Depending on the agent and how food is processed or treated prior to being ingested, food delivery could be disrupted prior to the agent reaching its target. For example, milk is generally pasteurized; some food is heated to high temperatures; other food is tested prior to distribution.

Vectors (human, animal, or object). An adversary could disseminate biological weapons via an infected human—provided the biological agent is transmissible. Under this scenario, an infected person could spread disease by close contact, coughing or sneezing, or otherwise transmitting bodily fluids. Infected persons could in turn spread the disease to others. This is similar to how a cold or flu ripples through a population. Although human carriers are possible, there are challenges to human-to-human dissemination. To be contagious, the carrier would likely need to be highly symptomatic (or incapacitated)—and thus raise suspicion. In addition, depending on the agent, contact might need to be very close, making widespread contagion complicated.

Adversaries could deliberately infect or use already infected animals to spread disease to other animals, or in rarer case, humans. A state, sub-state actor, or individual might also spread infection through insects or objects. Mosquitos, for example, are carriers of malaria and plague. Historically, adversaries introduced objects, such as infected blankets, as a means to spread illness; although it is not clear these attacks had much impact.

Proliferation and Development Challenges of Biological Warfare Agents and Munitions

State Programs

There is a long history of state development and use of BW agents for military purposes. Examples of early BW agent attacks include armies poisoning enemies' wells, the Viet Cong smearing excrement on swords and sticks to cause infection, and the Tartars catapulting cadavers into walled cities to spread plague. However, interest and focus on using biological agents as weapons grew considerably during World War I and through the Cold War period when many countries developed offensive BW programs.

Japan developed and maintained a notorious offensive BW program between 1932 and the end of World War II. Known as Unit 731, the program conducted experiments on prisoners, deliberately infecting them with biological agents. Unit 731 was also responsible for attacking Chinese cities with infected fleas and contaminating food and water supplies. According to one account, at least eleven Chinese cities were attacked through multiple means, including releasing up to 15 million fleas to try to spread plague.[19]

E 120 Biological Bomblet Cutaway

The United States initiated its own state-sponsored offensive BW program in 1943 located primarily at Fort Detrick (then Camp Detrick) in Maryland with testing sites in Utah and Mississippi. During the program's existence, the U.S. military developed, weaponized, and stockpiled many different agents, such as *Bacillus anthracis* (anthrax), botulinum toxin, Venezuelan equine encephalitis, and *Francisella tularensis* (tularemia). They also stockpiled anti-crop agents such as rice blast and wheat stem rust. President Nixon ended offensive aspects of the U.S. BW program in 1969. The U.S. military destroyed the vast bulk of its stockpiles of BW agents, but maintains small quantities for research on BW agent defense.

The Soviet Union also maintained a robust offensive BW program. Initiated in the 1920s under Joseph Stalin, the program weaponized numerous BW agents, such as *Bacillus anthracis* (anthrax), *Yersinia pestis* (plague), *Francisella tularensis* (tularemia), smallpox, Marburg virus, and others. The Soviet Union not only developed and stockpiled numerous agents, it also conducted significant research to genetically modify agents to enhance their stability and resistance to antibiotics.

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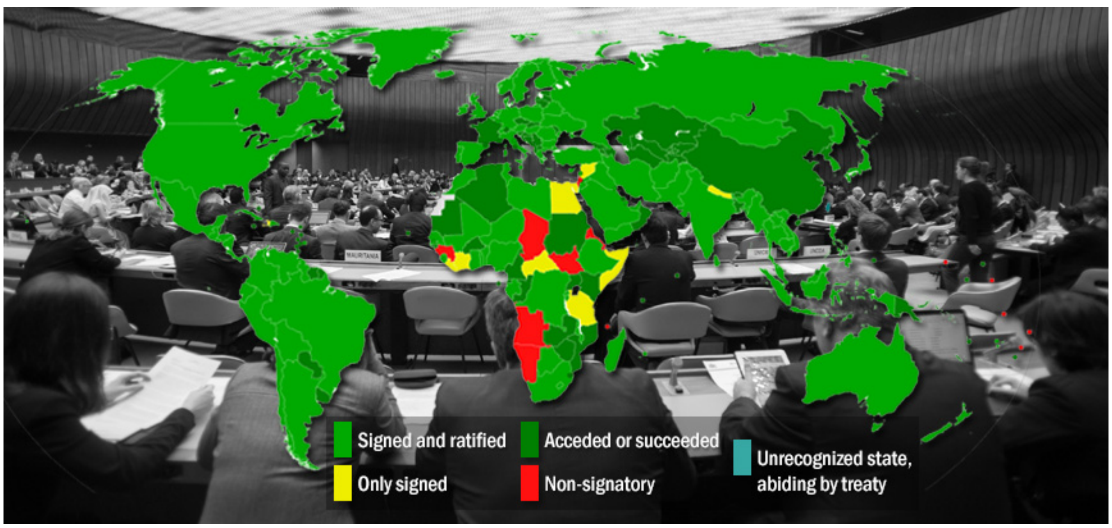
[19] LTC George W. Christopher, LTC Theodore J. Cieslak, MAJ Julie A. Pavlin, COL Edward M. Eitzen, Jr., "Biological Warfare: A Historical Perspective," *Journal of the American Medical Association*, Vol 278, No. 5 (June 1997).

Additional countries had confirmed state-sponsored BW programs at one time. These include Libya, France, Canada, the United Kingdom, Germany, France, Iraq, South Africa, and others.

In an attempt to limit the proliferation of BW and to disarm states possessing biological agents and munitions, the international community developed the BWC. As of 2015, 173 members have ratified or acceded to the Treaty. Under the terms of the BWC, member states are prohibited from using BW agents in warfare. They are also prohibited from developing, testing, producing, stockpiling, or deploying them. States are permitted to produce small quantities for medical or defensive purposes, e.g., to test the effectiveness of protective equipment or therapies.



Members of the Biological Weapons Convention
(Photo Credits: Map, Allstar86, https://en.wikipedia.org/wiki/Biological_Weapons_Convention#/media/File:BWC_Participation.svg; Background Photo, U.S. Mission Geneva/ Eric Bridiers, https://www.flickr.com/photos/us-mission/sets/72157649547084421/)

Despite the BWC, the proliferation of biological agents and munitions remains a serious national security threat. For some adversaries, acquiring BW agents and munitions is seen as an attractive option, viewed as a less expensive—and less detectable—alternative to developing nuclear weapons or building and maintaining large conventional forces. Although some have called BW agents "the poor man's atom bomb," it still requires significant funds and resources to develop a militarily-significant strategic arsenal.

Even signatories to the BWC have been known to continue to pursue BW weapons and agent research and development. For example, the Soviet Union, despite acceding to the BWC, maintained its large BW offensive program into at least the 1990s. The Soviet Union tried to keep the program and facilities secret. However, both defectors and the Sverdlovsk leak of anthrax spores in 1979 made public the Soviet Union's extensive BW program.

R-400A bombs photographed by UNSCOM inspectors at Murasana Airfield

It is very difficult to make definitive assessments as to which countries continue to pursue offensive BW agent and munitions programs. The dual-use nature of development facilities, the ability to develop BW clandestinely, and the lack of a verification regime for the BWC complicates determinations. However, open-source literature reports that there are a number of states suspected of seeking, researching, possessing, or otherwise pursuing BW agents and munitions.

Sub-state Programs

Beyond state-sponsored BW agent and munition programs, analysts suspect sub-state groups of pursuing BW agents and munitions. With increased technical information in the public domain and multiple transit and proliferation networks, many see a growing terrorist BW threat. Intelligence sources have identified indicators of sub-state actors, such as al Qaeda groups expressing interest in biological agents and weapons technologies. And, as mentioned above, the attempted Aum Shinrikyo biological attacks, the Rajneesh attack, and the successful anthrax letter attacks were all committed by sub-state actors.

While proliferation remains a grave concern, there are many challenges to acquisition and effective use of BW agents and munitions. Even with Aum Shinrikyo's extensive funding and scientific expertise, they never killed or incapacitated anyone with a BW agent despite repeated attempts. Some barriers to biological agent and munition acquisition and use include:

- Difficulty and cost to purchase, steal, or cultivate biological agents, particularly strains that are effective;

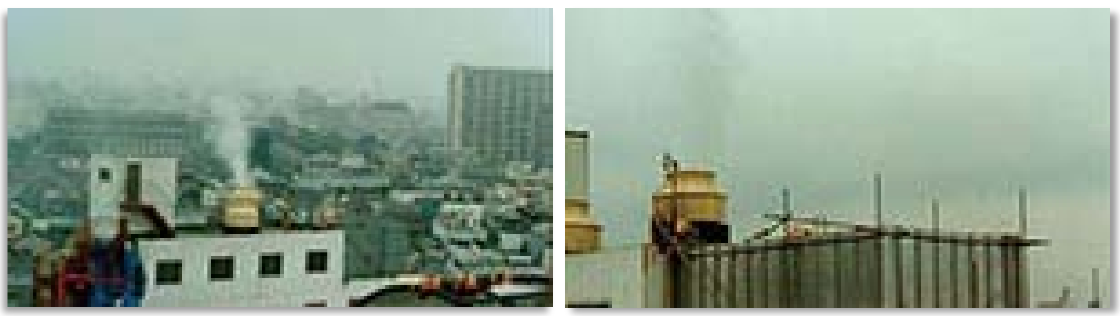
- Technical challenges to weaponizing biological agent. For example, it takes significant technical sophistication to refine *Bacillus anthracis* into particles fine enough to pass through the respiratory system but not so fine as to be exhaled and non-infective;

- Dangers working with biological agents and the potential for self-infection;

- Problems storing biological agents safely and reliably; and

- Challenges to disseminating the agent effectively.

These barriers are exacerbated for non-state actors with limited means and territory.



Aum Shinrikyo Sprayers
(Photo Credit: Photographs taken July 1, 1993, by the Department of the Environment, Koto-ward)

Conclusion

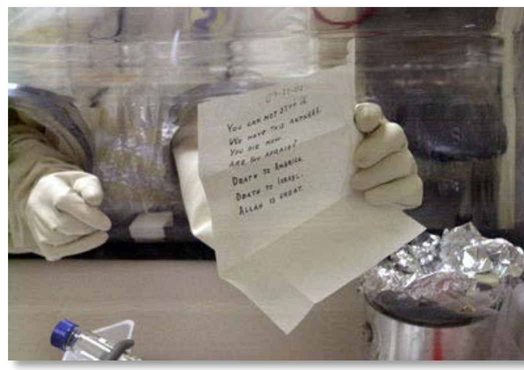
Gram-for-gram, biological weapons are the deadliest weapons ever produced.[20]

Biological weapon agents and munitions remain a serious concern to U.S. national security. As noted, BW agents have been used throughout history both by nation-states and sub-state actors, with varying effect. Many aspects of BW agents and munitions make them very attractive to adversaries. They can be highly lethal and can be acquired and used in small quantities. Many biological agents are

[20] Nuclear Threat Initiative, "Understanding the Biological Weapons Threat," http://www.nti.org/threats/biological/, 1.

contagious, allowing an adversary to inflict casualties beyond the initial infected population. They are often difficult to detect and attribute, as demonstrated in the Amerithrax case, which took years to investigate.

Despite the perceived advantages of BW agents and munitions, there have been no confirmed cases of state use of BW agents since Unit 731's attacks in World War II—although there have been allegations of state use of BW since that time. There is also evidence that some states continue to develop offensive BW agents and munitions. Many also fear that states that are not currently pursuing BW agents and munitions could rapidly regenerate a BW capability, despite the BWC prohibitions.



Amerithrax Investigation

On the sub-state side, there is evidence of terrorist group interest in biological agents and munitions. However, there have been relatively few terrorist uses of BW attacks in recent history and there are significant challenges to acquiring and using BW agents and munitions effectively. Nevertheless, the grave potential of BW agents requires the United States to remain vigilant in its efforts to prevent BW agent proliferation and ensure it has strong deterrent and defensive measures to protect our forces and population from BW-armed adversaries.

SECTION 4

Defensive Countermeasures

The U.S. government takes a layered, "defense-in-depth" approach to defending against CBW attacks. The goals are to prevent or roll back proliferation through diplomacy: contain CBW weapons and agents; discourage their use or threats of use through deterrence; and be prepared to effectively respond to CBW events.

Diplomacy

Treaties and International Agreements

Non-proliferation agreements and arms control treaties are tools for preventing the proliferation and use of CW and BW materials and technologies. Other forms of diplomacy include multilateral export control regimes and economic sanctions. **Figure 4-1** provides dates of U.S. signature and entry into force, where applicable, for each of these agreements.

United Nations Security Council Meeting

The Hague Conventions of 1899 and 1907 were two of the earliest multilateral treaties designed to govern conduct during warfare. The Hague Convention of 1899 contained a declaration prohibiting the use of projectiles for spreading asphyxiating gases, but the United States did not ratify this declaration. The Hague Convention

Treaty or Agreement	Date of U.S. Signature	Date of U.S. Entry into Force
Hague Convention of 1899	July 1899	September 1900
Hague Convention of 1907	October 1907	January 1910
Geneva Convention	June 1925	April 1975
BWC	April 1972	March 1975
Australia Group	June 1985	N/A
Missile Technology Control Regime (MTCR)	April 1987	N/A
CWC	January 1993	April 1997
Proliferation Security Initiative (PSI)	September 2003	N/A

Figure 4-1. Select Non-Proliferation Treaties and Agreements

of 1907 prohibited the use of poison or poisoned weapons during warfare, and it forbade the employment of weapons or material designed to cause unnecessary suffering.

The 1925 Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or other Gases, and of Bacteriological Methods of Warfare (the Geneva Protocol) prohibits the use of chemical and biological (CB) weapons in international armed conflict. However, it contains no explicit prohibition against producing or possessing such weapons. The United States signed the Geneva Protocol in 1925, but the U.S. Senate did not give consent to ratification until 1975.

The BWC prohibits the development, production, stockpiling, acquisition, or retention of microbial or other biological agents or toxins and their delivery systems by “States Parties” (member countries that have signed and ratified the BWC). The BWC allows for the production of small quantities of prohibited agents for defensive purposes, such as the calibration of detection systems or testing the effectiveness of protective gear. The BWC does not include an inspection regime, and data reporting is limited to voluntary reports regarding biological research facilities.

Similarly, the CWC prohibits the development, production, acquisition, stockpiling, retention, transfer, or use of chemical weapons—defined as chemical agents and their delivery systems. States Parties with declared CW agent stockpiles, including the United States, have committed to destroying their stockpiles and production facilities. Unlike the BWC, the CWC features an intrusive, on-site inspection regime—including short-notice Challenge Inspections—to verify the quantities of declared holdings or the lack thereof. As of August 2015, there were 190 States Parties to the CWC.

Multilateral Export Control Regimes

The regimes listed below constitute a framework for participating governments to address export control and WMD proliferation issues in a multilateral manner. Together, the regimes are comprehensive and strive to address the essential threats to security. Individually, the regimes target specific threats, including CB agents (Australia Group), delivery systems (Missile Technology Control Regime, or MTCR), or both (Proliferation Security Initiative, or PSI).

The Australia Group is an informal, voluntary group of countries that seeks to strengthen the export controls of member countries to prevent the spread of CBW agents. The first meeting of the Australia Group took place in 1985 and meetings are held annually. The United States is one of 42 member countries.

Like the Australia Group, the MTCR is an informal, voluntary agreement among the United States and other countries to enhance export controls. However, the focus of the 33 members of the MTCR is not the agents themselves but rather the transfer of ballistic and cruise missiles (including unmanned aerial vehicles) capable of carrying WMD. Under the MTCR, exports of Type 1 missiles—those capable of carrying a payload of 500 kilograms to a range of at least 300 kilometers—are regulated more staunchly than less-capable Type 2 missiles. The MTCR does not completely prohibit the transfer of Type 1 missiles but places a strong presumption of denial on their transfer. Also, the United States is one of 137 Subscribing States to the Hague Code of Conduct against Ballistic Missile Proliferation, which builds on the MTCR by promoting transparency and confidence building regarding the testing and transfer of ballistic missiles capable of delivering WMD.

In 2003, the United States launched the PSI in an attempt to stem the transfer of WMD, delivery systems, and related materials to and from nations and non-state actors of proliferation concern. Under the PSI, participants work together to develop legal authorities and procedures for interdicting suspect vessels. The PSI is not a legally-binding treaty but is instead a voluntary arrangement. More than 100 countries participate in workshops, training events, exercises, and interdiction operations as they see fit. Cooperation fostered under the PSI has resulted in the successful interdiction of many weapon shipments, such as a Panamanian interdiction of weapons being transported from Cuba to North Korea in July 2013.

In addition to international agreements, the United States has a number of unilateral programs designed to prevent the proliferation of CBW munitions and agents and to dissuade others from attacking the United States or its allies. One example is the Cooperative Threat Reduction (CTR) program, which was originally designed to secure and dismantle WMD in the former Soviet Union. With relations between the United States and Russia in decline, the focus of the CTR program since 2013 has shifted to assisting other countries with CBW preparedness activities, such as the implementation of biological countermeasures during the 2013-2015 Ebola outbreak in West Africa.

There are also U.S. laws and policies in place to prevent proliferation, including Presidential Executive Order 12938. This Executive Order, first released in November 1994 and last amended in 2005, prohibits the importation into the United States of goods, technology, or services from designated foreign persons suspected of WMD proliferation-related activity.

Deterrence

The United States uses nuclear and conventional deterrence to dissuade the use of WMD. Nuclear deterrence is carried out by U.S. Air Force nuclear bomber aircraft, dual-capable fighter aircraft, and intercontinental ballistic missiles, and by U.S. Navy ballistic missile submarines carrying submarine-launched ballistic missiles.

After the fall of the Soviet Union and prior to 2010, U.S. government policy stated that, since the United States had forsworn its offensive CB weapon programs, it would not respond to a CBW attack in kind. Instead, nuclear weapons could be used in response to a CBW attack on the United States or its allies. However, the 2010 *Nuclear Posture Review* (NPR) de-emphasizes the role of nuclear weapons in deterring the use of CBW agents or munitions. In place of nuclear weapons, the United States relies more heavily on conventional military superiority, advanced missile defenses, and CB defense capabilities:

> *Since the end of the Cold War, the strategic situation has changed in fundamental ways. With the advent of U.S. conventional military preeminence and continued improvements in U.S. missile defenses and capabilities to counter and mitigate the effects of CBW, the role of U.S. nuclear weapons in deterring non-nuclear attacks—conventional, biological, or chemical—has declined significantly. The United States will continue to reduce the role of nuclear weapons in deterring non-nuclear attacks.*[21]

The 2010 NPR offers a "negative security assurance" to any country that is a member of the Nuclear Non-Proliferation Treaty (NPT) and is in compliance with its nuclear non-proliferation obligations. Under this assurance, if such a country uses CB weapons against the United States, its allies, or partners, that country will face the prospect of a devastating conventional military response. Also, any individuals responsible for the attack, whether national leaders or military commanders, will be held fully accountable. A nuclear response remains an option against a country not deemed eligible for the negative security assurance.

Having a robust, effective, and demonstrated CBW response capability may also deter an adversary from attempting to deploy CBW munitions or release CBW agents. If one side is able to negate or mitigate the effects of a CBW attack, the other side may see little benefit in attempting to carry out the attack. For example, many U.S. service members are required to receive anthrax and smallpox vaccinations, are issued CBW protective equipment, and are required to attend regular training on the use of that equipment. During wartime, a potential adversary that is considering using anthrax or smallpox against our troops may decide otherwise, knowing that these preparatory measures would make such an attack largely ineffective.

Defense

Robust CB defense capabilities are needed in case diplomatic efforts fail to prevent proliferation or deterrence fails to prevent the use or threatened use of CBW agents or munitions. Also, demonstrating CB defense preparations and capabilities early

[21] Department of Defense, *Nuclear Posture Review Report*, April 2010, viii.

in the lead-up to a conflict may lead to de-escalation or a decision by the adversary to remove CBW attacks as an option.

For the DoD, the focus of overseas CB defense is sustaining military operations in potentially contaminated environments, supporting the Department of State when a foreign country requests U.S. assistance in responding to a CBW event (foreign consequence management, or FCM), and in some cases taking the lead for the U.S. response to a foreign CBW event. The capabilities that DoD brings to bear include counterforce options, active defenses, and individual and unit CB defense measures.

GBU-24 Paveway III Munition

Counterforce options include the use of force to destroy production and storage sites or delivery systems prior to their use against U.S. forces. This can include the use of special operations forces in the adversary's rear areas or air and naval use of kinetic weapons. Also, some non-kinetic means of disabling targets can provide the same functional effect as destroying a target with a kinetic weapon. For example, it may suffice to shut down a facility using electronic warfare.

When striking targets that may contain CB agents, weapon selection and targeting are important to prevent the spread of the agents and to prevent civilian casualties. Kinetic weapons can be effective but indiscriminate; a resulting explosion or fire could have collateral effects on near-by civilians or even friendly forces. Even electronic warfare options, which in some cases can be more precisely tailored than kinetic weapons, could result in unintended collateral effects, such as shutting down nearby civilian facilities such as hospitals.

The U.S. military develops "Agent Defeat" munitions and uses hazard prediction software to mitigate the possibility of collateral damage from hitting a CBW production or storage site. The DoD has developed and fielded munitions designed for this purpose, such as the Crash Prompt Agent Defeat (CrashPAD) and the Passive Attack Weapon System (PAWS).

Terminal High Altitude Area Defense (THAAD)

Active defenses include means of diverting, neutralizing, or destroying weapons or their means of delivery while en route to their target. Typical examples of active defenses are air and missile defenses, such as the Patriot and THAAD ground-based missile defense systems. In addition, conventional forces such as aircraft will execute counter-air and counter-ground operations against WMD sites.

CB defense capabilities are those necessary to ensure individuals, combat units, and installations can minimize the effects of a CBW attack and continue military operations. Examples of CB defense activities include hardening critical facilities; obtaining, training in the use of, and wearing protective gear (e.g., filtration masks and chemical-resistant suits); and the implementation of force health protection measures, such as:

- Vaccinating personnel against biological agents such as smallpox and anthrax. As an example, DoD personnel are required to receive certain vaccinations when traveling to high-threat theaters of operation.
- Assigning specialized CBRN response forces to major units or bases to provide assistance in reconnaissance, decontamination, and recovery operations.
- Implementing other measures to slow or stop an outbreak, such as restriction of movement, quarantine, or isolation. **Figure 4-2** provides more information on each of these measures.[22]

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[22] JCS, JP 3-11, B-11 – B-12.

Disease Outbreak Mitigation Measures

Restriction of Movement:

- Limiting the movement (e.g., to or from a military base) of people who are potentially infected to prevent the spread of disease.

Isolation:

- The separation of people who have a specific infectious illness from a healthy population.

Quarantine:

- The imposition of separation and restriction of movement measures on people who have not shown signs or symptoms of a disease but have been exposed to an infectious agent and may become infectious.

Figure 4-2. Restriction of Movement, Isolation, and Quarantine
(Photo Credits: Right Image, Jiří Sedláček, https://commons.wikimedia.org/wiki/File:Gate_of_N%C3%A1m%C4%9B%C5%A1%C5%A5_nad_Oslavou_military_airport,_T%C5%99eb%C3%AD%C4%8D_District.JPG)

In addition to protective measures for U.S. forces, the U.S. government may assist host nations in stockpiling CB defense equipment for its military forces, government personnel, and general population. A key provision of the CWC is that signatories are expected to assist those nations who may come under CW attack with advanced technologies and material.

For both chemical and biological agents, early detection is a key component of avoiding casualties. Detection methods include point detection with handheld instruments, wide-area detection with fixed or mobile monitoring systems, and bio-surveillance to track disease cases and detect outbreaks as early as possible. Data from detectors and bio-surveillance can be further analyzed in analytical field labs to help predict threats and guide decisions regarding the use of protective gear, medical countermeasures, and decontamination. Chemical and biological defense specialists fuse information from detectors and bio-surveillance with intelligence and information from other available sources to determine which agent was released, when the event occurred, and which areas were contaminated. Commanders then decide, based on the hazard and operational requirements, which areas will be avoided and which areas will be decontaminated. Areas are marked accordingly by personnel wearing appropriate protective equipment.

Hazard Detection and Marking

Collective Protection Systems[23]

If a CB agent is detected, personnel can protect themselves by donning individual protective equipment or moving into a collective protection facility. If available, collective protection is often favorable over individual protection because individual protection systems often have disadvantages of reduced mobility, increased breathing resistance, and heat build-up.

Responders also determine which assets and personnel are needed, when, and where. For example, decontamination may be required for personnel (ambulatory and non-ambulatory), equipment, facilities, terrain, and remains (human or animal). Each of these has specific decontamination requirements and procedures. See **Figure 4-3** for more details on decontamination.

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[23] JCS, JP 3-41, *Chemical, Biological, Radiological, and Nuclear Consequence Management*, June 21, 2012, II-29 - II-30.

Decontamination

Physical decontamination is the removal of particulates and hazardous solids. Biological decontamination requires cleaning and sanitization. Chemical decontamination is used to neutralize chemical agents.

Contamination control zones are established for safety and access control:

- The ***hot zone*** is the most hazardous contaminated area. Access to the hot zone is limited to properly trained and equipped personnel.
- Decontamination takes place in a "decontamination corridor" in the ***warm zone***, with access controlled on each end of the corridor.
- The ***cold zone*** is the area that is free of contamination where the response is coordinated.

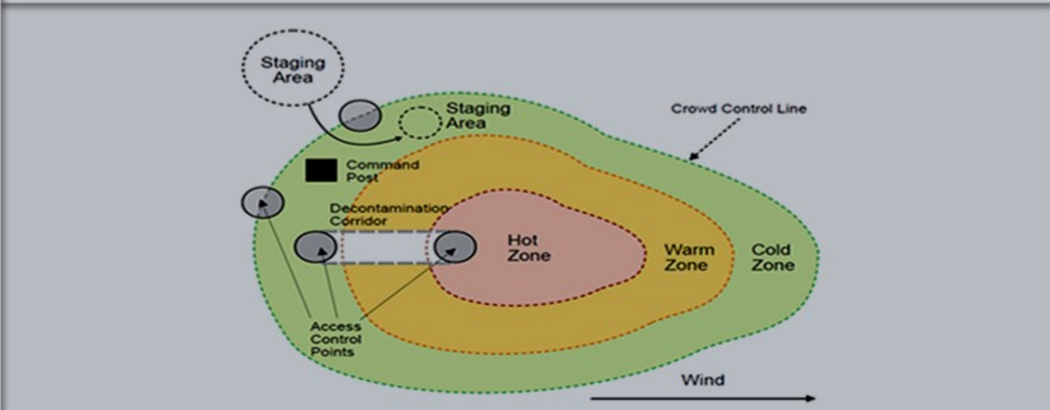

Figure 4-3. Decontamination

The area where a CBW event occurs may be permissive or contested. Commanders must consider the safety of responders and may be forced to wait until hostilities cease or abate before deploying them.

Commanders and responders must also take the long-term effects of the event and response into consideration. Some of these considerations include the potential release of contaminated run-off into the local environment; the storage, treatment, and disposal of contaminated human or animal remains; and the long-term disposition of contaminated response equipment that cannot be decontaminated.

Domestic Response

The US Armed Forces have a historic precedent and enduring role in supporting civil authorities during times of emergency, and this role is codified in national defense strategy as a primary mission of the Department of Defense.[24]

For a domestic CB incident, the DoD may be required to support the Department of Homeland Security (DHS) and other Federal, state, and local government response agencies. DHS is the lead for coordinating the federal response to a request by a state, local, territory or tribal agency for assistance to a catastrophic event. These agencies may include the Environmental Protection Agency for a chemical event or DHHS for a biological event. This support is known as Defense Support of Civil Authorities (DSCA).

The DoD has various general-purpose forces and assets available to support the civil response to a domestic CB incident. These capabilities include medical support, civil engineering, logistics, and security forces. They also have specialized units, such as WMD Civil Support Teams, and equipment, such as CB detectors and decontamination equipment, which can be employed in response to a domestic CB incident. Assistance is provided using the National Response Framework (NRF), the National Incident Management System (NIMS), and the Incident Command System (ICS). The NRF has an Oil and Hazardous Materials Response Annex that addresses chemical terrorism response, and a Biological Incident Annex that addresses biological terrorism response. **Figure 4-4** contains more information on the fundamentals of national incident response.

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[24] JCS, JP 3-28, *Defense Support of Civil Authorities*, July 31, 2013, vii.

National Response Fundamentals

National Response Framework (NRF):

- "The NRF is a guide to how the nation conducts all-hazards response. It is built upon scalable, flexible, and adaptable coordinating structures to align key roles and responsibilities across the nation...."

National Incident Management System (NIMS):

- "NIMS provides the template for incident management regardless of size, scope, or cause of the incident. It includes a core set of concepts, principles, terminology, and technologies covering the incident command system (ICS); multiagency coordination systems; unified command; training; identification and management of resources (including systems for classifying types of resources); qualifications and certification; and the collection, tracking, and reporting of incident information and incident resources."

Incident Command System (ICS):

- "The ICS, multiagency coordination systems, and public information systems are the fundamental elements of the NIMS that direct incident operations; acquire, coordinate, and deliver resources to incident sites; and share information about the incident with the public."

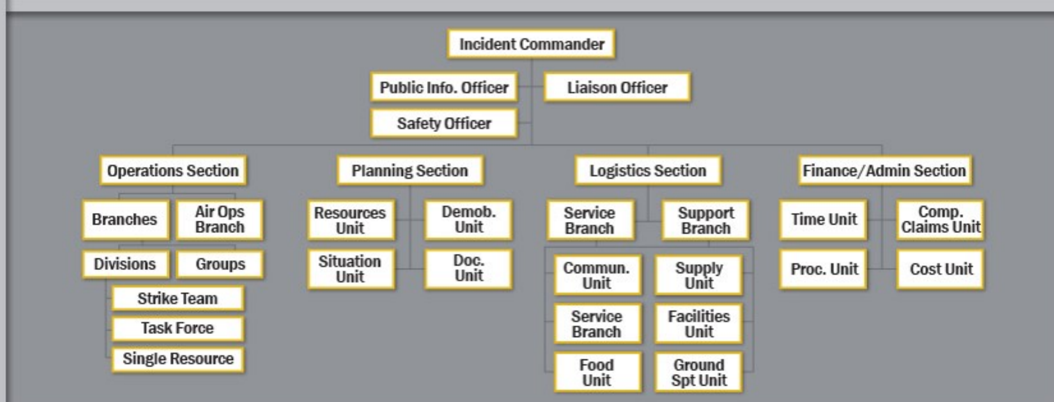

Figure 4-4. National Response Fundamentals[25]

Conclusion

The best way to defend against a CW or BW attack is to be prepared through the combination of up-to-date knowledge of adversarial intentions, appropriate and adequate quantities of equipment, and constant training. Non-proliferation efforts can prevent an adversary from obtaining CBW agents or delivery means, and deterrence can convince an adversary not to use them once obtained. If prevention

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[25] JCS, JP 3-28, I-5.

fails and a CBW attack is launched, options include active defenses and CB defense measures. These options should be capable of rapid employment, widely coordinated, and practiced routinely. Response planning should include the red-teaming of potential adversary courses of action and the incorporation of lessons learned from past events.

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Acronym List

AIDS	Acquired Immune Deficiency Syndrome
BW	Biological Warfare
BWC	Biological Weapons Convention
CBRN	Chemical, Biological, Radiological and Nuclear
CB	Chemical and Biological
CBW	Chemical and Biological Warfare
CDC	Centers for Disease Control and Prevention
CrashPAD	Crash Prompt Agent Defeat
CTR	Cooperative Threat Reduction
CW	Chemical Warfare
CWC	Chemical Weapons Convention
DHHS	Department of Health and Human Services
DHS	Department of Homeland Security
DOD	Department of Defense
DSCA	Defense Support of Civil Authorities
FCM	Foreign Consequence Management
HSPD	Homeland Security Presidential Directive
HIV	Human Immunodeficiency Virus
ICS	Incident Command System
JCS	Joint Chiefs of Staff
JP	Joint Publication
MTCR	Missile Technology Control Regime
NIMS	National Incident Management System

NPR	Nuclear Posture Review
NPT	Nuclear Non-Proliferation Treaty
NRF	National Response Framework
OPCW	Organisation for the Prohibition of Chemical Weapons
PAW	Passive Attack Weapon System
PSI	Proliferation Security Initiative
RCA	Riot Control Agent
THAAD	Terminal High Altitude Area Defense
TIC	Toxic Industrial Chemical
UN	United Nations
U.S.	United States
VEE	Venezuelan Equine Encephalitis
WMD	Weapons of Mass Destruction