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Nuclear Weapons and the Deterrence of Biological and Chemical Warfare

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Pragmatic steps toward ideal objectives

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Preface

In the evolving debate about the future roles and risks of nuclear weapons, the potential of nuclear weapons to deter or respond to threats or attacks with chemical and biological (CB) weapons has emerged as a key issue. Despite the entry into force of the Chemical Weapons Convention (CWC) and efforts to design and negotiate a verification mechanism for the Biological Weapons Convention (BWC), there is a real possibility of an increase in CB threats over the next several decades. Some experts argue that the United States must or should rely, either explicitly or implicitly, on nuclear weapons to counter CB threats or attacks. Others argue that the role of nuclear weapons can and should be limited to the deterrence of other nuclear weapons.

What role do and should nuclear weapons play in deterring CB use by states? What should be US policy for retaliating against CB use? To the extent that nuclear weapons currently play some role in deterring the use of CB—even if this is not stated policy—are there viable non-nuclear alternatives that would minimize the prospects that nuclear retaliation for CB attacks would ever seem appropriate?

In his study, *Nuclear Weapons and the Deterrence of Biological and Chemical Warfare,* Dr. Victor A. Utgoff takes on these and other important issues related to the utility of nuclear deterrence to counter CB threats. Utgoff begins by looking at situations in which CB might be used, the ends to which they might be employed, and the pressures for a nuclear response that such use would create. He postulates that there are three main reasons why the United States might consider using nuclear weapons to retaliate against CB use: (1) to respond to, or revenge, high numbers of deaths among US and allied citizens or troops; (2) to avoid a disastrous defeat; and (3) to avoid the higher costs that a conventional, rather than nuclear, response to CB attacks could lead to, such as a large increase in the number of casualties suffered by the United States and its allies. Facing high levels of deaths, possible defeat, or substantially increased costs of war, the US government could judge the consequences to be unacceptable and could also encounter strong domestic and foreign political pressure to use nuclear weapons, Utgoff observes. Yet, in considering alternative responses to CB use, the government would also need to consider how the US response could affect attitudes toward the military or political utility of nuclear, biological, and chemical weapons (NBC), proliferation motivations, or the risks of further use of NBC.

Taking action in advance to lessen the potential impact of CB attacks and increase the capability for conventional retaliation would reduce the potential pressures for nuclear retaliation, Utgoff reasons. The best option, he suggests, would be a composite strategy of arms control, defenses, and conventional retaliation. While none of these options seem likely to provide a complete solution in itself, combining them could go a long way to reduce the prospects that a nuclear response to CB attacks would seem needed or appropriate.

In particular, achieving reliable CB bans on the major powers should be a more tractable task than achieving reliable bans for the entire world. Given reliable CB bans on the major powers, the question of nuclear retaliation for CB use would be limited to use by small-to-medium aggressors. Successful interventions against such opponents should be possible even if they were to initiate CB attacks, if the United States and its allies protect themselves with strong CB defenses. Because of the overwhelming conventional superiority of the United States and it allies over such states, it should still be possible to defeat them, even taking the various burdens of CB defenses into account. Equally important, CB defenses for allied civilians could reduce the damage of CB attacks against them to the point where allied conventional forces would be able to impose commensurate punishment on the opponent if that were judged necessary. Alternatively, the goals of conventional retaliation might be to defeat, disarm, and reform the opponent, or to destroy directly its leaders.

Although the United States has already undertaken some efforts in each area—defenses, arms control, and enhanced conventional retaliatory capabilities—Utgoff observes that "integrating CB defense systems to create an overall capability for effective protection of military forces and civilians would require considerably greater effort than is being made currently." Adoption of a composite strategy would take time to implement, involve a greater degree of complexity than nuclear deterrence of CB, and entail additional costs to develop new capabilities. But the alternatives may also have costs—should nuclear deterrence of CB attack fail in some future war, damage to both sides could be devastating. A change to current policy leading to the adoption of a more explicit reliance on nuclear retaliation against CB attacks would be both unnecessary and unwise, in Utgoff's view.

This study was conducted under the auspices of the Henry L. Stimson Center's Project on Eliminating Weapons of Mass Destruction, which is intended to encourage a national and international debate on the long-term nuclear future. The project is based on the premise that the end of the Cold War, the dissolution of the Soviet Union, and the grave dangers of proliferation provide both reason and opportunity to reexamine fundamental assumptions regarding the relative benefits and risks associated with reliance on nuclear weapons as instruments of state policy.

The study is the fifth in a scries that examines key challenges for the elimination of weapons of mass destruction. Other studies in this series examine the implications of further reductions of nuclear weapons for US and Russian defense policy, the problems of verifying nuclear disarmament, and the challenges of safeguarding against violations of a ban on nuclear weapons. In undertaking this analysis, these studies seek to identify the main obstacles to the progressive elimination of mass destruction weapons from all nations and to propose solutions—both intermediate measures and longer-term approaches—to overcome these obstacles.

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About the Author

Dr. Victor A. Utgoff is a deputy director of the Strategy, Forces and Resources Division of the Institute for Defense Analyses. Previously he has been with the National Security Council Staff, the Center for Naval Analyses, and several aerospace firms. His most recent research has focused on the connection between US nuclear policy and proliferation, with much of this work appearing in a series of three articles published in the *Washington Quarterly*. Dr. Utgoff has also done research in the areas of arms control and confidence building, the future of military technology, and post-Cold War US requirements for armed forces. He is the author of several books and numerous papers, and a member of the Council on Foreign Relations.

List of Abbreviations

ANFZ	African Nuclear Weapons-Free Zone
ATACM	Army Tactical Missile System
ATBM	Anti-tactical ballistic missile
BW	Biological weapons
BWC	Biological Weapons Convention
CB	Chemical and biological
CW	Chemical weapons
CWC	Chemical Weapons Convention
NBC	Nuclear, biological, chemical

Nuclear Weapons and the Deterrence of Biological and Chemical Warfare

Should the United States declare that it reserves the right to retaliate with nuclear weapons if an aggressor makes chemical and biological (CB) attacks against it or its allies? This question has been hotly debated in recent years.[1] Actual US policy is ambiguous. The United States has made negative security assurances stating that it will not use nuclear weapons against states that do not have nuclear weapons and are not fighting with the support of those that do.[2] This policy implies such states need not fear nuclear retaliation for CB attacks.

On the other hand, recent statements by US defense officials seem to reserve the right to use nuclear weapons in response to CB attacks.[3] In addition, when the United States was concerned that Iraq might use CB weapons against the US-led coalition during the 1990–91 Persian Gulf War,

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[1] For some arguments in favor of doing so, see D.C. Gompert, K. Watman, and D. Wilkening, *U.S. Nuclear Declaratory Policy: The Question of Nuclear First Use* (Santa Monica, CA: RAND Corporation, 1995). For some arguments against, see George Bunn, "Expanding Nuclear Options: Is the U.S. Negating Its Non-Use Pledges?" *Arms Control Today* (May/June 1996).

[2] Bunn, "Expanding Nuclear Options," provides a short summary of the nature and history of US negative security assurances. For a broader discussion of positive and negative security assurances, see Michael Wheeler, "Positive and Negative Security Assurances," PRAC Paper #9, Center for International and Security Studies at Maryland (CISSM), School of Public Affairs, University of Maryland, (College Park, MD, February 1994).

[3] In countering claims that the Chemical Weapons Convention would weaken America, Secretary of Defense William Perry told the Congress that Washington would use nuclear force if necessary to respond to a chemical attack: "the whole range (of responses) should be considered—precision-guided munitions, Tomahawk land-attack missiles —and then we have nuclear weapons." See "Controversy rages over Perry nuclear comments," Reuters, 3 May 1996, 12:20:03 PDT. Robert Bell (title below), on the occasion of the US signing of two protocols to the African Nuclear Weapons-Free Zone (ANFZ), stated that while parties to Protocol I pledge not to use or threaten to use nuclear weapons against any ANFZ party, the protocol "will not limit options available to the United States in response to an attack by an ANFZ party using weapons of mass destruction." The White House, "Press Briefing by Mike McCurry and Robert Bell, Special Assistant to the President and Senior Director for Defense Policy and Arms Control, National Security Council," Press Release, 11 April 1996. See also Bunn, "Expanding Nuclear Options."

President Bush wrote a letter to Saddam Hussein that can readily be interpreted as threatening nuclear retaliation for CB attacks.[4]

In general, proponents of a declared policy of nuclear retaliation for CB attacks argue that the United States and its allies could suffer enormous damage from such attacks, and that minimizing their likelihood requires threatening the most devastating response possible. Opponents argue that other ways of protecting against CB attacks can be found, and that threatening nuclear retaliation for anything other than nuclear attacks works against the United States' immediate goal of stemming nuclear proliferation and against the ultimate goal of ridding the world of nuclear weapons.

There is merit in both sides' arguments. This paper addresses the question of the role that US nuclear weapons likely would play in their potential to respond to and thus deter CB attacks. In particular, it examines the pressures to retaliate with nuclear weapons that leaders could find themselves under in the event the United States and its allies were attacked with CB weapons in some future war. It argues that proper preparations beforehand can reduce those pressures to the point where, against small-to-medium regional aggressors at least, nuclear retaliation would seem inappropriate and unlikely.

Understanding how the United States might assess its option to retaliate with nuclear weapons for a major CB attack, and how defense policies and programs implemented beforehand could affect future assessments is important for at least two reasons. On the one hand, it would be

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[4] The two paragraphs stating the threat said: "Let me state, too, that the United States will not tolerate the use of chemical or biological weapons or the destruction of Kuwait's oil fields and installations. Further, you will be held directly responsible for terrorist actions against any member of the coalitions. [1st para.] The American people would demand the strongest possible response. You and your country will pay a terrible price if you order unconscionable acts of this sort." [2nd para.] "Bush Letter Warns Saddam of Stakes: 'War Choice is Yours to Make,' President Says in Rejected Message," *The Washington Post*, 13 January 1991, Final Edition, p. A20. The real meaning of this threat, how it was interpreted by Saddam Hussein and his senior advisors, and whether and how it may have led to Iraq's apparent non-use of CB weapons is uncertain. By the time the threat was made President Bush already had privately decided that US forces would not retaliate with nuclear weapons even if Iraq used chemical munitions. Still, Secretary of State James Baker in his meeting with Tariq Aziz in Geneva on the eve of Desert Storm, "purposely left the impression that the use of chemical or biological agents by Iraq could invite tactical nuclear retaliation." Tariq Aziz stated in 1995 that Iraq did not use chemical weapons because the leadership feared nuclear retaliation. This last statement has been questioned as possibly motivated by post-war political considerations, such as a desire to characterize potential use of Iraq's latent CB capabilities as readily deterred, and thus to suggest that these capabilities are not important enough to warrant the continuation of the United Nations sanctions against Iraq. See James A. Baker III with Thomas M. DeFrank, *The Politics of Diplomacy* (New York: G.P. Putnam's Sons, 1995), 359; and William M. Arkin, "Calculated Ambiguity: Nuclear Weapons and the Gulf War," *The Washington Quarterly* 19, no. 4: 3–18. See also, Paul I. Bernstein and Lewis A. Dunn, "Deterrence," in *Countering the Proliferation and Use of Weapons of Mass Destruction*, ed. Peter Hays, Vincent Jodoin, and Alan R. Van Tassel (New York: McGraw-Hill, forthcoming). Some experts believe that this 1995 statement by Aziz should be taken at face value. For example, C. Paul Robinson and Kathleen C. Bailey interpret the statement by saying: "The potential for a US nuclear response is known to have played a central role in deterring Saddam Hussein's use of CBW during Desert Storm." In: "To Zero or Not to Zero: A U.S. Perspective on Nuclear Disarmament," *Security Dialogue* 28, no. 2 (1997): 149–158.

a tragedy if a belief that the United States could be relied on not to retaliate with nuclear weapons tipped some future opponent's choice in favor of CB attacks. On the other hand, it would also be a tragedy if the United States were to rely excessively on nuclear deterrence of CB attacks and were not to pursue policies and programs that could supplement nuclear deterrence, reduce the damage done to both sides if deterrence were to fail, and make the role of nuclear weapons as narrow as prudence can allow.

The purpose of this paper is to help clarify both the role that US nuclear forces likely play in deterring CB attacks by other nations, and how that role can and ought to change. It begins with a short discussion of the nature of the threat posed to the United States and its allies by CB attacks. This is followed by a review of arguments that policy makers might advance in the aftermath of such attacks, in order to illustrate how such attacks could lead to nuclear retaliation. The paper then examines alternative policies and programs for deterring or defending against CB attack. It goes on to show how those alternatives might be fitted together to minimize the prospects that nuclear retaliation for CB attacks would ever seem appropriate.

The paper concludes with four implications of this analysis. First, any prewar declaration promising no nuclear retaliation for CB attacks cannot be counted on to hold in the aftermath of such an attack, at least under present conditions. If nuclear retaliation is seen at the time to offer the best prospects for suppressing further CB attacks and speeding the defeat of the aggressor, and if the original attacks had caused severe damage that had outraged American or allied publics, nuclear retaliation would be more than just a possibility, whatever promises had been made.

Second, the United States and its allies can create CB defenses that would reduce the potential damage from such attacks to levels that are generally comparable to those suffered in past conventional wars. Given such defenses, and the conventional military superiority over the small-to-medium powers that the United States and its allies plan to maintain, it seems unlikely that nuclear weapons would be needed to impose commensurate punishment on, or to defeat, any such aggressor that uses CB weapons.

Third, it would seem irresponsible not to build and maintain such CB defenses, given: (1) their relatively modest costs, (2) their values in reducing both the potential damage caused by CB attacks and the pressures to cause at least commensurate damage in retaliation, and, (3) their corresponding potential to discourage CB attacks in the first place.

Finally, a two-part composite strategy may be the most practical approach to largely eliminating the pressures to retaliate with nuclear weapons for CB attacks in wartime. The first part of the strategy would employ CB defenses and conventional retaliation to neutralize these pressures if small-to-medium aggressors were to attack with CB weapons. The second part of the strategy would focus the implementation of reliable CB bans on the great powers.

Nature of the CB Threat Posed in Warfare

To begin this analysis, it is necessary to illustrate first how nuclear retaliation for CB attacks against the United States and its allies is at least plausible as things stand today. There are many conceivable scenarios in which an aggressor might employ CB weapons that seem unlikely to lead to a nuclear response. One example might be a single chemical attack against a single US or allied air base that does not result in large casualties or affect the viability of the allies' military operations. An opponent might consider such an attack in order to demonstrate its will to use CB weapons against a US-led alliance, hoping that this might cause the alliance to reconsider the need for an intervention or to scale back its goals.

On the other hand, an aggressor might decide that there is no point in risking the initiation of CB attacks unless those attacks seem likely to have a decisive effect on the willingness or capability of the United States and its allies to continue their intervention. In this case, the aggressor might try to use CB weapons to: (1) to kill massive numbers of US or allied civilians or military personnel, (2) to defeat US and allied military forces, or, (3) to raise the cost of defending against aggression well above what it would be without CB attacks.

That nuclear retaliation is at least plausible if the aggressor's CB attacks were to achieve either of the first two results seems clear, for reasons that will be expanded on below. The third result could also lead to nuclear retaliation, if allied leaders judged they could not ask their troops to continue without doing everything possible to suppress further CB attacks.

The question then is whether CB attacks can have these results. Unfortunately, it appears that they can under some conditions, particularly given the generally low state of CB defenses that exists today. Specifically, very few countries have significant protection against CB attacks for their civilian populations. Further, while US forces are improving their capabilities to continue to fight in the face of CB attacks, few of the United States' potential allies could claim a capability to continue at all.

Given this generally low state of preparations, enormous numbers of casualties could be caused by CB attacks against civilians. For example, in relatively common weather conditions, two fighter aircraft using spray tanks loaded with the chemical weapon (CW) agent Sarin could kill the equivalent of 100 percent of the unprotected people in an area of approximately 3 square miles.[5] Approximately the same number of fatalities over about the same area would be expected from the

[5] A mathematical model widely used by the Department of Defense to estimate the casualty producing effects of chemical and biological weapons indicates that a spray tank filled with 600 kg of the nerve agent Sarin is sufficient to cause 80 percent fatalities for an unprotected population over an area of about 2.4 square kilometers. Two attacking fighter aircraft carrying two such tanks each could thus produce the equivalent of 100 percent fatalities for an unprotected population over an area of approximately 0.8 x 2.4 x 2 x 2 = 7.7 square kilometers or 3 square miles.

detonation of a first-generation nuclear weapon.[6] A single chemical attack of this kind made against a densely populated urban area could kill tens of thousands to well over a hundred thousand people.[7]

A biological attack would be even worse, as things stand today. To illustrate, a very small aircraft could dispense a line of the biological agent anthrax a few tens of kilometers upwind of a target area. As little as 20 kilograms of dispersed anthrax drifting downwind could cause the deaths of 50 percent of the unprotected population in an area of more than 150 square miles.[8] Made against the unprotected populations of ten large urban areas, such biological attacks could kill on the order of 20 million civilians.[9]

Chemical and biological attacks also pose a devastating threat to unprotected military forces. Destruction of major portions of the US and allied military forces intervening to defend against a CB-armed aggressor could cause their decisive defeat unless offset somehow.

Even if military forces were as well protected as current CB defense technology and rigorous training can allow, CB attacks against them can still reduce their effectiveness substantially. While such protection can limit the casualties from the direct effects of CB attacks to very low levels, it is very burdensome to use under some conditions.

For example, wearing current standard CB protective gear can reduce the performance of personnel in many important combat and support tasks by 50 percent or more, particularly in hot

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[6] The upper end estimate of the yield of the nuclear fission weapons once stockpiled by South Africa is 18 kt. A reasonable prediction of the fatalities from a nuclear detonation at optimal height of burst over an urban area can be made by assuming that everyone within the area that would be exposed to a 6 p.s.i. overpressure would be a fatality, while all those beyond would survive. An 18 kt weapon can produce an overpressure of 6 p.s.i. out to a range of 1 mile. Thus, such a weapon could be expected to result in the equivalent of 100 percent fatalities within an area of slightly over 3 square miles. For a description of the South African nuclear bomb, see *The Arms Control Reporter: A Chronicle of Treaties, Negotiations, Proposals, Weapons and Policy* (Cambridge, Mass.: Institute for Defense and Disarmament Studies, April 1993), 455.B.75. For the nuclear calculation, see Samuel Glasstone and Phillip J. Dolan, *The Effects of Nuclear Weapons*, Third Edition, prepared and published by the Department of Defense and the Department of Energy, 1977.

[7] Two urban areas that have figured prominently in hypothetical scenarios for the use of CB weapons are Riyadh, Saudi Arabia and Seoul, South Korea. The population densities of these areas are approximately 10,000 and 45,000 per square mile respectively. At these densities, the CW attack postulated above could result in 30,000 to 135,000 fatalities.

[8] This estimate was generated with the same model mentioned above. In order to achieve long range effectiveness, the attack was assumed to be made at night to avoid killing the agent quickly with ultraviolet light, and in a light wind and stable atmosphere that would allow the agent to drift downwind close to the ground. One hundred fifty square miles is the area of a medium-large city.

[9] The average of the population densities of Seoul and Riyadh is 27,500 people per square mile. Attacking 10 unprotected urban areas of 150 square miles at this average population density would lead to 10 x 150 x 27,500 x 0.5 = 20,600,000 fatalities.

weather.[10] Troops that are handicapped by such gear will suffer extra casualties on the battlefield. The substantial extra time taken to follow the needed protective measures, and to perform tasks while encumbered by suits and masks, is time lost for accomplishing military objectives. Moreover, the psychological burdens of combat are multiplied by the isolation imposed by suits and masks, as well as by the soldiers' awareness that there are many additional ways to become a casualty on a CB-poisoned battlefield.[11]

Of course, the vulnerabilities of civilians and military personnel to CB attacks are not completely separate problems. For example, US forces intervening on behalf of an overseas ally would have to make use of civilian airports and seaports that are usually near large population concentrations. CB attacks on these ports could kill large numbers of civilians. Similarly, intervening forces would depend on local civilian workers to unload ships and aircraft, and to provide ground transportation, fuel, food, and water. Attacks against civilians could make such support impossible.

Equally important, decisions to allow the United States access to needed territory and facilities would be influenced by regional political leaders' assessments of the prospects and potential consequences of CB and other types of attacks against their populations. A reasonable degree of protection for civilians could easily prove a political prerequisite for allowing US and allied forces to land in a threatened region.

The examples given above also illustrate another important characteristic of the relative threats posed by chemical and biological weapons as compared to those of nuclear weapons. In particular, matching the casualties caused by a relatively unsophisticated nuclear fission weapon can require chemical weapons weighing three times as much and occupying seven times the volume.[12] On the other hand, causing comparable casualties requires a biological weapon with less than one sixtieth the weight and one fifteenth the volume of such a nuclear weapon.[13] The very small size of

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[10] See "NBC Protection," FM3-4/FMFM 11-9, Headquarters, Department of the Army/Headquarters, US Marine Corps, 29 May 1992, pp. 2-6 through 2-16, to appreciate the work level limits imposed by wearing chemical protective ensembles.

[11] For an extended discussion of the various mechanisms by which chemical agent attacks can reduce substantially the effectiveness of various types of military forces, see Victor A. Utgoff, *The Challenge of Chemical Weapons: An American Perspective* (London: The Macmillan Press Ltd, 1990), 155–82.

[12] The *Arms Control Reporter* reports that the South African bomb was 1.8 m long and 0.62 m in diameter (giving it a volume of approximately 0.5 cubic m), and weighed 1000 kg. With a density of 0.8 that of water, the 2400 kg of Sarin calculated as capable of causing equivalent fatalities would have a total volume of 3 cubic m. Adding in 20 percent additional volume and weight to allow for the tanks and sprayers would give a total weight of 2900 kg and a total volume of 3.6 cubic m.

[13] The model referred to above estimates that crosswind dissemination of 3 kg of dry anthrax on a line upwind of a 6 square mile area would be sufficient to cause 50 percent lethality among unprotected people. This is equivalent to the 100 percent lethality over an area of 3 square miles that could be caused by a nuclear weapon with a yield of 18 kilotons. William C. Patrick III, President of BioThreats Assessment, and former director of the US Army's biological weapon (BW) program, estimates that 6.5 kg of dry anthrax could be disseminated by a system with a total weight of

biological weapons capable of strategically significant levels of destruction translates into a variety of difficulties in trying to eliminate biological weapons though arms control, to detect their manufacture, or to prevent them from being delivered to very valuable targets.

There are other significant differences among the three types of weapons, but these observations are sufficient for the purposes of this paper. They should make clear that CB attacks could cause enormous numbers of casualties among unprotected civilians and troops; impose burdens on US and allied military forces that could be sufficient to cause their defeat, even if they have effective CB defenses; and, short of defeat, raise very substantially the cost of defending against aggression.

Nuclear Retaliation for CB Attacks?

There would be no point in addressing the problem of nuclear retaliation for CB attacks unless such retaliation is a real possibility. As flat statements that the United States would never use nuclear weapons except to retaliate for nuclear attack seem increasingly common in debates on US nuclear policy, it seems appropriate to explore the arguments that might be made for and against nuclear retaliation for CB attacks.[14]

Possible Arguments for Nuclear Retaliation

In the event that CB attacks against the United States or its allies had caused massive numbers of US or allied deaths, posed the prospect of decisive defeat, or had substantially raised the costs of defending the interests being challenged, a variety of considerations could collectively argue for nuclear retaliation.

Public rage and a strong desire for vengeance could create intense political pressures on allied leaders for a devastating nuclear response.[15] In addition to anger for the large numbers of deaths that might have been caused, the opponent's use of "horror weapons," particularly if used against

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20 kg and a volume of approximately 0.03 cubic meters. A reasonable scaling down of this system taking into account that only the weight of the agent and its container would change significantly suggests that a system for delivering 3 kg of dry anthrax would have a total weight of approximately 16 kg and have a volume of only slightly less than 0.03 cubic meters. This is less than 1/60th the weight and 1/15th the volume of the South African nuclear weapon considered above. It is also about the size of a small suitcase.

[14] President Bush's reported decision not to use nuclear weapons in the event that Iraq were to use chemical weapons during the 1990–91 Gulf War is consistent with these statements. That decision may have been based on casualty estimates for CW attacks made against military targets with some CB protection. If this protection had been overwhelmed or exhausted, or if large numbers of allied civilians had been killed, a very different situation would have been presented to the president.

[15] George Quester, "The Response To Renegade Use of WMD," in *The Next Nuclear Crisis: A Defining Moment*, ed. Victor Utgoff (forthcoming), discusses why rage, a desire for vengeance, and other factors might make such a response seem to the American public like the right thing to do.

civilians, could offend the public's sense of fair play. Americans might see the offense as similar to the surprise attack on Pearl Harbor in 1941, although the intensity of the reaction could be even greater, particularly if civilians had suffered greatly.

If the aggressor's CB attacks had created a military imbalance that pointed toward defeat for the United States and its allies, military leaders could also argue that nuclear attacks against military targets could shift the balance back in favor of the alliance. They might also argue for nuclear attacks if substantial destruction of the opponent's CB capabilities were practical only by this means. Even if nuclear attacks held out little promise of eliminating the opponent's CB capabilities, military and political leaders might judge that immediate nuclear punishment could suppress the aggressor's willingness to continue with further CB attacks.

If allied military leaders judged that they could carry on with a less effective, but ultimately successful, conventional-only defense of allied interests, despite the aggressor's CB attacks, other arguments for nuclear retaliation might still carry great weight. It could be argued, for example, that political leaders simply could not ask their troops to accept the substantial imbalance in casualties that could result if only the enemy could use unconventional weapons.

Foreign policy considerations could also work to motivate nuclear retaliation in some situations. Failure to respond to a call for nuclear retaliation voiced by an ally that had suffered great damage from an aggressor's CB attacks could shatter the defending alliance. It might also cast great doubt on nuclear guarantees that have been an important component of other US alliances.

Other long term policy considerations might argue in favor of nuclear retaliation under some circumstances. If, for example, the aggressor's use of CB were to create a situation in which the allies' alternatives were either defeat or nuclear retaliation, accepting defeat would cast CB weapons as useable and effective offensive weapons.[16] This could have a variety of adverse effects, including spurring further proliferation. Retaliating with nuclear weapons to punish the aggressor could also be seen not only as justice for the case in hand, but also as an object lesson for those who might consider CB use in the future.[17]

Finally, it might be argued that the opponent's use of CB to cause great harm to the United States and its allies would remove any policy restrictions on retaliation with nuclear weapons, at least for proportional direct responses against the aggressor that are judged to be necessary to end

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[16] Barry Posen, in "U.S. Security Policy in a Nuclear Armed World or What if Iraq Had Had Nuclear Weapons?" *Security Studies* 6, no. 3 (Spring 1997): 1–31, also to appear as Chapter 2 of *The Next Nuclear Crisis*, discusses this possibility and its potential consequences at length.

[17] See Quester, "The Response To Renegade Use of WMD."

CB use. This argument, based on the international legal principle of "belligerent reprisal," could be seen to release the United States from honoring its negative nuclear security assurances policy.[18]

Possible Arguments Against Nuclear Retaliation

At the same time, a variety of substantive arguments could be made against nuclear retaliation.

First, it would be pointed out that actual use of nuclear weapons would violate a valuable international taboo that has been accumulating weight for more than 50 years. Further, if neither the aggressor nor any allies that might be supporting its aggression were recognized as having nuclear weapons, nuclear retaliation by the United States would violate the negative security assurance pledges made originally by President Carter and most recently reaffirmed in 1995 in the course of negotiations to extend the nuclear Non-Proliferation Treaty indefinitely.[19]

Second, in all cases where the stakes for the United States were less than truly vital, it could be argued that the most important objective in the aftermath of any highly destructive use of CB weapons would be to *not* escalate to the use of nuclear weapons. Nuclear retaliation might seem likely to increase the costs of the war to both sides well beyond the value of the actual stakes of the conflict.

Third, it could be argued that a US response that at least restored the status quo ante of the conflict without nuclear retaliation could set a most useful dual precedent. It would indicate both that aggression supported with CB weapons cannot succeed, and that the United States and its allies do not need nuclear weapons as a counter to CB attacks.

Fourth, it could be argued that nuclear retaliation might not end the use of CB, but instead, increase and prolong it. Further CB use could be possible, if the aggressor felt more committed to winning the issue at hand than it assessed the United States and its allies to be, if it saw further CB attacks on the United States and the allies as its only prospect for avoiding total defeat, or if it felt compelled to seek vengeance for the destruction wrought by the United States and its allies in their nuclear retaliation.

Finally, opponents of nuclear retaliation could argue that combinations of other alternatives should be considered, such as employing conventional forces to strike against enemy targets that might have originally been ruled off limits, expanding the scope and objectives of the war, seeking global agreement to impose total political and economic isolation on the offender, or even calling for a cease-fire and political resolution of the conflict.

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[18] See Bunn, "Expanding Nuclear Options," and Arkin, "Calculated Ambiguity."

[19] Discussed in both Bunn, "Expanding Nuclear Options," and Arkin, "Calculated Ambiguity."

Implications of the Uncertain Balance of Pros and Cons

How these arguments for and against nuclear retaliation might balance out in any actual situation is impossible to predict. US presidents have refused to employ nuclear weapons in drawn-out bloody wars in Korea and Vietnam, where they might have brought those conflicts to a quick end. Still, the United States and its allies did not suffer nuclear, biological, or chemical weapons (NBC) attacks in those wars, and the large numbers of casualties that were suffered took years rather than a few hours or days to accumulate.[20] One should not be surprised if actual CB use quickly resulting in enormous numbers of casualties made the balance of pros and cons seem very different from what history or peacetime war games might suggest.[21]

It seems certain that there would be intense debate about any decision to retaliate with nuclear weapons. This debate could sweep aside current policy icons, such as the statement that nuclear weapons are unusable, or that nuclear escalation would be easy under such circumstances, or that the US decision should be bound by its negative security assurances. Prior US declaratory policies for nuclear weapons would have some weight in the debate, but many of the other considerations discussed above could carry more weight in determining the decision.

If a decision were made to retaliate with nuclear weapons, very difficult questions would be posed about what targets to strike, and toward what ends: Would military utility be the sole objective of the strikes, or would it seem necessary to impose some extra measure of pain on the opponent's regime and/or population in return for the pain that the original CB attacks might have caused to allied populations?

In thinking through how to respond, the United States and its allies should also consider how their attacks would influence the post-war responsibilities they would face, the perceived utility of nuclear deterrence in the post-war world, and how they would want history to judge their actions.[22] Whether the leadership would prove cool enough to take the time to consider such factors is an open question, however.

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[20] In both cases, the large numbers of casualties suffered were accumulated over periods of years. The CB attacks postulated here could lead to even higher numbers of fatalities that would be imposed in a matter of hours.

[21] A long series of war games by RAND showed overwhelming reluctance on the part of participants to recommend US use of nuclear weapons in response to a wide variety of simulated nuclear weapons use by regional opponents. While these results are interesting, one can question whether the players were able to appreciate the enormous political and psychological pressures that would be present if the scenarios considered had been real. Few, if any, of the participants had held the most senior military and civilian positions in government where responsibility for the stewardship of the nation and its military forces can be keenly felt. See Marc Dean Wilmot, Roger Molander, and Peter Wilson, *The Day After...Study: Nuclear Proliferation in the Post-Cold War World*, volumes I and II (Santa Monica, CA: RAND, 1993).

[22] Brad Roberts, "Rethinking How Wars Must End: NBC War Termination Issues in the Post-Cold War Era," in *The Next Nuclear Crisis*, argues why and how post-war considerations should be a more important factor in making any future nuclear use decisions than they were expected to be in the event of a nuclear war between the United States and the Soviet Union.

While no one can know whether and how the United States and its allies might retaliate with nuclear weapons for CB attacks, it is clear that the weight of argument in favor of nuclear retaliation can be reduced by efforts made beforehand to reduce the damage-causing potential of CB weapons and to increase the effectiveness of conventional means of punishing or defeating the aggressor. Ways to do these things are discussed in the next four sections.

Reducing Pressures for Nuclear Retaliation by Means of Cooperative Measures to Eliminate CB Weapons

There would be no case for retaliating for CB attacks if these two classes of weapons could be eliminated through cooperative measures. What are the prospects for this?

Efforts to ban chemical weapons have come a long way in recent years.[23] Suppliers of the means for manufacturing chemical weapons have worked together for years to limit access by suspect states to the needed materials and equipment. After more than two decades of negotiations, the Chemical Weapons Convention (CWC), which prohibits states from owning chemical weapons and requires all those already having such weapons to eliminate them, entered into force in the spring of 1997.

Nonetheless, the struggle to achieve rigorous universal compliance with the CWC promises to be long and hard. The United States and Russia still need to complete the elimination of their massive stocks of chemical weapons, a process that will take many years to accomplish safely. While 165 nations have signed the convention and 99 nations have ratified it, nations such as Iraq, Libya, North Korea, and Syria have not accepted the convention.[24] Getting the remaining holdouts to join will not be easy. Implementing the agreed monitoring provisions with sufficient rigor to provide reliable assurance that no state has significant stocks of these weapons will be a challenging, expensive, and time-consuming process.

Whether or not chemical weapons will eventually be totally eliminated everywhere is an open question. Still, with sufficient political effort, money, willingness to accept intrusive monitoring, and pressure on holdouts, it seems plausible that eventually the CWC regime could eliminate all militarily significant CW arsenals.

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[23] See Michael Moodie, "Ratifying the Chemical Weapons Convention: Past Time for Action," *Arms Control Today* 26, no. 1 (February 1996): 3–9; "The Future of the Chemical Weapons Convention: An Interview with John D. Holum," in *Arms Control Today* 26, no. 10 (January/February 1997). For a skeptical assessment of the Chemical Weapons Convention (CWC), see James Schlesinger, Caspar Weinberger, and Donald Rumsfeld, "No to the Chemical Arms Treaty," *The Washington Post*, 5 March 1997.

[24] As of 10 September 1997.

The situation for biological weapons is more difficult. Biological weapons are banned by the Biological Weapons Convention (BWC), which entered into force in 1975. To date, 158 nations have signed it, and it has been ratified by 140 of these states. Holdouts here include Algeria, Sudan, and Israel. When the BWC was being negotiated, a number of factors suggested that biological warfare was impractical. As a result, it seemed unnecessary to build monitoring and verification procedures into the convention.[25]

Important among these factors were the difficulties of manufacturing some of the more effective biological agents at reasonable cost, of stockpiling them safely, and of making biological agents survive the trip from delivery system to within the victim's body. Since the completion of the BWC, however, advances in biotechnology have made biological warfare much more practical.[26] Particularly important, new bio-engineering techniques have opened the door to the far less expensive and simpler manufacture of drugs, foods, synthetic fibers, and other materials. A result has been the dramatic international growth of commercial manufacturing capabilities that can also be used to produce biological agents quickly and at low cost.

Given the very small amounts of the more potent biological agents needed to attack large concentrations of unprotected people, the emergence of this international bio-engineering industry creates a formidable arms control problem. In particular, while a few tens of kilograms of biological agent could kill most of the population of an unprotected city, tons can now be manufactured within days from infinitesimal amounts of seed stocks using equipment that can be hidden in a small warehouse. Thus, verifying the BWC appears impractical, at least by the methods that have been employed in arms control monitoring in the past.

Concerns about the ease of covert manufacture of biological weapons with strategic potential, coupled with evidence that a growing number of states are pursuing biological weapons despite the BWC, have led to efforts in recent years to develop effective means for monitoring compliance with the convention.[27] While some progress has been made, much remains to be done. Effective

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[25] In testimony before the Senate Foreign Relations Committee in 1974, Fred Iklé, then Director of the Arms Control and Disarmament Agency, argued that ratification of the convention denied the United States no "viable military option," as the usefulness of biological weapons was "dubious at best." See Robert L. Bartley and William P. Kucewicz, "'Yellow Rain' and the Future of Arms Agreements," *Foreign Affairs* (Spring 1983): 806.

[26] See Malcolm R. Dando, "New Developments in Biotechnology and their Impact on Biological Warfare" (Paper presented at a conference organized by the Friedrich Ebert Stiftung on Enhancing the Biological Weapons Convention, Bonn, 6–7 May 1996). See also, US Army Medical Research Institute of Infectious Diseases, "Biological Weapons Proliferation," Technical Report (Ft. Detrick, MD.: DNA [Defense Nuclear Agency]), MIPR-91-715; and Brad Roberts, ed., *Biological Weapons: Weapons of the Future?* (Washington, DC: The Center for Strategic and International Studies, 1993).

[27] See Malcolm R. Dando and Graham S. Pearson, "Controlling Biological Weapons, The Fourth Review Conference of the Biological and Toxin Weapons Convention: Issues, Outcomes, and Unfinished Business," *Politics and the Life Sciences*, March 1997.

monitoring of the BWC will require a greater degree of intrusion into the internal affairs of states than does the CWC, and sensitivities about potential losses of valuable proprietary commercial information are higher.

If a workable BWC monitoring system is eventually identified and accepted, it will likely take many years to implement it with sufficient rigor to provide reliable assurance that biological warfare capabilities are not being manufactured. In addition, here, as with the CWC, considerable effort will be needed to achieve universal adherence to the BWC.

Overall, it seems likely that progress toward reliable and effective global bans on both biological and chemical weapons will be slow. In addition to the technical difficulties involved, political leaders seem likely to continue postponing payment of the substantial political and dollar costs required.[28] Thus, CB threats may be reduced or contained, but reliable and complete elimination of both chemical and biological warfare threats from all states seems unlikely for a very long time.

Events that might change this unhappy prognosis include some devastating use of CB weapons that shocks the world, or the steady spread of increasingly violent terrorist incidents that suggest that highly destructive CB terrorism is just around the corner. On the other hand, such events might also lead states to conclude that effective CB arms control is impossible and that they need CB capabilities for their own protection.

While this paper is aimed at understanding the connection between CB arsenals and nuclear deterrence, which can only make sense against states, efforts to prevent CB terrorism could also affect the prospects for effective bans on CB ownership by states. Preventing CB terrorism that is not sponsored by states will require mechanisms for international cooperation and the development of many of the same kinds of intrusive intelligence and interdiction capabilities as are required for effective bans on state ownership of CB weapons. Thus, actual CB terrorism, or even a heightened general awareness of its terrible potential, could spur faster movement toward making the CWC and BWC fully effective.

Finally, though reliable and universal chemical and biological arms control bans may be a very long time in coming, even imperfect bans could be useful. Discovery of violations of widely supported bans on CB would help to clarify that an aggressor is an outlaw. This could aid the

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[28] While the eventual nature and costs of reliable CB arms control among the major powers are very uncertain, the costs of implementing the CWC can provide a starting point for speculating as to the order of magnitude of its cost. The US government currently estimates the implementation cost of the CWC at $70M for the first year. (Moodie, "Ratifying the Chemical Weapons Convention: Past Time for Action.") Dando and Pearson, in "Controlling Biological Weapons, The Fourth Review Conference," argue that the BWC can be monitored by modifying and applying the same general approaches taken to monitoring the CWC. Thus, it might be reasonable to suppose that another $70M for the first year might be required. Still, given the finer resolution and greater intrusiveness that seems likely to be required for monitoring the absence of efforts to develop and maintain biological warfare capabilities, one might expect the costs of effective monitoring of the BWC to be substantially higher.

formation and cohesion of a coalition to oppose such a state. It could also help to clarify the interests at stake, and to legitimize to the American public and the larger international community the levels of military force that may be needed to bring the confrontation to a satisfactory conclusion.

Reducing Pressures for Nuclear Retaliation by Means of Defenses Against CB Weapons

There would not be a case for nuclear retaliation for CB attacks if these two classes of weapons could be largely prevented from reaching prospective targets, or from damaging them substantially if they did. What are the prospects for doing this?

Defending Against Chemical Attacks

The prospects for reasonably effective defenses against CW attack seem promising. Nearly a ton of non-persistent chemical agent is required per square mile to ensure very high levels of casualties among unprotected populations.[29] This implies that large weights and volumes of CW munitions, and correspondingly large numbers of aircraft or missiles, would be needed to attack even modest numbers of large targets, such as cities, air bases, and seaports.[30]

The large sizes and weights of the chemical weapons needed to have strategic effects create multiple opportunities to defend against them. Specifically, they imply that manufacture of the required chemical warfare agents would likely need to be done in an industrial chemical plant that US and allied intelligence would have some prospect of identifying beforehand, and which could then be attacked in a crisis or war. Similarly, if large numbers of missiles or aircraft are required to deliver chemical agents to their targets, efforts to ready such attacks would be more obvious to allied intelligence, allowing them to be blocked by preemptive attacks.

The need to use relatively large missiles and aircraft to carry such large quantities of CW agents should allow prepared defenders to engage the attackers effectively as they fly toward their targets. If the defenders were able to subject the attackers to multiple interception attempts, even modest probabilities of success each time would multiply to make the attacker's eventual destruction very likely. For example, if each intercept attempt had a probability of success of 70 percent, an

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[29] Calculations of footnote 5 above adjusted downward to the original 80 percent fatality level projected by the Department of Defense model. 2400 kg for 80 percent fatalities over an area of 3 square miles is 800 kg per square mile or nearly a metric ton per square mile.

[30] For example, attacking the 25 air bases and the two seaports (with an assumed average area to be targeted of 15 square km each) employed in Desert Storm would require over 100 tactical aircraft of the payload capacity assumed in our earlier calculation to reach their targets with a total of over 126,000 kg of Sarin. Attacking an entire city, such as Riyadh (with an assumed area to be targeted of 400 square km) would require approximately the same size attack as for these 27 military targets.

attacker would have less than a 3 percent chance of penetrating a defense that allowed three interception opportunities.

Even if chemical weapons were to arrive in the neighborhoods of their targets, in contrast to the situation with nuclear weapons, populations could still have practical means for protecting themselves. As noted above, troops could protect themselves with masks, suits, and antidotes, etc., although they would experience some extra casualties and reductions in their efficiency that could be severe while significant concentrations of chemical agents were present.[31] Civilians could protect themselves by wearing masks and remaining indoors, preferably in rooms sealed with tape against the entry of chemical agent vapors.[32] In protecting both civilians and military personnel, warning systems also would be needed to tell when chemical attacks were being made and when it was safe to relax protective measures.[33]

The various means for defending against chemical attack can have important synergistic effects. Overcoming personal protection measures against chemical attack would require at least 100 to 1000 times as much chemical agent as attacking military personnel and civilian populations that are unprotected.[34] Decontamination measures would free an air base of the need to use burdensome chemical protective suits and force the opponent to attack it again to slow its operations. The need to attack with greater weights of agent, or repeatedly, would require additional missiles or aircraft

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[31] The burdens of maintaining high levels of CW protection from any one attack should die away relatively quickly. Non-persistent agents such as Sarin drift away with the wind. Within a few hours persistent agents such as VX evaporate away completely when temperatures are high or to levels where masks can be removed when temperatures are moderate. At low temperatures, wearing CW uniforms is far less of a burden than wearing them at higher temperatures and agent evaporation rates are so low as to make the risk of not wearing a mask acceptable under wartime conditions. See "Operational Guidelines: Survive to Operate in a Chemical Warfare Environment," Chemical Agent Persistence, Section 3, Technical Reference Document, USAFE, March 1984, Air Force Aerospace Medical Research Laboratory, Wright Patterson Air Force Base. Finally, persistent chemical agents are quickly degraded by rain.

[32] For descriptions of the type of protection against CB attack that could be adopted by civilians, see Ilan Yeshua, "Chemical Warfare: A Family Defense Manual," The Jerusalem Post Edition, published by the Centre for Educational Technology, printed in Israel, 1990; Karl Lowe, Graham Pearson, and Victor Utgoff, "Potential Values of A Simple BW Protective Mask," Institute for Defense Analyses Paper P-3077, September 1995. For a description of the type of protection against CB defense that is prescribed for US military forces, see "NBC Protection," FM 3-4/FMFM 11-9, Headquarters, Department of the Army/Headquarters, US Marine Corps, 29 May 1992.

[33] The Defense Department has given particularly high priority to the development of improved CB sensors. See Department of Defense, *Department of Defense Nuclear/Biological/Chemical (NBC) Defense: Annual Report to Congress*, March 1997, pp. 2-4 through 2-10, and Counterproliferation Program Review Committee, Department of Defense, *Report on Activities and Programs for Countering Proliferation and NBC Terrorism*, May 1997, especially pp. 1-10 and 5-40.

[34] A protection factor of 1000 (100 for a simple CW mask and 10 for a sealed shelter) is projected in "State Comptroller Faults Gas Mask Distribution," The Jerusalem Post in English, 15 April 1991, p. 7, cited in FBIS-NES-91-075, 18 April 1991, p. 25. A factor of 1000 is conservative for a well-fitted military CW mask. Kemira Safety OY of Finland offers a relatively simple NBC mask, the M"95 which is stated to provide a total leakage of 0.01 percent which is equivalent to a protection factor of 10,000.

sorties that could quickly deplete the aggressor's forces, particularly if active defenses were able to destroy large numbers of delivery vehicles en route to their targets. The larger numbers of chemical munitions, aircraft, or missiles needed to mount substantial chemical attacks would be more difficult for their owner to conceal and protect against preemptive attack in crisis or war.

In sum, it appears that combinations of these defensive measures can provide a reasonably effective defense against chemical attack. Moreover, as discussed below, the extra cost of adding effective chemical defenses to the conventional defenses the United States and its allies already plan to buy are comparable to those of many other defense programs.

Defending Against Biological Attacks

The prospects for preventing biological weapons from causing enormous numbers of casualties are comparable to those for chemical attacks, although the relative cost effectiveness of the various means for doing so are quite different.

As noted above, 20 kilograms of anthrax can destroy 50 percent of the population within an area of over 150 square miles. Thus, a ton or less of such a BW agent could be sufficient to do strategic levels of damage to a large nation by means of attacks on unprotected populations.[35] As this amount of agent could be covertly manufactured in any one of what could be a large number of otherwise legitimate facilities, the prospects for effective preemptive attacks to destroy an opponent's BW agents before they could be used are much poorer than in the case of chemical weapons.

Further, because such very small amounts of BW agents would be sufficient to devastate unprotected populations, very small numbers of very small delivery systems could be used to make BW attacks. Worse yet, because lethal concentrations of BW agents could travel many tens of kilometers downwind, the opponent need not approach very closely to the intended target to attack it.[36] These unhappy facts imply that an opponent could create a BW attack capability that could be very difficult, if not impossible, to interdict before its delivery systems had been launched, or while they were in transit to the areas in which they would dispense their payloads.

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[35]A metric ton of dry anthrax would be more than sufficient to destroy 50 percent of the unprotected populations residing in 7500 square miles of urban area. For example, it would be sufficient to attack ten of the largest metropolitan areas in the United States containing over 60 million people and kill half of them.

[36] The primary factor limiting how far downwind BW aerosols can travel is the rate at which these agents die when exposed to the atmosphere and especially sunlight. Dry anthrax, released into a low wind stable atmosphere after the sun has gone down can remain lethal till dawn. Thus the danger can extend 50 miles or more from the release point. For information on the decay rates of BW agents once released into the atmosphere, see "Chemical and Biological Contamination Avoidance," FM 3-3/FMFM 11-17, Headquarters Department of the Army/Commandant Marine Corps, Washington, DC, 16 November 1993, Appendix B.

This does not mean that the United States and its allies should not try to develop capabilities to destroy opposing BW capabilities before they could reach their targets. Allied intelligence might be able to penetrate the security precautions taken by the opponent's government or military services and discover where threatening BW agents, munitions, or any specialized delivery systems were located, thus opening up the possibility of attacking them. The opponent might even plan on using relatively large tactical aircraft or missiles to deliver BW attacks, thus opening the possibility of destroying them before they were launched or while en route to agent dispersal areas.

Offsetting the possibility that destroying BW attack capabilities before they could reach their targets may be far more difficult than in the case of CW attack capabilities, preventing BW agents from damaging populations whose neighborhoods they reach is significantly easier. Several characteristics of BW agents make this so.

First, BW agents that attack through the digestive system can be guarded against by eating well cooked food and drinking boiled water—measures that could be adopted by large populations during wartime or whenever war might be a real possibility. Second, no BW agents that attack through the skin are practical for large-scale use.[37] Third, there are effective vaccines and antidotes for most of the agents that typically have been chosen by states interested in creating biological warfare capabilities.[38] Fourth, bio-engineering techniques could open the door to more rapid and less costly development of antidotes and vaccines for currently known BW agents that do not already have them, as well as for any new types of BW agents that potential opponents might have developed, provided they could be discovered by allied intelligence long enough in advance. Finally, masks that are effective against chemical warfare agents are generally effective against BW agents, as well. Further, masks that are effective against BW alone are considerably easier and less expensive to make than CW protective masks.[39] In particular, a mask designed solely to protect against BW attacks would

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[37] A few toxins are known to attack through the skin, for example, "T-2," better known as "Yellow Rain," which is one of the many varieties of mycotoxins. Very large amounts are required to produce lethal effects and simply washing the skin provides effective decontamination. Substantial protection against BW attacks through the skin is provided by clothing, or by remaining indoors, as civilians can readily do if they receive timely warning of such attacks.

[38] For a list of potential BW agents, their effects, and an indication of whether there is an effective vaccine or treatment for each, see "Chemical and Biological Contamination Avoidance," Appendix B. The Department of Defense's Medical NBC Defense Programs and Modernization Strategy calls for the development of medical counters to eliminate nearly all of the deficiencies noted in the above list within the next 3 to 14 years. See *Department of Defense NBC Defense: Annual Report to Congress*, page 3-15.

[39] In order to be effective, BW aerosol particles must be in the 1- to 5-micron size, which is small enough to be breathed in but not so small as to be easily breathed out again. Such particles can be removed by what are essentially fine dust filters. CW agents are normally gaseous materials that must be removed from breathing air by using activated charcoal to absorb the high boiling point vapors. This more complex process makes the construction of CW masks considerably more expensive.

be appropriate for the protection of civilians. High efficiency dust masks available on the open market for around $5 each would be sufficient for the purpose.[40]

The most important missing technical components of an effective defense against BW attack are sensors that can warn of incoming BW attacks, and provide an "all-clear" when the agents have blown by, or have died away to potency levels that are no longer particularly dangerous—a matter of hours for most agents in most circumstances. The US Defense Department recognizes this gap, is fielding an initial set of warning sensors, and is developing improved sensors for the longer run.[41]

Collectively, these characteristics of BW agents make possible the creation of defenses that could very substantially reduce the potential damage from large-scale BW attacks.

Costs for CB Defenses

While the costs of acquiring effective protection against CB attack are substantial, they are comparable to those for other major defense programs.[42] There are three major components of currently planned capabilities to protect US military forces from CB attack: (1) passive protection from CB agents that arrive in the vicinity of the forces, (2) active defenses to interdict the delivery of CB agents, and (3) forces for attacking the opponent's CB capabilities before they can be used. US forces already have substantial capabilities in each area, so establishing an effective CB defense involves purchasing systems such as defenses against tactical ballistic missiles to fill in currently existing gaps. A reasonable estimate of the costs of acquiring an effective CB defense for US military intervention forces appears to be in the range of $30 to 40B.[43]

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[40] Assuming reasonable care in fitting the mask to the face, simple masks such as made by the 3M Corporation can provide a protection factor of 1,000–10,000. Such masks come in several sizes, are adjustable, and cost under $5 each to the government even when bought in small lots. Obtaining a good fit requires a few minutes instruction and practice. Infants and people with faces having unusual shapes or beards will need more expensive solutions such as positive pressure masks or shelters which are already available on the open market.

[41] In 1997, the Department of Defense Counterproliferation program made detection, identification, and characterization of BW agents the first priority for development of advanced capabilities. See *Report on Activities and Programs for Countering Proliferation and NBC Terrorism.*

[42] Acquisition costs would make up the largest part of the total costs of creating a CB defense capability. Total costs would also include some additional funding for training military forces in the use of new types of equipment, and perhaps also for more intense CB defense training. In addition, the civilian CB capabilities envisioned would involve setting up and maintaining a cadre organization prepared to distribute stored equipment quickly and provide training to civilians who would in turn train others. This mission might even be assigned to national guard and reserve organizations. If done with civilians, a cadre organization of 20 full time people for each US state and territory would cost on the order of $100M per year for a ten-year program cost of $1B. Adding another 1000 instructors to allow more intense CB defense training for US military forces would cost another $1B over ten years. As will be clear from the estimates developed below, these costs are a small fraction of the cost of acquiring the needed materials and equipment or of the range of uncertainty projected for those acquisition costs.

[43] A rough total cost of acquiring a capability to protect from CB attack US military forces carrying out a major intervention can be estimated by summing the acquisition costs for: (1) protecting the forces from CB agents that arrive in their vicinity, (2) interdicting delivery systems carrying such agents, and, (3) attacking CB capabilities before they

If regional allies are to protect their civilians from CB attack, they could add: (1) missile defenses for major urban areas that would not be well protected as the result of close proximity to US intervention forces, (2) CB warning systems to tell their citizens when individual protection measures should be followed, and (3) some modest amount of CB protection equipment and training. A reasonable estimate of the costs of acquiring such things might be in the general neighborhood of $130M for every major urban area to be protected plus $50 per capita. At these prices, acquiring such a CB defense for the 20 major urban areas and the approximately 100 million citizens of the states that were regional allies of the United States during the 1990–91 Persian Gulf War would total around $8 to 10B.[44]

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can be launched. The first category of costs can be estimated by totaling the cost required to fill out the CB protection requirements for "2 major regional contingencies" as listed in "Appendix F," p. 1 of the *Joint Service NBC Defense Research, Development and Acquisition Plan: Supporting Planning Period FY98-13*, Joint Service Material Group, April 1996. Nearly all the costs of the individual items are listed in "Appendix D: Development and Procurement Descriptive Summaries" of the same report. Those that are not listed have close analogs that are listed there. This process results in acquisition costs of $6.3B for reconnaissance, detection, and identification of CB agents, $1.6B for CB protection, and $65M for decontamination. The planned equipment investments seem high in the first category and low in the third, and surely additional items will be discovered to be needed as the program progresses toward completion. In any case, the total acquisition cost for these three categories of equipment sums to $7.9B. The second category of costs includes a wide variety of specialized equipment to give artillery and tactical air forces the capability to destroy opposing CB capabilities. The bulk of the acquisition cost for this capability would be for the missiles and special fuses needed. For purposes of this rough cost estimate, we assume the purchase of 200 modified Army Tactical Missile System (ATACMs) missiles at $1.1M each and 200 air-to-surface missiles similar to the GBU-28 A/B (but with the "Hard Target Smart Fuse" being developed by the Defense Special Weapons Agency) at an assumed cost of no more than $50K each. With an additional $25M for specialized targeting and support equipment, this estimate for the acquisition cost of specialized CB counter-force capabilities totals $0.25B. See *Report on Activities and Programs for Countering Proliferation and NBC Terrorism* for a description of the Department of Defense program to develop a CB counter-force capability. See Ted Nicholas and Rita Rossi, *Military Cost Handbook*, Data Search Associates, 1996, for baseline costs for missiles. Both missiles costs have been increased slightly to account for modifications including the smart fuse. An estimate of the third category of acquisition costs can be found in *Ballistic Missile Defense, 1995 Report to the Congress*, prepared by the Department of Defense Ballistic Missile Defense Organization, p. 2-22. This document provides estimates of the acquisition cost for the "TMD Active Defense Core Programs" of $12.8B for the land-based upper tier defense, $4.9B for the land-based lower tier, and $3.7B for the sea-based lower tier. These figures total $21.4 B. Summing the acquisition costs for the three categories of capabilities for protecting US intervention forces from CB gives a total of $29.55B. Given the substantial uncertainties in how these defense programs will evolve and be fitted together, and some allowance for the cost growth that is commonly seen as defense programs progress toward deployment, a reasonable estimate for the total might be $30 to 40B. Allies would also need to protect their forces from CB attack in similar ways. As the method of projecting their protection costs employs some of the same information used to estimate the costs of protecting allied civilians, the costs of defending allied military forces is projected in the endnote after next.

[44] The costs of protecting allied civilians from CB attack should be borne by their governments. These costs would be reduced to the extent that protection of civilians can take advantage of the protection systems already developed for military and civilian use and by the presence of military forces with their CB protection systems, specifically their active defenses, counter-force capabilities, and warning systems. The three main capabilities required to protect regional allies' civilians would be: (1) simplified CB masks adequate to protect civilians who are not required to be as active as military forces, a supply of available medical countermeasures, such as antidotes and simple vaccines, and provisions to provide aid to those who become sick or injured from CB attacks; (2) some modest amount of

Next, the cost for regional allies to protect their military forces from CB attack sufficiently well to allow them to fight with the United States might fall in the neighborhood of $150M per ally. This assumes that a typical regional ally would provide on the order of 25,000 military personnel who would operate within only one area that is not co-located with US forces with their assumed protection.[45]

Finally, some specialized protection capabilities could be needed to protect US civilians. While the small-to-medium states might not have an appreciable capability to strike the United States with CB-armed missiles or aircraft in the foreseeable future, CW, and especially BW attacks by covert agents inserted into the United States are a possibility. Protection against such attacks would

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collective protection to allow for essential government activities, protection of infants, invalids, etc.; and (3) additional active defenses and CB attack warning systems to protect major urban areas that are not protected by their proximity to military operations. A reasonable estimate for acquiring the first category of capabilities would be $50 per person. This could allow $20 for a simplified mask, $20 for antidotes or simple vaccines if they can be made available in a timely manner, and $10 for instruction in the use of these materials and on how to prepare a useful CB shelter in the home. Masks of the needed types and low cost are made by a number of countries, including the United States, Israel, and Finland. For example, see the 5000 Series Respirators made by the 3M Corporation, which have a cost to the US government of less than $13.00 each. The costs for available medicines are based on those for common antibiotics that are useful against a variety of BW agents. To the extent that other types of medical countermeasures are made available, we assume that their development costs are borne by governments, that they are produced in large quantities by modern bio-engineering techniques, and that their acquisition costs are thus low enough for widespread use. Instruction is assumed to be available as a result of preparation made beforehand, and would consist of printed material, TV, and personal instruction through public organizations such as the Red Cross/Crescent. A reasonable acquisition cost estimate for simplified collective protection for civilians is $40 per square foot. This cost is based on the use of "tennis bubble" type shelters equipped with high efficiency air filters, stronger blowers to overcome the greater resistance of the improved filters, and backup electricity generators. If we assume that each protected person is given an average floor space of 25 square feet, then the cost of providing such protection to 10,000 people in a major urban area would be $10M. The third category of protective equipment for civilians is also estimated on a per city basis. Active defenses are assumed to include an Anti-tactical ballistic missile (ATBM) battery, similar to the Patriot upgrade known as PAC-2. The cost for a battery with a radar, associated support equipment, eight launchers, and a total of 64 missiles is approximately $100M. Warning sensors provided to each city would include the equivalent of 3 CB standoff detection systems with an assumed range of 10 km costing $2M each, plus the equivalent of 200 CB point detection systems supporting the scanning of people and traffic flowing in and out of the area. This equipment is assumed to cost $30K for devices to detect CW agents or container fills that might be BW agents, and $1M each for 2 BW detectors to test suspicious container fills. The total cost for detection equipment is thus $18M per city, giving a grand total for this category of approximately $120M per city. PAC-2 missile costs are taken from the *Missile Cost Data Handbook*, Data Research Associates, 1996. The cost for CB detectors are projected from those given in *Joint Service NBC Defense Research, Development and Acquisition Plan*. To complete these calculations, we need to postulate how many civilians and how many extra cities would need to be protected. Approximately20 major allied cities and 100 million civilians are within 1000 miles of Iraq. If this population were to be protected as suggested above, the total cost would be $130 M/city x 20 cities + $50/person x 100M people = $7.6B.

[45] Assuming a nominal regional ally's force includes 25,000 personnel operating within an independent area, the ATBM, collective shelter, and warning and detection systems can be assumed to cost approximately the same as calculated above for a nominal city, i.e. $130M. Based on the information cited in endnote 43, a reasonable cost for protective ensembles and medical preparations would be $1K per capita for a total cost of roughly $25M. This gives a total cost for protecting a nominal regional ally's contribution of military forces of approximately $150M.

require a network of sensors to warn of CB attacks, at least in urban areas. It would also require the kind of individual CB protection prescribed for allies above, collective protection for some small fraction of the population that could not use masks effectively, and instructional materials on how to make effective use of individual CB protection equipment and how to gain some degree of protection by taking shelter at home. Acquiring the means to protect US civilians from CB attacks in this manner would could cost roughly $25 to 35B.[46]

While these costs for protecting military forces and civilians are substantial, the United States and its allies can afford them if they choose. Annual US defense procurement has been $42 to 44B over the last few years. At this spending level, a $30 to 40B acquisition program to defend military personnel against CB attack would amount to 7 to 10 percent of total defense procurement spending over the next ten years. Some of this spending is already programmed into future US defense budgets and the Department of Defense has recently decided to increase spending for counterproliferation programs by $1B over the next five years. Still, as current procurement spending is widely seen as insufficient to support a reasonable rate of force modernization, timely acquisition of effective protection from CB attack for US forces could require some increase in the defense budget or additional reductions in the size of the conventional forces to be maintained. Finally, the $30 to 40B for protection of civilians from CB attack would be a tiny percentage of total US personal income or the size of the government budget, especially if the program was implemented over a period of perhaps five years.

Acquisition of protection for regional allies' forces and civilians is also within their means, though it could require wealthier allies to provide some assistance to their poorer neighbors. For example, acquisition of protection against CB attacks for the states that were US regional allies in the Persian Gulf war would total somewhere in the neighborhood of $10B. If this capability were acquired over a period of five years, it would amount to about 0.7 percent of the total personal incomes of the citizens of those states. Nonetheless, convincing those states to make such expenditures would be a daunting proposition.

Final Comments on Defending Against CB Attacks

This quick sketch of the potential for effective defenses against strategic CB attacks does not begin to capture all the detail involved in making such protection a reality. Among other things, effective CB protection requires an implementing organization, training of a cadre of people to get the CB defense system up and running when needed, stockpiling of special protective materials,

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[46] Protection for US civilians is sized to allow masks and other individual protection materials for 260 million citizens at $50 per capita ($13B), plus collective protection for 5 percent of the population at 25 square feet per person and $40 per square foot ($13B), plus standoff CB sensors at $2M each in numbers sufficient to monitor the most densely populated 100,000 square miles of US territory that contains nearly all the population ($5B). These amounts total $31B. Upgrades of buildings already equipped with air filtering systems, and use of the substantial amount of floor space that is already served with highly filtered air might reduce substantially the need to create additional collective shelter. A reasonable range of total acquisition costs for CB protection of the US population is $25 to 35B.

arrangements for their timely distribution, and arrangements for providing timely warning of attacks to all who might be affected. Moreover, the reach of the CB attack capabilities fielded by potential proliferators could increase to several thousand kilometers, making the numbers of people and the sizes of the areas that might need to be protected from attack by CB-armed missiles or aircraft very large.

Further, achieving high levels of effectiveness would be a difficult task, particularly for civilian CB defenses. Civilians will need to be given a mask that can provide a tight fit and instruction on how to achieve that fit. They will also need instruction on how to interpret warning and all clear signals, and how to cope with the various challenges of staying protected for periods that could extend for many hours.[47]

Still, it appears technically and economically feasible to create CB defenses that could dramatically reduce the pressures for nuclear retaliation, at least for CB attacks made by small-to-medium aggressors whose conventional forces would be no match for those of the allies, even taking the operational burdens of CB protection into account. Specifically, such defenses should eliminate any prospect that such states could use CB weapons to defeat the United States and its allies.[48] Further, such defenses should also reduce the number of casualties expected as a result of very large CB attacks from tens of millions to perhaps hundreds of thousands to a few million.[49] While even

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[47] For some information on the difficulties of achieving good mask fits, see "State Comptroller Faults Gas Mask Distribution." For information on relatively simple techniques by which civilians can achieve good fits, see Warren R. Myers, Majid Jaraiedi, and Lynette Hendricks, "Effectiveness of Fit Check Methods on Half Mask Respirators," *Applied Environmental Hygiene*, 10, no.11 (November 1995). For a summary of some of the difficulties Israel encountered in its CW defense efforts during the Persian Gulf War, see Johnathan Wallis, "Israeli Civil Defense Programs vs. Chemical Warfare: The 1991 Persian Gulf War," IDA informal paper, 16 March 1995.

[48] "NBC Protection," p. 3-8, states that units wearing CB protective gear and masks according to doctrine should suffer no net increase in casualties due to indirect fire of CB munitions by the opponent, but that increased casualties will result from reduced effectiveness in force-on-force battles, and from errors, overheating, and increased psychological stress. It also states that the effects of these factors are difficult to predict without the benefit of combat experience. Still, two possible benchmarks for gauging the risk of direct effects of exposure to CB agents are that: (1) US troops tested as part of their CW training at the Army's Chemical Center and School at Ft. McClellan almost never get poisoned in their live agent decontamination drills, and (2) during WWI production of mustard gas at the main British plant at Avonmouth, approximately 1 percent of the work force got contaminated per day. See Edward M. Spiers, *Chemical Warfare* (Urbana, IL: University of Illinois Press, and Basingstoke: Macmillan, 1986), 27. These two benchmarks suggest that, for well equipped and trained troops, casualty rates of an additional 1 percent per day from contamination with CB agents might be expected. With active defenses, preemptive strikes, the effects of environmental degradation of CB agents, and enough extra personnel to compensate for the extra burdens of CB protection, it should be possible to ensure that the fraction of the force required to operate in an environment significantly contaminated with CB agents at any given time is small. Thus, all things considered, it seems reasonable to conclude that appropriately trained and equipped forces could avoid defeat as a result of an opponent's use of CB. This is not to say that the United States and its allies should simply accept these burdens for any extended time.

[49] Civilians cannot be expected to achieve and maintain the same level of proficiency in using CB protection as military forces. At the same time, with timely warning, most civilians could remain inside sealed rooms or shelters until the threat of CB contamination from an attack had receded to reasonably safe levels. Simply staying indoors and

these lower losses are horrible to contemplate, they are comparable to the losses that states have proven willing to suffer in the past to defend themselves in conventional war.

The burdens of employing such CB defenses in wartime would be substantial, both for civilians who would be forced to interrupt their lives and for forces required to continue fighting. They could prove tolerable, however, particularly if some other form of retaliation could impose commensurate burdens—and punishment—on the aggressor. In fact, if reasonably effective CB defenses existed, they would open up the possibility that conventional retaliation for CB attacks could prove adequate.

Finally, to the extent that an aggressor credits the United States and its allies with effective defenses against CB attacks, it should see such attacks as less likely to improve its situation, although still as risking commensurate or stronger retaliation. Thus, the combination of CB defenses and the prospect of strong retaliation could work together to tip the aggressor's decision against making CB attacks in the first place.

Conventional Retaliation for CB Attacks

There also would not be much of a case for retaliating with nuclear weapons for CB attacks if conventional retaliation alone could still make the opponent far worse off than if it had not used CB weapons. In order to guarantee this, two conditions would have to be met. First, US and allied conventional forces would have to remain able to fulfill at least the original goals they had declared for themselves in confronting the aggressor, and to do so on roughly the original time table. Second, the costs to the opponent of its aggression would have to be seen to increase substantially as a result of its use of CB weapons.

Clearly, if the opponent's use of CB had crippled the conventional forces that the United States and its allies had been able to bring to bear, the first condition could not be met. Thus, these forces must be protected sufficiently well to prevent CB attacks from substantially delaying their campaign or compromising its goals. This would require very effective CB defenses of the kinds described above.

Guaranteeing that the aggressor would be substantially worse off for having used CB weapons could be done in a number of ways. In all cases, the United States and its allies would need to expand and intensify their military actions beyond what had already been planned or underway.

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masked would provide a high level of protection. A reasonable estimate might be that 2 to 5 percent of civilians with such protection available would not use it effectively. Thus, the 20 million casualties postulated above for a BW attack against and unprotected population would be reduced to casualties of 400,000 to 1 million given only the kinds of passive protection described.

Three alternative objectives the United States and its allies might logically set for their conventional forces are discussed below.

Defeating, Disarming, and Reforming the CB User

Probably the most satisfactory expansion of US/allied war goals would be to commit to defeating, disarming, and reforming the aggressor, assuming that this had not already been a declared goal. This goal would be consistent with a judgment by the United States and its allies that no government that had demonstrated a willingness to employ CB for aggression should be allowed to survive.[50] The costs of meeting such a goal would likely be higher than those of merely restoring the status quo ante prevailing before the aggression.

Meeting such a comprehensive goal against small-to-medium sized aggressors should be feasible, however, provided that the United States and its allies had protected both their forces and their civilians reasonably well from CB attacks, and had sufficient forces available to prevail despite the extra burdens of those defenses. Protection of civilians would be important to guard against the possibility that the opponent would launch a final spasm of CB attacks as it saw the end coming and tried to stave off defeat or, judging it had nothing left to lose, sought to avenge its coming end. As indicated above, even with good CB protection, civilian casualties from such attacks could be very high.

While it may be difficult to judge with peacetime mind-sets how the possible costs of totally defeating the opponent would be weighed, history suggests that the United States and its allies would be willing to chance such costs. At least one powerful example is provided by allied decision making in World War II. When the allies chose unconditional surrender rather than offering a negotiated settlement, they knew that several million additional casualties would be the cost of achieving it. They also knew they could not live in peace with governments that had imposed such massive destruction on them.

Direct Destruction of the CB User's Leadership

An alternative expansion of US/allied war goals would be a direct effort to destroy the aggressor state's leader and his or her regime, again presuming this had not already been a clear goal of the United States and its partners. As these officials can be expected to have taken great care to hide themselves from US and allied intelligence, and could be difficult to kill even if their locations were known, achieving this goal might be very difficult.[51]

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[50] In the 1990–91 Persian Gulf War, Iraq did not demonstrate a willingness to use or even to threaten to use CB weapons against the alliance, though it had such weapons capable of reaching allied forces and cities. While the alliance was not willing to see Iraq totally defeated, it did require Iraq to agree to give up its NBC weapons programs.

[51] For example, the opponent's leaders could be located in very deep, hardened bunkers with entrances shadowed by terrain in such a way as to make attack with aircraft or missiles impossible, or the shelter could have within it the capability to clear bombed entrances.

Given its potentially high value, however, a capability for this expansion should be pursued nonetheless. One can imagine intelligence coups of the kinds that might allow such attacks. For example, the recruiting of a highly placed agent or the interception of a leader's communications might allow him or her to be precisely located. In addition, the capabilities of conventional munitions to destroy hardened shelters where leaders might try to hide are improving.[52]

Note that circumstances could arise in which the targeted leaders were known to be in some small number of shelters that were so well hardened as to be impervious to conventional attack, but were vulnerable to attack with low-yield, earth-penetrating nuclear weapons. This could also be true of key components of the aggressor's CB capabilities. Should such a situation arise, the argument for making such a limited use of one or a very few nuclear weapons could seem very persuasive, particularly if US and allied leaders were confident that collateral damage would be very small.

Defenses against CB attacks for both allied forces and civilians would be important for this option, as well. While destruction of an aggressor's leaders could end any prospect of further use of CB, successors might try to pursue their predecessors' policies. Alternatively, die-hard supporters might have been left with instructions to seek revenge with further CB attacks. For example, Saddam Hussein is reported to have pre-delegated the authority to retaliate with CB-armed missiles in the event that Baghdad was attacked with nuclear weapons during the 1990–91 Persian Gulf War.[53]

Commensurate Punishment

The third type of expanded war goal would be to punish the aggressor by destroying targets that were valued very highly, and which had not previously been the focus of allied attacks. The principle of letting the punishment fit the crime would suggest selecting targets similar to those that the opponent had attacked with CB weapons. If the opponent had been careful to restrict CB attacks to military targets whose counterparts were already being heavily attacked by allied conventional forces, other types of targets might have to be selected.

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[52] US conventional capabilities for destroying hard targets are being improved as part of two Advanced Concept Technology Demonstrations within the Department of Defense Counterproliferation Program. See *Report on Activities and Programs for Countering Proliferation and NBC Terrorism*. See also, "The Threats Go Deep," Address to the Defense Writers Group in Washington by Maj. Gen. Gary L. Curtin and George W. Ullrich, director and deputy director, respectively, of the Defense Special Weapons Agency, Air Force Magazine, October 1997; and George I. Seffers, "ATACMS Gets Mission To Be Bunker Buster," *Defense News* 12, no. 40 (6–12 October 1997).

[53] Certain documentation supports the contention that Iraq was actively planning and had actually deployed its chemical weapons in a pattern corresponding to strategic and offensive use through surprise attack against perceived enemies. The known pattern of long range missiles (Al Hussein) supports this contention. Iraq stated during visits of both the Chairman and the Deputy Chairman [of the United Nations Special Commission], that authority to launch biological and chemical warheads was pre-delegated in the event that Baghdad was hit by nuclear weapons during the Gulf War. See "Report by the Executive Chairman of the [United Nations] Special Commission [S/1995/864]" submitted to the United Nations Security Council on 11 October 1995, paragraph 28.

The United States and its allies would measure the results of the aggressor's CB attacks first and foremost by the number of people that had been killed. Many of the casualties could be civilians, even if the aggressor had aimed its CB attacks at military or military-related targets. As argued above, CB attacks aimed at key infrastructure targets, such as sea- or airports, or at allied forces, which in many cases would be located near cities, could lead to enormous numbers of civilian fatalities. Attacks directly aimed at concentrations of civilians would lead to even greater losses.

To the extent that an aggressor's CB attacks had led to large numbers of civilian fatalities, and particularly if it were clear that this had been the opponent's purpose in using CB weapons, attacking the aggressor state's civilians in response could seem most appropriate. In the event of such CB attacks, could allied conventional forces be expected to be capable of destroying as many or more of the aggressor's civilians?

Once again, the existence of CB defenses would be key. As indicated earlier, if allied civilians had been left unprotected, BW attacks against them could lead readily to tens of millions of civilian casualties. In such a case, commensurate retaliation by means of direct attacks on the opponent's civilians with conventional forces of the sizes the United States and its allies are planning to maintain could take weeks to months, even if unopposed.

On the other hand, if allied civilians were well protected, casualties from CB attacks directed against them could be on the order of hundreds of thousands to perhaps several million. While even these lower numbers are terrible to contemplate, allied conventional forces could be expected to be capable of visiting commensurate damage on the opponent's population within a few days, if largely unopposed.[54]

Even with CB defenses, the allies would need a substantial air power advantage to carry out such a strategy. Allied aircraft would need to be able to survive the aggressor's air defenses well enough to allow the multiple missions that might be needed to inflict damage commensurate with the several million fatalities the aggressor might have caused. More generally, the overall military balance of power would have to favor the alliance enough to allow diversion of the air power needed for the retaliatory action without jeopardizing the success of the allies' conventional military campaign. The need for such an advantage suggests that this kind of retaliatory expansion of the war might only be practical against small-to-medium aggressor states, and then only when the allies had reasonably effective CB defenses.

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[54] The Department of Defense is adding guidance systems to existing general purpose bombs. This modification, employing a combination of inertial guidance and global positioning systems, will allow a single guided bomb to totally destroy a large multistory building with high probability. Using such weapons, and assuming typical urban population distributions, conventional retaliatory attacks with approximately 50 B-52 sorties attacking large buildings with 2000 lb. bombs or approximately 40 B-1 sorties attacking smaller buildings with 500 lb. bombs could cause 600,000 fatalities. Larger numbers of aircraft could be employed and such attacks could be carried on for several days if necessary.

Indirect means might also be available for retaliating with conventional forces in commensurate terms for the aggressor's destruction of allied civilians with CB weapons. General Colin Powell, then Chairman of the Joint Chiefs of Staff, considered the possibility of bombing the dams on Iraq's major rivers as a potential response to Iraqi use of CB weapons during Desert Storm.[55] The likely result would have been enormous destruction and loss of life in Iraqi cities downstream.

Comparing Alternatives for Conventional Retaliation

These three alternative forms of conventional retaliation for an aggressor's CB attacks compare in interesting ways. The first—defeating, disarming, and reforming an aggressor that had used CB—seems the most effective choice for the long term. It would be felt as a threat by every supporter of the aggressor's regime. While potentially the most costly to carry out, this option would minimize the potential that the state in question would ever repeat such an offense.

The second alternative—killing the aggressor's highest leaders—seems the quickest, cheapest, and most just, if it were feasible. The damage done would be most directly focused on those responsible for the aggression and the use of CB. If successful, it could short-circuit the need to complete an expensive military campaign against the aggressor.

The third alternative—commensurate retaliation against civilians—seems the least desirable. The targeted civilians might bear little direct responsibility for the CB attacks that motivated their destruction. While allied military forces would likely follow orders to carry out such attacks, they might find such operations profoundly disturbing in the long run, as could the US and allied general populations. The threat of commensurate damage could play an important role in backing up the other two forms of conventional retaliation, however. It might deter an opponent from lashing out with CB attacks in response to direct attacks against its leaders, or in an attempt to stave off or avenge an approaching total conventional defeat.

All three alternatives for conventional retaliation call for strong CB defenses for the United States and its allies. The first and third would not likely prove feasible unless the United States and its allies also had a very strong conventional military advantage, which is to say, it might not be useable against a great power military competitor armed with CB. With regard to the second alternative, success might be doubtful absent a dramatic intelligence coup.

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[55] On "PBS Frontline: The Gulf War," aired 9–10 Jan. 1996, General Powell said "one of the things we actually kicked around was knocking off the dams on the Tigris and Euphrates Rivers, which would have caused enormous destruction downstream. I'm not sure that's one we ever would have done because the loss of civilian life would have been terrible and we had not thoroughly analyzed [it]. We knew how to hit the dams but I don't know if we really analyzed what the effect downstream would have been. But, nevertheless, it would have been a good one to threaten the Iraqis with. And, of course, there was always the implicit threat of nuclear weapons. I don't think we ever would have used them but, nevertheless, the Iraqis didn't know that and we could have if the provocation was serious." Note that General Powell is supporting the contention presented earlier in this paper that devastating CB use could have reopened the issue of retaliation with nuclear weapons.

A Composite Strategy for Minimizing US Dependence on Nuclear Retaliation to Deter CB Attacks

It seems clear that by adopting a composite strategy that combines all five of the alternatives to nuclear deterrence that have been discussed here, the United States can reduce far below current levels its dependence on nuclear retaliation to deter CB attacks. For the foreseeable future, none of these alternatives seems likely to be a complete solution to the threat of CB weapons in warfare. On the other hand, each alternative offers unique benefits. Collectively, they could sharply reduce the potential threats posed by CB weapons in warfare and, thereby, pressures to retaliate with nuclear weapons for use of CB weapons, and to make such threats an explicit part of US policy.

CB defenses are needed to limit the damage that can be done to the United States and its allies by CB weapons. In addition to its obvious and immediate benefit, damage limiting also would: (1) reduce the amount of damage that might be seen as necessary retaliation, (2) preserve the efficacy of the conventional forces needed to retaliate, (3) reduce the potential damage from follow-on CB attacks that the aggressor might hope would deter the alliance from retaliating, and (4) shorten the time needed for completion of the more extended forms of conventional retaliation that the alliance might choose.

The three forms of conventional retaliation each offer unique and useful deterrent roles. Collectively, they could be applied to a wider range of potential future CB threat scenarios and, in particular, to a wider range of potential aggressor and alliance mind-sets than any one of them standing alone.

The prospect of effective CB arms control also appears to be unique and important. As argued above, reliable and comprehensive CB bans seem unlikely for the foreseeable future. With strong CB defenses and conventional retaliatory options, however, the risks can be tolerable, even if cooperative measures cannot prevent some small-to-medium states from having CB capabilities. On the other hand, since defenses and the threat of conventional retaliation may not be sufficient for deterring use of CB weapons by the great powers, the latter must be included in a reliable CB ban, if the United States is to undermine the pressures for nuclear retaliation to all large-scale CB use.

Achieving effective CB arms control among the nuclear powers seems likely to be considerably easier than achieving it universally, for several reasons. Perhaps the most important reason is that the nuclear states are the ones that should see the least value in owning CB weapons, as they already have effective strategic deterrent forces. Second, and closely related, whatever needs the declared nuclear powers may see for stabilizing relationships among themselves with the threat of devastating retaliation can be met solely with nuclear weapons. Third, emphasizing CB arms control for the nuclear states means far fewer states need agree to the intrusive measures required. Finally, the declared nuclear powers generally support the status quo and would benefit if adoption of this composite strategy were to help discourage troublesome military challenges to the world order.

Note that the composite strategy would still have substantial value even if effective CB arms control among the nuclear powers were to prove impossible. In this case, the CB defense and conventional retaliation components would still mean that the United States and its allies need not threaten the non-nuclear states with nuclear retaliation for CB attacks. Nuclear retaliation might seem appropriate in the event of CB attacks by a nuclear-armed state, but for them would not be inconsistent with the US negative assurances policy.

Conclusions

The preceding analysis strongly suggests that the United States should adopt the composite counter-CB strategy described above. This strategy, combining reliable CB arms control at least among the nuclear powers, strong defenses against CB attacks by non-nuclear aggressors, and powerful conventional retaliatory options, could dramatically reduce the prospects that CB attacks against US forces and regional allies would ever be resorted to in wartime, or, if they were, that they would generate overwhelming pressures on US leaders to retaliate with nuclear weapons.

A composite strategy made up of these five components would be consistent with a world order in which peace and stability among the nuclear powers is underwritten by their conventional forces, plus at most "low salience" nuclear deterrence that is not directed at the non-nuclear powers. Its adoption would reflect the establishment of conditions in which non-nuclear responses to CB attacks made by non-nuclear powers would seem much more likely than they do currently. In other words, it could make the current US nuclear negative assurances policy a reasonably safe prediction of US behavior rather than an aspiration as it appears to be now.

Implementing such a strategy would be difficult. Clearly, in aggregate, it is far more complex than a strategy of nuclear deterrence for CB attacks. Nuclear deterrence involves clearly communicating to the prospective CB user that the United States has the capability and the will to make the modest number of nuclear strikes required to do at least commensurate damage to the aggressor. The composite strategy involves making all of its components work reasonably well, components that each seem substantially more involved than nuclear deterrence. Further, whereas capabilities for nuclear retaliation already exist, some difficult parts of the composite strategy must be created. Finally, nuclear threats can inspire far greater fear than the conventional threats envisioned as part of the composite strategy. Nuclear threats imply annihilation of the CB user's regime, its military, its industry, and even its society. In contrast, nations have survived conventional attacks and defeat many times in history.

Implementation of the composite deterrent strategy would take many years. Some difficult technical problems remain to be solved, such as developing BW detectors that can be effective over wide areas in the presence of other types of air pollution. In addition, while the cost to implement such a composite strategy would be comparable to those of other major defense programs, finding

the funds for it will still be very difficult, particularly as acquisition begins for some of the more costly components, such as theater missile defenses.

The advantages of a composite conventional strategy of this kind nevertheless seem compelling for at least five reasons.

First, and foremost, the CB defense component implies less damage for both sides if an aggressor were to use CB weapons against the United States and its allies. Arranging to defend our vital interests with minimum potential destruction all around seems a moral imperative.

Second, reasonably effective CB defense could enable the best conventional response to CB use by a small-to-medium state: defeat, disarmament, and reform of the offender.

Third, while renegade states seem likely to understand that CB use against the United States and its allies could lead to punishment that they would never choose to bring down on themselves, nuclear deterrence of CB use by renegade states may be significantly more likely to fail than nuclear deterrence among the nuclear powers. Differences in cultures and especially in styles of communication, differences in perspectives on how the ambitions of states armed with CB deserve to be accommodated, and less experience with renegade states solving disputes through diplomacy could lead to angry words and mistaken decisions to test the resolve of the United States and its allies. To the extent that deterrence of CB use seems more likely to fail with such states, the goal should be to ensure that it fails in the least damaging way possible, which points to the need for CB defenses.

Fourth, to the extent that a composite conventional CB deterrent strategy eliminates any need to consider nuclear retaliation for CB attacks, it helps to minimize the necessary role for nuclear weapons in US strategy. This is stated US grand policy. Less dependence on nuclear weapons strengthens US arguments against nuclear proliferation and increases moral pressures on the other nuclear states to minimize their own dependence. Less dependence on nuclear weapons also means a reduced range of circumstances where US concerns that it might be forced into nuclear retaliation might weigh against taking responsible military action.

Finally, effective implementation of this kind of composite strategy could help to open the possibility that nuclear weapons might someday be eliminated. It would obviate the need to retain nuclear weapons to deter CB attacks by the non-nuclear powers. Moreover, the prospective elimination through arms control of the CB capabilities of the nuclear powers is tightly linked to the prospects for eliminating nuclear weapons as well. At a minimum, reliable elimination of CB will require the kind of cooperation needed to eventually eliminate nuclear weapons. At a maximum, future decisions by the great powers that they no longer need to deter each other with nuclear weapons seem likely to imply that they will not see a need to deter each other with CB weapons either.