Why The Other Services Should Examine The Air Force's Counter-CW CONOPS

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by Maj. Lawrence Pravecek

Introduction

Prior to Operation DESERT STORM, U.S. military personnel were not trained or equipped to fight in a chemical warfare (CW) environment. According to a 1991 General Accounting Office (GAO) report, "many soldiers have not been adequately prepared to survive and sustain operational missions in a chemical environment."[1] The U.S. military drawdown of the 1990s made preparation to fight CW-armed adversaries even less of a priority. While U.S. forces remained unprepared to fight in a chemical environment, the likelihood of operating in that type environment increased. The 1997 Quadrennial Defense Review stated, "the threat or use of chemical or biological weapons is a likely condition of future warfare, including in the early stages of war to disrupt U.S. operations and logistics."[2] The military was faced with a situation where it would likely fight in an environment where it was ill-equipped and ill-trained to win. To ensure continued mission success in an evolving threat environment, the U.S. military must organize, equip, and train its forces to carry out operations in a CW environment.[3]

In response to this changing threat environment, the U.S. Air Force developed its C-CW CONOPS, approved in January 2002. The C-CW CONOPS is a more flexible system, based on a variety of studies, allowing for localized areas of maximum wear of protective equipment and a quicker restoration of combat operations. This new system, however, has received a great deal of criticism in the defense community, especially from the Army. The crux of the debate concerns the persistence of chemical agents. The Air Force believes that new studies show that chemical agents, such as VX, pose a much more limited hazard than Army doctrine indicates.

The other services should closely examine the work the Air Force has done developing is new plan to fight in a chemical environment. While most Army and Navy forces are maneuver forces, a significant portion of their combat capability relies on fixed bases. At these fixed bases, the Air Force C-CW CONOPS can help improve their ability to support forward combat operations. The Army and Navy can apply many of the tenets with little difficulty, since Air Force planners have built a plan that can be applied flexibly to many operating locations with a minimum of additional equipment.

The Threat Environment

The CW threat is not likely to go away. In fact, due to its conventional warfare superiority, the U.S. military faces increasing proliferation challenges. The January 2001 Secretary of Defense report, *Proliferation: Threat and Response*, states: "Key states of proliferation concern are continuing to try to acquire and develop dangerous weapons… NBC [nuclear, biological, and chemical] weapons increasingly are viewed as asymmetric means to counter the West's superior conventional military capabilities."[4] As U.S. conventional strength grows, so does the attractiveness of attacking U.S. military bases and units with chemical weapons.

This type of thinking about the CW threat is not new. Secretary of Defense Les Aspin introduced his Defense Counterproliferation Initiative in 1993. His October 1993 "Report on the Bottom-Up Review," stated: "More than 25 nations either have or are attempting to acquire weapons of mass destruction—nuclear, biological, or chemical. In most areas where U.S. forces could potentially be engaged, our likely adversaries already possess chemical and biological weapons."[5] Since then, the chemical weapons threat to U.S. troops has grown.

The Air Force Response

Approved in February 2002, the C-CW CONOPS is a dramatic departure from the old concept of operations in a chemical warfare environment. Under the old system, any chemical attack was assumed to cause a base-wide contamination problem, resulting in long-term, base-wide Mission Oriented Protective Posture 4 (MOPP 4) wear, which quickly degraded operations. [6] The C-CW CONOPS emphasizes restoration of combat operations while promising to improve combatant safety.

The C-CW CONOPS reflects a new way of thinking about "the ability to survive and operate," emphasizing the "operate" portion, as opposed to the previous emphasis on the "survive" portion. It incorporates into one coherent framework the change in Air Force thinking about likely threats to airfield operations. The Air Force has gone from expecting massive chemical strikes to anticipating more solitary chemical attacks. It has also changed from threat-based to capability-based forces. Finally, it has taken advantage of the advancing knowledge in fate of agents. The combination of these three factors results in a passive defense approach that is one portion of a larger Air Force and Department of Defense strategy for countering chemical weapons. This approach calls for greater attention being paid to chemical defenses prior to an attack and faster reconstitution of operating capacity after an attack.

The C-CW CONOPS differs significantly from past operations, which were designed with a different threat in mind. Assuming a fight in the Fulda Gap under a continuous onslaught of CW-tipped artillery called for a different strategy than operating in a theater where an enemy launches a few SCUD missiles in an attempt to disrupt operations. In addition to addressing the challenges of a different threat environment, the C-CW CONOPS also reflects a different attitude about fighting in a chemical environment. Completely stopping the operational mission to handle the chemical environment is no longer acceptable. The Air Force's warfighting strategy is different from before because it concentrates on the mission rather than the environment.

Main Assumptions of the C-CW CONOPS

The C-CW CONOPS makes three main assumptions about droplet size, vapor hazard, and liquid hazard, and these are the root of the controversy. Some planners, especially army chemical warfare specialists, believe that the Air Force based its assumptions on flimsy science, and the new doctrine will lead to greater danger for military personnel. The Air Force counters with studies showing the validity of its arguments.

The first assumption concerns droplet size. There are many different delivery methods for chemical weapons, including spray tanks, artillery shells, aerial bombs, missiles, rockets, unmanned aerial vehicles, cruise missiles, and grenades. According to the U.S. Congress Office of Technology Assessment, “chemical munitions are designed to convert a bulk payload of liquid or powdered agent into an *aerosol* of microscopic droplets or particles that can be readily absorbed by the lungs, or a *spray* of relatively large droplets that can be absorbed by the skin.”[7] A spray can be generated by a spray tank carried by a helicopter or aircraft, while an aerosol can be generated by any of the munitions. The assumption of the C-CW CONOPS is that the most likely delivery method to pose a threat to an airbase is a supersonic tactical ballistic missile (TBM), and the most effective fusing is an air burst. This type of delivery generates a fine aerosol that produces a higher agent vapor concentration than larger droplets, but the vapor dissipates more rapidly.[8]

To obtain the maximum dispersal for a CW agent, a ballistic missile needs to employ an air burst rather than a ground burst. According to Air Force Manual 10-2602, a ground burst limits the dispersal and effectiveness of the agent: “Ground burst warheads with chemical and biological agents create the greatest hazard within the immediate area surrounding the impact point. Most of the agent effectiveness will be lost from the force of warhead impact.”[9] On the other hand, an air burst provides better results: “Airburst warheads provide the most effective area coverage and dispersion pattern for chemical and biological agents.”[10] Only VX can survive an airburst, however, in militarily significant amounts. G-series agents are more volatile, and can therefore best be delivered in a ground burst. The C-CW CONOPS concludes that VX delivered by TBM is thus the most likely threat to air base operations.

The result of an optimal air burst is a cloud of vapor that falls to the ground downwind of the delivery. AFMAN 10-2602 summarizes the process: “If an agent, such as VX, is released at an optimal burst height of about 250 meters (about 800 feet) above ground level, the agent falls to the ground over the next 60 minutes in the downwind direction of the prevailing wind. The average size of the VX liquid droplets that reach the ground from such an attack are expected to be about 200 to 250 microns, or about the thickness of four sheets of paper.”[11] This type of delivery is very different from the old assumptions used in CW planning, and the results led to an examination of the tables used to estimate agent persistence. This examination led to the next two assumptions.

The second and third assumptions concern the duration of the liquid hazard on surfaces found at a typical airbase and the duration of the vapor hazard. In the past, planners assumed that the hazard from CW agents would persist for days or weeks. This belief was widespread, although not entirely consistent. From the 1956 Army and Air Force Manual, *Military Chemistry and Chemical Agents,* Tabun (GA) and Soman (GD), nerve gases developed before VX, had the following characteristics: “*Persistency effect.* Depends on munition used, weather, etc. Heavily splashed liquid persists 1-2 days under average weather conditions.”[12] The other nerve agent of the time, Sarin (GB), “evaporates at approximately the same rate as water.”[13] Unstated was the assumption that however the agent was delivered, it would remain in a condition where it could be a “heavily splashed liquid.” A 1952 Navy publication, *Chemical and Biological Warfare Defense,* stated, “GB is the least persistent (about 12 hours under ordinary conditions); the others [GA and GD] have a persistency of more than 12 hours under similar conditions.”[14] Even current U.S. Army guidance is not entirely consistent, with different field manuals giving different lengths of vapor hazard present for the same agent. Despite the inconsistencies, Army manuals generally agree that chemical agents such as Sarin, Soman, and Mustard gas present a vapor hazard for one to ten hours, and VX for 241 to 1776 hours (ten to seventy-four days).

The Army tables to determine chemical agent persistence were a problem for Air Force planners for two reasons. First, the tables do not distinguish between a liquid hazard and a vapor hazard, and they mention only duration of vapor hazards. Second, the tables give figures only for CARC

(chemical agent resistant coating) painted surfaces, with multipliers given for grassy and sandy terrain. No data is given for surfaces most commonly found at air bases—concrete and asphalt.

Three different studies have filled in these gaps in the data. Tests at the Dugway Testing Center, Naval Surface Warfare Center, and in the Czech Republic have gone a long way in answering the questions pertinent to Air Force planners. The Dugway tests took concrete and asphalt samples from thirteen different runways and piers to test with VX The Naval Surface Warfare Center tested three CW agents on six materials commonly found in a military environment: expeditionary airfield landing mats, non-skid coating used on aircraft carrier flight decks, non-skid coating used on other surface ships, topcoat paint used on Navy and Air Force rotary and fixed-wing aircraft, tent material, and concrete. The tests in the Czech Republic focused on the evaporation rate of CW agents on fixed site materials, such as grass, sand, asphalt, and concrete.

The results from these three tests for VX, previously thought to be extremely persistent, are consistent with each other but completely inconsistent with the Army field manual tables. The tests show that very little VX actually evaporates, especially from concrete. The VX sorbs into the concrete and is virtually impossible to remove from it.[15] Rich McNally, an expert in CW agents, analyzed the findings from the studies. He wrote that the Dugway test showed “current models greatly overestimate the rate and amount of V-agent evaporation from concrete.”[16] He continued, writing that in the Naval Surface Warfare Center test, “concrete showed exceptional sorbative capability of all agents tested, resulting in very low evaporation of chemical agents and very low surface liquid chemical agents.”[17] Finally, about the Czech tests, he wrote, “Czech extraction results show significant breakdown of VX and GD on concrete surfaces; [tests] measured cumulative VX vapor from concrete significantly lower than models predicted.”[18] His conclusion, and the position adopted by the Air Force, was that the tests showed that VX does not pose the extended threat reflected by Army field manuals.

The Air Force used the data obtained from these tests to make its assumptions about liquid and vapor hazard. The liquid hazard is thought to be less than ten minutes on concrete, up to four hours on grass, up to six hours on painted surfaces, and hours to weeks on unpainted metals and glass. Table 1 is a summary of the liquid hazard data:

Surface	**Time in Hours**
Asphalt	<10 minutes for neat agent tens of minutes for thickened agent
Grass, sand, soil	A few minutes up to 4 hours
Painted surfaces	Up to 1 hours on most surfaces As long as 6 hours on some paints
Unpainted metal or glass	Hours to weeks
Table 1: Chemical Agent Liquid Hazard	

The vapor hazard, although not quantified as well as the liquid hazard, is nonetheless characterized as not as long lasting as previously thought. The C-CW CONOPS states, “V-class agents, the only chemical agents likely to survive a SCUD airburst, are non-volatile. When sorbed into surfaces, they present vapor levels that are lower and shorter in duration than predicted in current models that assume all the agent remains on the surface until evaporated.”[19] H and G series agents are also assumed to present a lower vapor hazard than previously thought.

The three assumptions combine to paint a post-attack picture very different from the standard Cold War scenario. Instead of an attack that covers the entire base with a layer of dripping,

persistent chemicals, the new picture is an attack with a small number of air burst ballistic missiles depositing a chemical vapor cloud over a limited portion of a base. The post-attack environment, while potentially lethal, is not an insurmountable obstacle to combat operations.

Operational Implications of the New Assumptions

An analysis of these assumptions led the Air Force to three operational implications. First, a chemical attack will likely result in less widespread contamination with a shorter hazard duration. Second, the combination of the sorbative qualities of many airfield surfaces and the low sensitivity of currently fielded liquid and vapor detectors means that contamination may be difficult to determine. Third, after chemical agents sorb into porous surfaces, they do not present a liquid pick-up or transfer hazard. As a result, equipment and personnel can move from a contaminated area to a clean area without the risk of spreading the contamination on tires or feet.

The implication of a more limited hazard profoundly changes the operational mindset. Instead of assuming that an entire airbase would have to operate in MOPP 4 for days or weeks because everything is contaminated, a geographically limited hazard means that part of the base will be contaminated, but part will not. After an initial period to determine the extent of the contamination, portions of a base can return to a lower MOPP level sooner and restore operations quicker. More thought and effort must be given, therefore, to plan out a detection and communication system to give commanders the information they need to make timely and accurate MOPP level decisions. The required contamination reporting puts increased emphasis on the base command and control system, along with putting more pressure on commanders to weigh the risks properly. Air base planners also have an increased responsibility to create an effective sectoring strategy for dividing the base that takes into account potential threats, local wind and weather patterns, and operational patterns.

Currently fielded CW detection equipment presents another challenge, which folds into the second operational implication. The postulated worst case delivery method, a VX air burst of a TBM, creates a vapor and liquid hazard that poses a detection problem. Chemical agents sorb quickly into concrete and asphalt, but still present a low level vapor hazard. This means that after an attack, an airman may be unable to detect a liquid hazard with M8 or M9 paper, because the agent would already be sorbed into the concrete, but a vapor hazard may still be present for an hour. The C-CW CONOPS states, “The lack of liquid and vapor detectors sensitive enough to detect low volatility agents makes it difficult to detect the presence of some anticipated threat agents. Once the agent has sorbed into the surface, low-levels of vapor will remain which could pose a risk to unprotected personnel. The duration of potential low-level vapor hazards will vary with different agent/surface combinations.”[20] Understanding that the absence of detection does not equate to absence of agent is critical for a commander who will make MOPP level decisions.

The final operational implication of the characteristics of chemical agents on airfield surfaces is that once a chemical agent sorbs into concrete or asphalt, it no longer presents a liquid or pick-up hazard. When a sectoring plan is in place to segregate contaminated areas from clean areas, this characteristic means that equipment and personnel can move from a contaminated area to a clean area without spreading the contamination. Equipment and personnel are thus not restricted to working only in a contaminated area, meaning that the flexibility may exist to recover critical assets to restore combat operations.

From these assumptions and operational implications, the Air Force developed the C-CW CONOPS, which calls for “new approaches for operating in a chemical environment.”[21] These new approaches include the following six main elements:

- Contamination avoidance;
- Detailed operational effectiveness assessments;

- Mixed/split MOPP operations;
- Commander involvement and risk management;
- Cross-functional and base-wide involvement;
- Protection of personnel and marking and identifying contaminated areas and surfaces.

Applying each of the elements is necessary for proper execution, because the C-CW CONOPS demands active participation from all base units and organizations. Attempting to restore operations as quickly as possible makes the system more complicated and more reliant on effective command and control at all levels.

Applying the C-CW CONOPS

The easiest way to understand how the C-CW CONOPS changes operations is to take a chronological approach, looking at pre-attack, trans-attack, and post-attack periods. Pre-attack includes both the planning phase and the operational phase prior to an attack. Post-attack includes both immediate actions and the longer-term effort to restore operations.

1. Pre-attack Planning

Under previous plans, pre-attack planning was generally limited to training of personnel, acquisition of equipment, and identification of shelters. In 1952, Navy training was generally broken into principles of CW agents and attacks, CW defense including individual and collective protection, and decontamination.[22] By the late 1990s, Air Force training had not advanced significantly, with most training of airmen coming from Air Force Handbook 32-4014, *Ability to Survive and Operate Procedures in a Nuclear, Biological, and Chemical (NBC) Environment,* which concentrated on the same areas.[23] The greatest emphasis of the training was on individual survival, especially individual protective equipment (IPE). The next most important training area was decontamination. The emphasis on these two areas reflects the belief that contamination was unavoidable, and survival was the primary goal with the mission happening some time in the future. The May 1991 GAO report, *Chemical Warfare: Soldiers Inadequately Equipped and Trained to Conduct Chemical Operations,* stated, “unit commanders… continue to view chemical defense as a separate task rather than as a condition of combat.”[24] Air Force thinking followed along those same Army lines. CW was a task unto itself, and once the CW portion was over, then a unit could get back to the real combat operation. The training reflected the general understanding of the situation.

The pre-attack phase of the C-CW CONOPS reflects the belief that contamination will be limited and thus can be avoided. The planning phase focuses on two areas, contamination avoidance and hazard reporting. A vulnerability assessment is the first step for commanders to determine what assets are required to accomplish the mission, which assets need protection, and what protection means are available. This first step shows that mission accomplishment is the primary goal, regardless of environment. The ability to survive in that environment is a given. Part of the vulnerability assessment, therefore, is an assessment of the availability of IPE equipment. Also included in the assessment is determining the unit’s decontamination capability, since lack of an ability to decontaminate certain assets may drive specific contamination avoidance measures.

The next portion of the planning phase is the development of a detection network. This development includes dividing the base into sectors, assigning hazard monitoring responsibilities, training post-attack reconnaissance (PAR) teams, and establishing reporting procedures to the wing operations center. Dividing the base into sectors can be done along organizational or functional lines, and bases can be divided into a few or into many sectors. Each strategy has its strengths and weaknesses, so base-wide involvement is necessary to create a plan that will work for the most units. Where sector lines are drawn can determine which units have hazard reporting responsibilities, which in itself is not a problem. The challenge is ensuring that the entire base is

properly monitored for hazards. Once units know their area of responsibility, they can determine how many PAR teams to train. Once units know what reporting procedures to follow, they can train and practice those procedures.

Along with the big picture planning for contamination avoidance and hazard reporting, units still need to accomplish individual training. The entire plan assumes that individuals understand how to wear and use their IPE gear correctly, but the training must also include the basic elements of the C-CW CONOPS. When individuals understand the importance of each of the concepts, the plan should function properly.

2. Trans-attack Phase

The trans-attack phase highlights another difference between the old methods and the C-CW CONOPS. When under attack, the old plan had people abandon vehicles and dive into ditches. Since every part of the base was going to receive its share of chemical agent, this strategy provided the most protection from blast and fragment hazards but ignored contamination risks. The C-CW CONOPS emphasizes continued adherence to the idea of contamination avoidance, stating the personnel will, "finish final contamination avoidance tasks when notified of an air or missile attack; seek overhead cover with splinter protection; and don protective equipment."[25] AFMAN 10-2602 list alternatives to consider before diving into a ditch: "Actions for Personnel in Open Areas. When the attack warning sounds (or notification is received) individuals in open areas should seek the best available protection (building, bunker). Ideally, this protection should be within 200 feet and provide overhead cover. If such protection is unavailable, move to a ditch, depression, or structure that provides protection from blast, fragments, and small arms fire."[26] In the past, running 200 feet to a building would have been considered dangerous; now, remaining unprotected from contamination is dangerous.

3. Post-attack Phase

The post-attack phase is the most dramatic departure from the old system. Previously, after an attack, the entire base would remain in MOPP 4 indefinitely, and operations would begin with the decontamination process. Pilots returning from sorties would process through the decontamination line in life support, eventually emerging at the other end, ready to enter the clean, over-pressured squadron building. Contamination of equipment was assumed, and many resources were dedicated to decontaminating equipment to return it to service. The attitude was similar to the Army way of thinking—fighting the chemical agents was the war, and the enemy had to wait until the Air Force was done deconning. Under this system, a degradation of sortie production was part of the cost of doing business in a CW environment.

The C-CW CONOPS does not accept this level of degradation. After an attack, airfield damage assessment teams (ADAT) and PAR teams identify and report the hazard while the majority of base personnel remain protected during the initial phases of chemical agent deposition. The detector network delivers information from the PAR teams around the base to the commander. The commander then makes mission versus risk decisions in implementing MOPP levels in different sectors. With an overriding concern for personnel safety, the focus is nonetheless on the mission. Non-contaminated sectors return to operating in MOPP 2. In contaminated areas, personnel wear MOPP 4, and they begin operating again. If contamination avoidance procedures have been successful, some equipment may not have been contaminated and can be transferred to clean sectors. Mission critical items can be decontaminated to an operational level and placed back into service. AFMAN 10-2602 states the intention of these efforts: "decontamination operations are intended to help sustain or enhance military operations in NBC environments by preventing or minimizing mission performance degradation, casualties, or loss of resources."[27] The goal is not winning a war against chemical agents; the goal is getting back to the mission.

The difference between the two methods of operating in a CW environment comes from the difference in understanding of that environment. In the past, there was no reason to discuss contamination avoidance, since chemical agents would be dripping from every surface. In that environment, sustaining any type of operation took much more effort than normal operations. The aim was just to operate at all, and hope that the enemy was having just as difficult a time coping with the environment. Today, however, a different view of the CW environment leads to a different outlook. Contamination can be avoided. Operations can be restored.

Conclusion

U.S. military thinking about chemical weapons has advanced significantly in the past twelve years. In 1992, the *National Military Strategy of the United States* did not mention chemical warfare at all, referring to WMD only in terms of stopping proliferation.[28] The fall of the Soviet Union had eliminated the possibility of fighting in a chemical environment. New threats emerged, however, in the form of chemical weapons used as an asymmetric method of countering conventional superiority. By October 1993, the Department of Defense began trumpeting the need to have the capability to carry out operations in the face of a chemical attack.

The change in threat environment eventually led to a change in the understanding of what capabilities the military would require. In the past, planners thought the most likely place to encounter chemical warfare was in a large-scale conflict with the Soviet Union. The plans reflected the thinking that the Soviets would use their large stockpile of chemical weapons to saturate U.S. equipment and troops. Any small chemical attack would be just a precursor to the larger attack.

This type of thinking changed after the fall of the Soviet Union and Operation DESERT STORM. U.S. forces now had conventional superiority, and if enemies had chemical weapons, their stockpiles were small. The greatest threat of chemical attack was from limited missile attacks. While these attacks would result in smaller areas of contamination, U.S. commanders still had only one all-or-nothing response available for base protection. The plan, which made sense while planning to fight the Soviets, was overkill when fighting a less capable enemy. The all-or-nothing plan also degraded combat capability by decreasing sortie-generation rates. Commanders needed a more flexible set of tools.

The C-CW CONOPS emerged from this need for more flexibility. By examining the assumptions of fighting in a chemical environment, planners discovered that limited attacks could have significantly less lasting impact on operations. By modifying operations, commanders could preserve their current combat capability while protecting their people. No longer would an entire base operate under MOPP 4 conditions for extended periods. Commanders received the capability to counter a finite threat with a finite response.

This mission focus is central to the C-CW CONOPS. The plan emphasizes restoring combat capability as quickly as possible, with an emphasis on pre-attack planning. Commanders conduct operational effectiveness assessments to determine critical assets, and then plan how to prevent contamination of those assets. Because of the limitations imposed by currently fielded chemical agent detectors, units need to develop detailed plans for placement and checking of detectors. Units also need to develop a notification system to consolidate information from various part of the base. Commanders then make risk management decisions based on the information received from the field. Although the system is much more complex than the former single level of response, it does allow units to get back into the fight quicker.

The C-CW CONOPS offers a new way of addressing the problem of operating a fixed base in a CW environment, based on a particular understanding of the operational environment. One key to applying the C-CW CONOPS successfully is adopting a new mindset for countering a chemical

attack. The old mindset was to protect *future* combat power by protecting lives. The new mindset is to protect *current* combat capability through prudent risk management. This new perspective allows commanders to focus on the mission, rather than merely the environment—solutions, rather than problems.

The C-CW CONOPS is a good change in mindset for the Air Force, and the other services should examine the work the Air Force has done to see how it can help their own fixed-base operations. Adopting a common set of operational standards for fixed base operations will simplify equipment procurement and personnel training while it enhances combat capability. When the other services challenge their Cold War assumptions about CW, they will discover the Air Force C-CW CONOPS as much to offer.

References

1. U.S. General Accounting Office, *Chemical Warfare: Soldiers Inadequately Equipped and Trained to Conduct Chemical Operations* (Washington, D.C., 1991), 28, GAO/NSIAD-91-197. See also Albert J. Mauroni, *America's Struggle with Chemical-Biological Warfare* (Westport, CT: Praeger, 2000), 215.

2. William S. Cohen, The Report of the Quadrennial Defense Review (Washington, D.C.: Office of the Secretary of Defense, 1997). section 3.

3. This paper considers only chemical weapons, not biological weapons. Although certain CW countermeasures apply to biological warfare, the characteristics of the two types of weapons are different enough to be considered separately.

4. U.S. Department of Defense, *Proliferation: Threat and Response* (Washington, D.C.: Office of the Secretary of Defense, 2001), 3.

5. Les Aspin, *Report on the Bottom-up Review* (Washington, D.C.: Office of the Secretary of Defense, 1993), 73.

6. MOPP level 4 is the highest level of MOPP gear and requires the wearing of overgarment, field gear (helmet, web belt, canteen and, if used, body armor (worn over the overgarment)), footwear covers (over-boots), mask, hood, and gloves. It is used when the highest degree of protection is required, such as Alarm Black notification and also post-attack reconnaissance-until the actual hazard has been determined. Only the installation commander can direct the change in MOPP levels. Notional MOPP levels for forces ashore are presented as follows in *Joint Publication 3-11 (Joint Doctrine for Operations in Nuclear, Biological, and Chemical (NBC) Environments, July 11, 2000)*:

	Level 0	**Level 1**	**Level 2**	**Level 3**	**Level 4**
Overgarment	Readily available	Worn	Worn	Worn	Worn
Overboots	Readily available	Carried	Worn	Worn	Worn

Mask & Hood	Carried	Carried	Carried	Worn	Worn
Gloves	Readily available	Carried	Carried	Carried	Worn
Table 2: MOPP Levels					

From Lt. Gen. Charles R. Hefelbower and others, "Counter-WMD Concepts of Operations at U.S. and Allied Air Bases," in *Countering WMD: A Decade Worth of Effort* (Maxwell AFB, Ala: USAF Counterproliferation Center, August 2004.)

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9. U.S. Air Force, *Air Force Manual 10-2602: Nuclear, Biological, Chemical and Conventional (NBCC) Defense Operations and Standards* (May 29, 2003), 2.7.3.1.

10. Ibid., 2.7.3.2.1.

11. Ibid., 2.7.3.2.1.

12. U.S. Air Force, *Air Force Manual 355-7: Military Chemistry and Chemical Agents* (August 3,1956), 26.

13. Ibid., 25.

14. Bureau of Naval Personnel, *Chemical and Biological Warfare Defense* (Washington, D.C.: Government Printing Office, 1952), 24.

15. The term “sorb” is a term of art within the community reflecting the various interactions that occur between liquid agents and surfaces with which they come into contact. This includes the traditional absorption (the wholesale soaking in of a substance) and adsorption (sticking of individual molecules to a surface, like activated charcoal scavenging poisonous gases in gas masks) as well as the more complicated chemical interactions of physisorption and chemisorption. From Lt. Gen. Charles R. Hefelbower and others, "Counter-WMD Concepts of Operations at U.S. And Allied Air Bases."

16. Lt Col Sam Flade, Maj Jim Hickman, and Rich McNally, *USAF C-CBRN Efforts*, undated briefing.

17. Ibid.

18. Ibid.

19. U.S. Air Force, *C-CW CONOPS*, 6.

20. Ibid., 7.

21. Ibid.

22. *Bureau of Naval Personnel.*

23. U.S. Air Force, (March 1, 1998). *Air Force Handbook 32-4014 Vol 4: USAF Ability to Survive and Operate Procedures in a Nuclear, Biological, and Chemical (NBC) Environment*

24. U.S. General Accounting Office, 28.

25. U.S. Air Force, *C-CW CONOPS*, 10.

26. U.S. Air Force, *AFMAN 10-2602*, A3.8.2.

27. Ibid., 3.4.2.1.

28. Colin L. Powell, *National Military Strategy of the United States* (Washington, D.C.: 1992), 1.

About the Author

Air Force Major Lawrence Pravecek is a recent graduate from the National Security Affairs (NSA) Department at the U.S. Naval Postgraduate School. This *Strategic Insight* is derived from his masters thesis, completed in September 2004, titled "Expanding The U.S. Air Force Counter-Chemical Warfare Concept of Operations."