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DEFENDING AMERICA

REDEFINING THE CONCEPTUAL BORDERS OF HOMELAND DEFENSE

TERRORISM, ASYMMETRIC WARFARE AND CHEMICAL WEAPONS

Final Draft

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The following report is an excerpt from the final draft of a book on Homeland Defense being prepared as part of the CSIS Homeland Defense project. A substantially revised version will be published as a Praeger book later in 2001.

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Chemical Weapons as Means of Attack

Chemical weapons have not been used effectively in attacks on the American homeland. Reports that the bombers of the World Trade Center considered trying to add a chemical weapon like sodium cyanide to their explosives seem to be untrue, and led to an unsubstantiated assertion by the trial judge.[1] There have, however, been a number of attempts to use chemical weapons by domestic extremists and individuals. For example, in 1997, members of the KKK plotted to place an improvised explosive device on a hydrogen sulfide tank at a refinery near Dallas, Texas.[2] There is a well-established, low-level risk that such weapons will be used in the future, although there is no way to predict the frequency of such attacks, their scale, potential success, or lethality.

There are a wide range of countries involved in the development of chemical weapons. Table 4.3 provides a recent unclassified US intelligence summary chemical weapons activities by nation. It is only a partial list. The US intelligence community is tracking a total of approximately 25 nations which are believed to be carrying out some form of state-sponsored chemical and/or biological weapons development. As has been discussed earlier, at least two foreign terrorist groups are also believed to have active chemical and biological weapons efforts/

Effective planning for Homeland defense must consider the fact that the US currently has limited ability to properly characterize the impact of chemical weapons in any form of attack. Many terrorist uses of chemical weapons will not be inherently more lethal or more painful than the use of explosives. At the same time, it must consider the risk that chemical attacks can produce much larger levels of damage than nominal lethality estimates indicate and virtually any use of such weapons will have a far different psychological impact. Chemical weapons are weapons of terror and intimidation as well as a means of producing casualties and physical destruction.

The Impact and Variety of Possible Chemical Weapons

Experts like the Center for Disease Control have found that the US may faces a wide range of threats from different types of chemical weapons and toxic agents, many of which are not normally considered to be weapons. A CDC study notes that the chemical agents that might be used by terrorists range from sophisticated military agents to toxic chemicals commonly used in industry. The criteria the CDC suggested for determining priority chemical agents include:[3]

- chemical agents already known to be used as weaponry;
- availability of chemical agents to potential terrorists;
- chemical agents likely to cause major morbidity or mortality;
- potential of agents for causing public panic and social disruption; and
- agents that require special action for public health preparedness.

The CDC lists several categories of chemical agents as presenting enough of a threat to require active public health planning. These include nerve agents, such as tabun (ethyl N,N-dimethylphosphoramidocyanidate), Sarin (isopropyl methylphosphanofluoridate), soman (pinacolyl methyl phosphonofluoridate), GF (cyclohexylmethylphosphonofluoridate), and VX (o-ethyl-[S]-[2-diisopropylaminoethyl]-methylphosphonothiolate). They include blood agents such as hydrogen cyanide and cyanogen chloride; and blister agents such as lewisite (an aliphatic arsenic compound, 2-chlorovinyldichloroarsine), nitrogen and sulfur mustards, and phosgene oxime. And, they include pulmonary agents like phosgene, chlorine, and vinyl chloride; and incapacitating agents like BZ (3-quinuclidinyl benzilate);

Other agents on the CDC's list are more commercial in character. They include heavy metals like arsenic, lead, and mercury; and volatile toxins like benzene, chloroform, and trihalomethanes. Other agents include explosive nitro compounds and oxidizers, such as ammonium nitrate combined with fuel oil. They include pulmonary agents like phosgene, chlorine, and vinyl chloride; persistent and nonpersistent pesticides; and dioxins, furans, and polychlorinated biphenyls (PCBs). They include flammable industrial gases and liquids like gasoline, propane; and poison industrial gases, liquids, and solids, like the cyanides, and nitriles. Finally, they include corrosive industrial acids and bases like nitric and sulfuric acid.

Many of the items the CDC list are widely available on the US market and include commercial organo-phospates and parathion, and the military lists of possible agents is much longer and includes additional toxic smokes, herbicides, flame materials, and toxic industrial compounds[4]. As a result, it is hardly surprising that CDC studies also note that there was no way to predict precisely what chemicals might be used, particularly in low level attacks.

This creates major problems for response planning: "Because of the hundreds of new chemicals introduced internationally each month, treating exposed persons by clinical syndrome rather than by specific agent is more useful for public health planning and emergency medical response purposes. Public health agencies and first responders must render the most aggressive, timely, and clinically relevant treatment possible by using treatment modalities based on syndromic categories (e.g., burns and trauma, cardiorespiratory failure, neurologic damage, and shock). These activities must be linked with authorities responsible for environmental sampling and decontamination."

The Probable Lethality and Effectiveness of Chemical Attacks

Just as it is easy to underestimate the importance of conventional explosives, it is easy to exaggerate the lethality of most chemical weapons. Many forms of lower level attacks using chemical weapons might do no more or less damage than attacks using conventional weapons. For example, the World Trade Center bombing killed six and injured over 1,000, and could easily have killed hundreds if the bomb had been better placed.[5] Large high explosive weapons can easily be equal to both chemical and radiological weapons as "weapons of mass destruction."

It is also an illusion that the effects of chemical weapons are always radically worse or more repellant than the damage done conventional weapons. No one who has actually visited a battlefield and seen anyone with a fragmentation wound in the stomach and then seen a prisoner affected by a moderate dose of mustard gas is going to accept for a second that one casualty is somehow worse than another.[6]

The characteristics of a representative range of chemical weapons are summarized in

Parts One to Three of Chart 4.1, along with a rough comparison of their lethality to the lethality of a 1,000-pound bomb. It should again be noted that the relatively high lethality estimates the are based upon questionable military literature, and that there has been little historical correlation between such theoretical lethality models and real-world casualties.[7]

While there are good models as well as bad ones, much of the military effects data on chemical weapons in the unclassified literature is based on theoretical models whose inherent validity is suspect, and which do not track with either the historical data on the use of chemical weapons in World War I or Iraq's use of chemical weapons in the Iran-Iraq War. There are also extremely sharp variations in such estimates. Some estimates give nerve gas attacks near-nuclear lethalities, while others indicate that the effects could be highly localized and produce random concentrations with much more limited numbers of deaths.[8]

In many cases, the results of limited animal testing is generalized on tenuous grounds. The lethality data are then scaled-up using models of how weaponized chemical vapors are deposited. Some of these models ignore temperature, wind, and heat conditions and assume optimal scattering of the vapor evenly over large areas. These same problems affect the modeling of the lethality of biological and nuclear weapons as well as chemical weapons, but the higher estimates of lethality in chemical weapons effects modeling seem uniquely exaggerated. This is particularly true when the input data are drawn from unclassified estimates that are ultimately drawn from Soviet literature on missile warhead behavior, some of which seems to be little more than analytic nonsense.

The December 15, 1999 report of the Advisory Panel to Assess Domestic Response Capabilities for Terrorism Involving Weapons of Mass Destruction, also known as the Gilmore Commission, provides what seems to be a more accurate picture of the probably lethality of chemical attacks on the US homeland,[9]

> …developing a means to disseminate sarin effectively is likely to prove a far greater challenge to terrorists than is producing the agent itself. Although sarin's high volatility greatly simplifies weaponization, terrorists who may seek to cause mass casualties will need a fairly sophisticated means of spreading the agent in sufficiently large quantities over their intended target area. For wide coverage in an open area,

> such as a city, an airplane equipped with a suitable industrial or crop sprayer could be a satisfactory mechanism for dissemination. Alternatively, terrorists could equip a truck and drive through the target area, taking care, of course, to ensure that its passengers are properly sealed off from the chemical agent. Temperature, wind speed, inversion conditions, and other meteorological factors, however, would likely determine the effectiveness of any attack. For example, as sarin and other chemical agents are exposed to the environment, they tend to be dispersed by the wind, which necessitates the use of large amounts of material to ensure that a given target receives a sufficiently high dose. In fact, the need to produce and disperse sufficiently large amounts of sarin or other chemical agents to achieve the mass-casualty levels that may be sought by terrorists arguably drawn to chemical weapons in the first place ironically may be the biggest disincentive for their use.
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> A U.S. Defense Department model illustrates the problem. Releasing ten kilograms (22 pounds) of sarin into the open air under favorable weather conditions covers about one-hundredth of a square kilometer with lethal effects. Since population densities in U.S. urban areas are typically around 5,000 people per square kilometer, such an attack would kill about 50 people.
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> Releasing 100 kilograms (220 pounds) of sarin into the open air affects about ten times as much area and therefore would kill approximately 500 people. Releasing 1,000 kilograms (2,200 pounds) into the open air would cover several square kilometers, killing about 10,000 people. Thus, only in an open-air attack using amounts approaching 1,000 kilograms of sarin would the effects become distinctly greater than that attainable by such traditional terrorist means as conventional explosives. One way for terrorists to overcome these problems would be to carry out an attack in an enclosed space, such as a domed stadium, office building, or subway system.

The effectiveness data used by the US Army also are relatively conservative, and are summarized in Part Two of Table 4.4. Once again, however, such data are highly nominal and provide only a tenuous basis for predicting casualty effects. The same is true of a potential sabotage or terrorist release of toxic chemicals of the kind shown in Part Three of Table 4.4. Only nominal area of evacuation -- not lethality -- data are available.

These caveats in no way mean that chemical attacks cannot be highly lethal under some circumstances. In 1984, for example an incident took place in Bhopal, India, where a disgruntled employee at a pesticide plant precipitated an explosion in one of the storage tanks by adding water to it. This led to the massive release of methylisocyanate and the noxious fumes affected thousands of people living near the plant. Four months later, some 1,430 persons were reported to have died as a direct result of the leak—a figure that increased to the 3,800 reported by Indian officials seven years later. A total of 11,000 persons were disabled or harmed from exposure to the gas. This one case was serious enough to lead to laws that require public reporting on all similar industrial risks in the US.

Military estimates of lethality also generally assume prompt medical action and some assume rapid decontamination or evacuation of the area. Response can fail or be ineffective if it is not properly organized. Chemical weapons can have lingering effects as poisons, and act as contact or food poisons for days after they cease to be effective as mass agents. BVX, HD, HN, L, and HL are all persistent agents that can remain lethal for weeks.[10] Effective and timely decontamination could well be impossible. Casualty recognition can be difficult with some weapons, where there is either a psychomimetic agent or a quiescent period in terms of symptoms. In some cases, the use of antidotes like Atropine could create medical problems of their own. In others, severe exposure can require up to a week of intensive treatment for nerve gas, and months to years for inhaled blistering agents.[11]

Nevertheless, past estimates of chemical weapon lethality have borne little relation to either the actual lethality achieved in combat or the area actually covered with a given amount of agent. After more than five years of using chemical weapons for example, the Iraqis still found that even nerve gas was often more useful in area denial, forcing rapid withdrawals, or in creating panic than as a killing mechanism per se.[12] The tendency to estimate lethality in terms of neat wind-borne ellipses or “plumes” has also confused the lethality issue. Under most real world conditions, it is likely that small chemical weapons would have very limited areas of lethality, and that wide area coverage would require far larger amounts of agent than are likely to be feasible in state covert, proxy, terrorist, or extremist attacks on the US homeland.

One “wild card**”** that might change this situation is the potential existence of “fourth generation” chemical weapons. According to some reports, Russia developed far more lethal chemical weapons during the Cold War and brought them to production readiness. At least some experts believe that it is possible that far more lethal chemical weapons exist than are listed in unclassified studies. One thing is clear. It is possible to produce chemical weapons with the lethality of the nerve gases using precursors that are not controlled by the Chemical Weapons Convention, and there are intelligence indicators that some countries are developing such weapons or have produced them.

Methods of Delivery

Most chemical weapons are not easy to handle or deliver, and even nerve gas has to be used in large amounts to achieve high levels of coverage and lethality. Obtaining suitable delivery systems can be a real problem, although covert attacks can be conducted from fixed locations in an urban area, and suitable dual-use delivery systems are readily available in the form of crop duster aircraft and simple spray generators that can be readily adapted for delivery of a variety of agents.

At the same time, the quantities of chemical agent required to conduct low level attacks are relatively small when compared to industrial production of similar commercial chemicals, which poses problems for detection. Terrorists could employ same amounts of CW agents in a variety of means utilizing simple containers such as glass bottles**.** The lethality of any given chemical weapon would also increase strikingly if it was used in a closed environment like an office building with a forced air system, or disseminated under ideal conditions in an urban environment.

Lethality may also be only one consideration in choosing the means of delivery for a covert or chemical terrorist attack. Much would depend on the perceptions of the attacker of the full range of post-attack impacts of using a chemical weapon. It is far from clear, for example, that civilians would ever accept a building as safe where persistent chemical agents had been used, regardless of the success of contamination efforts. Gulf War syndrome and Agent Orange are one thing in the context of US military serving over seas; chemical attacks are quite another in the context of civilians living in America.

As is the case of virtually all forms of attack on the American homeland, the psychological and political impact of a given strike would also be as important as the resulting physical damage or body count. An attack on the US Capitol building with minor casualties would have far more symbolic and political impact that a high-casualty attack on a hotel. Attacks on targets with high media profiles and live new coverage can be important almost regardless of their effectiveness. The visible physical symptoms of chemical weapons, their horrifying reputation, and their alien nature will be a critical "effect," although many forms of fragmentation wounds cause at least as much suffering in practice.

Detection and Interception

Chemical weapons can impose serious problems in terms of detection. The flow of people and goods across the Canadian, Mexican, Alaskan, and Hawaiian borders, and the East and West Coast, is so intense that it is unclear that any detection system would find the amounts used in covert, proxy, and extremist/terrorist attacks – even assuming that truly cost-effective and reliable detection devices become readily available and could cover binary or trinary ingredients. Even if reliable, low cost detectors and detection systems do become readily available – as some experts assume – this does not mean that they will be able to cover enough areas and means of shipping to cope with the volume of commercial shipping into the US, and provide a reliable method of detection and defense. Any gaps in coverage are likely to be openly documented, and the details of US detection systems are likely to become part of the open literature – giving foreign attackers much of the information they need.

The domestic production of weapons will probably only be detectable by receiving a warning through human intelligence, or tracing the flow of key equipment and ingredients which may legally and physically impossible. Once a weapon is actually used, detection may also be too late. This would certainly be true in the case of an attack exploiting a closed air system, and might well be true of a modified drone or crop sprayer. Even if an antidote or safe area is available, it is unclear that anyone would have the time and capacity to react to a first use, or that defense would be affordable.

The problems in developing effective interception, defense, and response measures can be compounded by using more than one group of attackers, and by mixing agents that require different kinds of protection and decontamination. They can be compounded by the use of persistent agents, near simultaneous attacks in a number of areas, and sequential attacks designed to target those who respond to initial attacks. Furthermore, it is far from clear whether the detection and sensor systems necessary to cover entire urban areas, and provide detection and characterization of an attack, will be cost-effective.

Acquiring Chemical Weapons

Many experts believe that most terrorists will find it difficult would be to obtain the necessary chemical weapons, in the necessary amounts, and develop an effective delivery system or device.[13] Acquiring chemical weapons would not be a problem for most governments, but the ease with which most domestic or foreign terrorists can obtain or manufacture such weapons has sometimes been exaggerated. The December 1999 report by the Advisory Panel to Assess Domestic Response Capabilities for Terrorism Involving Weapons of Mass Destruction makes the following points:[14]

> It has sometimes been claimed that producing Sarin and other nerve agents is a relatively easy process, to the extent, according to one authority, that "ball-point pen ink is only one chemical step removed." While Sarin may be less complicated to synthesize than other nerve agents, the expertise required to produce it should not, however, be underestimated. The safety challenges involved would, at a minimum, require skill, training, and special equipment to overcome. For this reason, the level of competency required for producing sophisticated chemical nerve agents, including Sarin, will likely be on the order of a graduate degree in organic chemistry and/or actual experience as an organic chemist—not simply a knowledge of college-level chemistry, as is sometimes alleged.
>
> Moreover, as with biological weapons, developing a means to disseminate Sarin effectively is likely to prove a far greater challenge to terrorists than is producing the agent itself. Although sarin's high volatility greatly simplifies weaponization, terrorists who may seek to cause mass casualties will need a fairly sophisticated means of spreading the agent in sufficiently large quantities over their intended target area. For wide coverage in an open area, such as a city, an airplane equipped with a suitable industrial or crop sprayer could be a satisfactory mechanism for dissemination.
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> Alternatively, terrorists could equip a truck and drive through the target area, taking care, of course, to ensure that its passengers are properly sealed off from the chemical agent. Temperature, wind speed, inversion conditions, and other meteorological factors, however, would likely determine the effectiveness of any attack. For example, as Sarin and other chemical agents are exposed to the environment, they tend to be dispersed by the wind, which necessitates the use of large amounts of material to ensure that a given target receives a sufficiently high dose.
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> In fact, the need to produce and disperse sufficiently large amounts of Sarin or other chemical agents to achieve the mass-casualty levels that may be sought by terrorists arguably drawn to chemical weapons in the first place ironically may be the biggest disincentive for their use. A U.S. Defense Department model illustrates the problem. Releasing ten kilograms (22 pounds) of Sarin into the open air under favorable weather conditions covers about one-hundredth of a square kilometer with lethal effects. Since population densities in U.S. urban areas are typically around 5,000 people per square kilometer, such an attack would

kill about 50 people.

Releasing 100 kilograms (220 pounds) of Sarin into the open air affects about ten times as much area and therefore would kill approximately 500 people.[15] Releasing 1,000 kilograms (2,200 pounds) into the open air would cover several square kilometers, killing about 10,000 people. Thus, only in an open-air attack using amounts approaching 1,000 kilograms of Sarin would the effects become distinctly greater than that attainable by such traditional terrorist means as conventional explosives. One way for terrorists to overcome these problems would be to carry out an attack in an enclosed space, such as a domed stadium, office building, or subway system.

A similar GAO analysis of the ease with which attackers could obtain chemical weapons found that,[16]

Experts from the scientific, intelligence, and law enforcement communities we spoke with agreed that toxic industrial chemicals can cause mass casualties and require little if any expertise or sophisticated methods. Generally, toxic industrial chemicals can be bought on the commercial market or stolen, thus avoiding the need to manufacture them. Chlorine, phosgene, and hydrogen cyanide are examples of toxic industrial chemicals. DOD classified further details concerning the use of toxic industrial chemicals.

Experts believe that unlike toxic industrial chemicals, for various reasons, most G and V chemical nerve agents are technically challenging for terrorists to acquire, manufacture, and produce. Examples of the G-series nerve agents are tabun (GA), Sarin (GB), and soman (GD). VX is an example of a V- series nerve agent. According to chemical experts, developing nerve agents requires synthesis of multiple precursor chemicals. On the basis of our review of a technical report, 11 we concluded that some steps in the production process are difficult and hazardous. Although tabun production is relatively easy, containment of a highly toxic gas (hydrogen cyanide) is a technical challenge. Production of Sarin, soman, and VX requires the use of high temperatures and generates corrosive and dangerous by- products. Moreover, careful temperature control, cooling of the vessel, heating to complete chemical reactions, and distillation could be technically infeasible for terrorists without a sophisticated laboratory infrastructure. Blister chemical agents such as sulfur mustard, nitrogen mustard, and lewisite can be manufactured with ease or with only moderate difficulty. However, experts told us that buying large quantities of the precursor chemicals for these agents is difficult due to the Chemical Weapons Convention.

…Chemical experts believe that chemical agents need to be in vapor or aerosol form (a cloud of suspended microscopic droplets) to cause optimal inhalation exposure and to cause an effect. Vapors and aerosols remain suspended in the air and are readily inhaled deep into the lungs. Another method is to spray large droplets or liquid for skin penetration. A chemical agent could be disseminated by explosive or mechanical delivery. Further, chemical agents can be disseminated in vapor, aerosol, or bulk droplet form from delivery devices.

According to the experts, terrorists could disseminate chemical agents using simple containers such as glass bottles with commercial sprayers attached to them or fire extinguishers. However, the chemical agent would need to withstand the heat developed if disseminated by explosives. Moreover, according to chemical experts, the successful use of chemical agents to cause mass casualties requires high toxicity, volatility (tendency of a chemical to vaporize or give off fumes), and stability during storage and dissemination. Rapid exposure to a highly concentrated agent in an ideal environment would increase the number of casualties. These experts agree that disseminating a chemical agent in a closed environment would be the best way to produce mass casualties. Weather affects exterior dissemination, particularly sunlight, moisture, and wind. Some chemical agents can be easily evaporated by sunlight or diluted by water. The experts stated that it is also difficult to target an agent with any precision or certainty to kill a specific percentage of individuals outdoors. For example, wind could transport a chemical agent away from

> the designated target area.
>
> …The 1995 attack by Aum Shinrikyo, an apocalyptic religious sect, in the Tokyo subway using the chemical nerve agent Sarin elevated concerns about chemical and biological terrorism. Twelve people were killed and many more were injured as a result of that incident. Some experts have noted that despite substantial financial assets, well-equipped laboratories, and educated scientists working in the laboratories, Aum Shinrikyo did not cause more deaths because of the poor quality of the chemical agent and the dissemination technique used.

It should be noted, however, that these views again reflect the tendency to see the threat of “terrorism” as being separate from the more sophisticated threats that could be posed by proxy attacks and state actors. The risks would change radically if states became involved and used or provided the chemical weapon. There has also been at least one successful terrorist use of chemical weapons without state aid. The Tamil Tigers used commercially obtained chlorine gas on a besieged Sri Lankan special forces group at East Kiran in June 1990. The attack worked, although all the Tigers did was take drums of the chemical from a nearby paper plant, wait for the right prevailing wind, and open the drums.[17] It is also dangerous to rule out industrial sabotage. Sabotage by one man at a plant at Bophal in 1984 did, after all, kill far more people than the attacks of Aum Shinrikyo.

At the same time, the GAO analysis ignores the availability of a wide range of commercial poisons which can be used to produce limited numbers of casualties, but which are described in detail in the unclassified military literature issued by the US Army. It should also be noted that the Advisory Panel drew most of its database from models tailored to the use of chemical weapons in largely open-air conditions. It is not clear that such models are valid in built-up or urban areas. Tanker trucks could be used to deliver the chemicals needed to deliver an agent in office buildings. Some lethal gases or chemicals rise, but all current chemical weapons are actually vapors that are heavier than air. An attacker could exploit these characteristics in those buildings with large open spaces or forced air systems, or by the use of elevator shafts and other vertical corridors.

The dissemination and persistence of chemical weapons in attacks launched from outside a closed air system like a large office building would be a function of heat, wind patterns, and terrain obstruction. Even under military conditions, real world dissemination never follows the neat, predictable elliptical patterns used in military models. Concentrations vary sharply over the dissemination area, and "skip effects" can blow lethal concentrations substantial distances down wind.

An attack on an urban area using a delivery system like a commercial aircraft or aircraft modified as a drone, and either crashed into an urban area or uses as a line source sprayer, would deposit chemical weapons over the complex surface of urban "canyons." Depending on the time of year, temperature, etc., such an agent might either be remarkably persistent near the ground or be deposited over a large vertical areas with little lethality. At present, the open literature simply does not provide a useful basis for drawing any conclusions, and this presents major problems in both assessing risk, and the value of given detection, characterization, and response measures.

The Impact of Technological Change

Finally, it is not clear from open sources how changes in chemical technology and production over the coming twenty-five years will affect the ways in which state actors, proxies, and terrorist/extremist groups can attack the United States. Key issues include:

- Advances in the way chemical weapons can be manufactured and used – including changes in related technologies like remote controlled crop sprayers, etc.
- The possible existence of "4th generation" weapons far more lethal than existing nerve gases.
- Whether control regimes and regulatory/safety controls will outpace any advances in the ability to make chemical weapons and use new commercially available ingredients.
- The level of security the US can develop to prevent the transit of chemical weapons or precursors into the United States.
- The capability and cost of new detection and characterization systems, and the ability to cost-effectively deploy them.
- Advances in protection and treatment.

It should be noted in this regard that the GAO has repeatedly cited the lack of comprehensive risk assessments as a problem in federal programs.[18] The unclassified literature the federal government issues on the risk posed by chemical weapons tends to ignore the need to forecast changes in risk, just as it tends to use generic lethality data of uncertain provenance and value.

The Aum Shinrikyo Case Study

Aum Shinrikyo makes an interesting case study of what a terrorist organization can do. It is somewhat misleading for GAO to state that Aum Shinrikyo did not cause more deaths "despite substantial financial assets, well-equipped laboratories, and educated scientists working in the laboratories…because of the poor quality of the chemical agent and the dissemination technique used."[19] Aum experimented with a wide range of chemical weapons, including nerve agents like Sarin, tabun, soman, and VX, and considered hydrogen cyanide, and possibly phosgene and mustard. Aum selected Sarin precisely because it was relatively easy to manufacture, and any problems with the result are more a reflection on Aum's peculiar internal structure and lack of effective organization than the technical problems in manufacturing chemical weapons per se.[20]

Aum does seem to have been successful in buying the formula for Sarin from a Russian and in getting all of the necessary equipment to make it successfully. It is also important to note that Iraq produced its first mustard gas in small lots at a university affiliated facility in less than six months, and initially rejected rushing forward with the manufacture of Sarin because it was not persistent and was unstable under heat and daylight conditions, and not because of the difficulty in making small amounts.

Aum attempted several different chemical attacks. It evidently staged its first attack on a rival religious leader in 1993, but its first successful attack was on the judges in a civil suit against Aum in Matsumoto in June 1994, where a heating element, fan, and sprayer on a refrigeration truck were used to kill seven people and injure 144. The Tokyo subway attack that took place in March 1995 killed only 12 people but injured more than 1,000. The delivery mechanism consisted of plastic bags of Sarin punctured in subway cars, where puddles of diluted Sarin were allowed to evaporate. This was an extremely crude delivery method, and even so the Japanese authorities reported some effects for as many as 5,000 people, and the prosecutors claimed 3,398 were injured.

Better tactics in using the same dissemination technique could easily have produced far more lethal results, and there are a number of simple and more effective dissemination techniques.[21] For example, Aum Shinrikyo could have achieved high lethality efforts introducing the same agent into the closed air systems in many high rise office buildings, or simply by releasing pools of Sarin over wide areas in the floor of the Kasumigaseki subway station, rather than leaving it in bags in subway cars. Aum planned similar attacks for May 5, 1995 and July 4, 1995, and it is still unclear why they failed.

There are different descriptions of what Aum did, and some illustrate how the risk could have been much greater. Reporting by Chris Bullock and Kyle Olson describe the Aum attacks as follows:[22]

> Kyle Olson: On a warm June evening (in 1994), a group of cult members drove a truck similar to one illustrated in this picture into the city (Matsumoto, north of Tokyo) on a mission, a very explosive mission, a mission to kill three judges who were about to hand down a ruling in a land dispute, which it was believed by the cult, they were going to lose. The decision had been made that they could not afford to lose that ruling, they had to prevent it from being issued. Moreover it provided an opportunity to field test Sarin gas, a weapon that the cult had been experimenting with for some time. In fact a weapon which they had actually tested on animals on a station in Western Australia in 1993.
>
> The device was designed around the notion of a truck that would carry a container of Sarin, would be preheated, raised to a vapor point and released as a cloud, an aerosol, literally a poison gas. Now the original plan was to attack the judges at their offices in downtown Matsumoto, however the cult miscalculated, in fact the leader of the group overslept that day. They got on the road late, they got to the target city late, and they had to improvise, and unfortunately Aum Shinrikyo had something of a genius for improvisation. They determined that the three judges were all living in the same dormitory in a residential neighborhood. They waited until dark, drove their truck into a parking lot adjacent to the development, and released a cloud of Sarin gas. The cloud very quickly swept up, taken by the winds essentially in what was a courtyard, moved up into open windows of various apartments and dormitories throughout the area, and in a very short time, seven people were dead and more than 500 people were taken to hospitals in this very quiet town.
>
> Now the event stands out historically for several reasons: first of all, this was the first use of nerve agent in a terrorist setting; it was a use not by a state but by a private group of individuals against civilians; and of particular note was that by and large the rest of the world paid absolutely no attention. This was a major story in Japan and in a few other pacific nations; it captured no attention in Western Europe nor in the United States. As a result, when the cult drove away, they were effectively invisible, and by the way, no ruling has ever been handed down in that land dispute.
>
> Chris Bullock: Nine months later, Aum used Sarin again, this time in the Tokyo subway, killing a dozen people and making 3-and-a-half-thousand people ill. Kyle Olson says the lessons from Aum Shinrikyo's actions are clear.

> Kyle Olson: First of all the Tokyo subway attack, the objective of the attack, was not to kill hundreds or thousands of random strangers in the Tokyo subway. It had a very specific purpose: the cult had learned that the police in Tokyo had been trained the week before in chemical protective gear and tactics by the military, in anticipation of raids against cult facilities that were set to begin on Monday, March 20th, 1995. The reason the cult decided to attack the Tokyo subway on Monday March 20th, was to kill as many policemen on their way to work as possible. You see all of those trains converged at Kasumigaseki station, which serves the headquarters of the Japanese police agency.
>
> You see, Aum's actions I would argue, were perfectly logical. We've heard them characterized as an insane cult, an end-of-the-world cult, a group of mad scientists in Buddhist monk clothing. Well actually I would argue that Aum's actions were perfectly logical. They had established their own value system. They essentially set themselves up as a society in conflict with larger society. A self-legitimized group that rejected and ultimately was going to have to confront that society at some level. Given that they didn't have enough men, enough guns, enough bullets to fight society and fight the police, let alone the military, they had to go with an asymmetric option, they had to find a trump card, and to this end it made perfect sense to think about weapons of mass destruction. Once they knew the police were about to attack, a pre-emptive strike was by their thinking, forced upon them. They could not afford to have their plans derailed.

Political and Psychological Effects

Casualties would not be of critical importance in attacks where the main consequence was intended to be psychological and/or political. It should also be noted that a number of multiple, near simultaneous small attacks could have a major impact in causing public fear and panic, forcing the US into a massive defensive response, and dominating media coverage. For example, out of the 5,010 Japanese that reported to hospitals after the Aum attack on the Tokyo subway during the first 24 hours, some 74% showed no symptoms of nerve agent exposures and were diagnosed as "worried well." By this standard, there were three to four times more psychological victims of the attack than physiological victims. Israel exhibited a similar pattern in response to Iraq's Scud attacks during the Gulf War, as did Iran during Iraq's Scud attacks on its cities during the Iran-Iraq War.[23]

Once again, there is no reason to tie perceptions of the seriousness of the use of weapons of mass destruction to actual mass destruction or mass casualties. If anything, attackers might feel they could make more political or psychological gains by demonstrating the ability to attack without creating the political backlash that would come from large numbers of deaths.

The Problem of Response

In spite of these uncertainties, chemical weapons are the weapon of mass destruction that most first responders and law enforcement agencies feel they are best prepared to deal with. They feel that most chemical attacks present many of the same problems and uncertainties as dealing with the shipment of similar hazardous materials (HAZMAT), or large-scale industrial accidents. They already have to prepare for such HAZMAT incidents, and the estimated total casualties from most chemical attacks are unlikely to put an impossible burden on medical services. The law enforcement aspects, and forensics, of dealing with chemical attacks present challenges, but law enforcement experts believe most incidents will have a clear location and clear chains of evidence.

The US has made advances in chemical weapons attack detection, at least at the military level. The Army and Marine Corps have fielded the M21 Remote Sensing Chemical Agent Alarm (RSCAAL) to provide standoff detection of nerve and blister agents. The hand-held Improved Chemical Agent Monitor (ICAM) provides all deployable units with a rapid, chemical agent monitoring and identification capability for nerve and blister agent vapors. There is a broad consensus, however, that there are still major problems in rapid detection and characterization, and in training and equipping suitable emergency medical personnel and facilities. These problems would be least significant if a chemical weapon was used in a single closed area. They could be more serious if a chemical weapon was combined with an explosive device in attacking a building or facility, and responders had to characterize and deal with two sets of destructive effects at the same time.

Serious response problems could occur if a chemical attack could be conducted in enough volume to cover a large area. A truly successful attack against a crowded subway could, for example, saturate response services and present major problems in determining the area covered by the agent and how many people were actually exposed and with what effect. The number of false reports, and people seeking cautionary or panic medical treatment would rise sharply. The fear of sequential or follow-on attacks would grow, and so would the problems in decontamination.

Such "military-level attacks" present problems very similar to those the Department of

Defense is now planning to defend against overseas, and recent DoD reporting on these attacks provides considerable insight into both the current problems in such defense and some of the new options the US is trying to develop. It is also clear that any major defense and response effort would be very intrusive and could have major side-effects:

> The greatest chemical warfare threats to our forces are agents that affect the central nervous system and cause convulsions and respiratory failure (nerve agents), and those that have a blistering effect (e.g., mustard). The U.S. Army Medical Research Institute for Chemical Defense provides a department focus to improve warfighter protection against chemical weapons.
>
> Protective clothing and protective masks with appropriate filters will afford protection to service personnel by preventing exposure. If an individual were to be exposed to a nerve agent, the MARK I Nerve Agent Antidote Kit with its two autoinjectors, one containing atropine and the other 2-PAM chloride, are effective counters against the physiological effects of various nerve agents and are issued to deployed forces. Three MARK I kits are issued to each individual with specific instructions on usage following exposure. A disposable autoinjector with an anticonvulsant drug (Convulsant Antidote for Nerve Agents, or CANA) is also issued to troops and is administered by a buddy following the administration of the third MARK I kit when the three MARK I kits are used. In addition, personal skin decontamination kits (M291), to be used by the individual in the event of exposure to chemical agents, are issued to the troops.
>
> When faced with a soman or tabun nerve agent threat, another drug, known as pyridostigmine bromide (PB), is available and would be employed at the direction of the military Commander in Chief following established procedures. Soman and tabun bind very quickly and irreversibly in the body to the enzyme necessary for nerve conduction. This rapid and irreversible binding phenomenon, known as "aging," can be lessened if PB is already circulating in the body through pretreatment. PB can and does interfere with the permanent binding of these agents, and can, therefore, improve the chances for survival of exposed individuals who have not had enough time to don full protective gear with masks or were unaware of the presence of soman. DoD is seeking FDA approval to use PB, coupled with the standard post-exposure treatment using the MARK I kits, as a pretreatment adjunct when forces are faced with the soman or tabun threat. PB has been approved for human use by the FDA as a safe and effective treatment of certain neuromuscular disorders, such as myasthenia gravis (a disease that affects neuromuscular control); however, PB has not yet been approved in the United States for human use as a nerve agent pre-treatment. While it would be unethical to test PB in humans for efficacy against nerve agents, the effectiveness of PB against soman and tabun has been well-documented in animal models.
>
> Critical issues of medical chemical defense include the ability to protect… from the very rapidly acting nerve agents and persistent blistering agents, as well as choking and respiratory agents. A Joint Medical Chemical Defense Research program seeks to maintain the technological capability to meet present requirements and counter future threats, pro-vide individual-level prevention and protection to pre-serve fighting strength, and provide medical management of chemical casualties to enhance individual survival and return to duty…Medical chemical defense R&D materiel solutions under evaluation or development include:

- CW Agent (CWA) Scavengers —Human enzymes that have been genetically engineered to destroy nerve agents are being developed.

- Advanced anticonvulsants that are water-soluble and long-acting are being evaluated for control of nerve agent-induced seizure activity.

- Reactive topical skin protectant creams are being developed that not only prevent penetration of CWA but will also destroy them.

- Antivesicants are countermeasures that provide reduction in mustard-induced tissue swelling, ocular opacity, and skin damage. Effects of Exposure to Non-Lethal Levels of CWA—The incidence and probability of chronic medical effects of single and multiple low-level exposures to CWA are being investigated. Novel Threat Agents —Current medical regimens used for protection against the conventional nerve agents are being evaluated as a countermeasures for novel threat agents.

- Cyanide Countermeasures —Medical compounds (e.g., methemoglobin formers and sulfide donors) are being evaluated for safety and efficacy as pretreatments for cyanide poisoning. An external, noninvasive, personal exposure monitor is being transitioned for development and fielding to track the levels of these cyanide pretreatment compounds.

- Chemical Casualty Management —Technologies to assist in the diagnosis, prognosis, and management of chemical casualties in a medical treatment facility are being developed.

- Respiratory Agent Injury —Mechanisms of respiratory agent injury are being determined and medical countermeasures for respiratory agent casualties are under investigation.

A medical chemical defense product coming out of the R&D program for which an FDA license is pending is the Topical Skin Protectant (SERPACWA), a barrier cream effective against nerve and vesicant agents.

Large scale, open air attacks would present additional problems if very large amounts of ifagent could be broadly disseminated, or industrial sabotage -- a Bophal-like incident -- produced the same effect. No currently deployed detection system can accurately measure the plume or area coverage of such an attack, and most detection systems would present problems in reliably characterizing the exact weapon used and/or the amount of the weapon present in given areas. In many cases, little is also known about what constitutes a lethal dose, symptomology, treatment, and long-term effects.

While sophisticated individual detection and characterization devices are available and much more reliable and advanced systems are completing development, there as yet are no rapidly deployable arrays that can be used in urban environments, and must responders have no funds to acquire them. There are no current plans to broadly disseminate gas masks or the antidote to nerve gas before a crisis – even if warning occurs – and there are severe limits on the ability to treat large numbers of gas victims even in urban areas.

While most urban responders have plans for handling the public relations aspects of chemical accidents, it is far from clear that these plans would work in dealing with major chemical attacks or sequential attacks. It is also clear that national and local media at best have token preparations to report on such attacks, and to perform a civil defense role. The psychological dimension presents problems because it is not clear that the normal decontamination of areas, facilities, and buildings will not leave trace problems or that the public can be convincingly reassured of what is and is not safe. More broadly, the long-term medical effects of a large-scale attack are very difficult to characterize, and the Gulf War has shown how the resulting uncertainties can create major medical, psychological, and political problems.

Fortunately, under most conditions these problems may prove moot. Although some models indicate that limited amounts of sophisticated chemical weapons can produce thousands of casualties, it is more likely that a serious chemical attack or incident would produce 1,000 casualties or less. It would take a highly sophisticated group to launch multiple attacks and produce large amounts of highly lethal agent. As a result, it seems unlikely that either defenders or responders will have to deal with the kind of chemical attack(s) that could cripple a significant part of the economy, paralyze a city, vastly over-saturate available response and medical facilities, cause lasting panic and a loss of faith in political institutions, or threaten the fabric of American society, In this sense, chemical weapons differ fundamentally from biological and nuclear weapons.

Nevertheless, the threat posed by chemical weapons illustrates the need to be able to measure the existing capabilities of federal, state, and local defenders and responders, to determine what can be done to improve their capabilities with minimal or no additional resources, and then to expressly address what level of additional capability the nation is and is not willing to fund. At present, federal efforts are just beginning to develop a detailed picture of existing national capabilities, and much of the governmental effort at every step is concerned with basic endeavors to understand the problem, coordinate, and train. There is no question that this is producing real progress, but it does not create a system or architecture for Homeland defense, and no one has seriously addressed the question of "how much is enough?"

One key problem is that defense and response against chemical, biological, and radiological attacks must generally begin at the local level, and state and federal aid will normally come hours or days after the event. Local law enforcement, emergency services, and medical services must bear the brunt of trying to stop or contain an incident if there is warning and ameliorate the consequences if it succeeds. In the case of most chemical attacks, like most high explosive attacks, local and regional capabilities will be decisive in determining the outcome. Regional and federal resources cannot be brought to bear in time without extensive and precise warning.

This, however, raises the question of what local resources are needed, and what federal role if any is needed to provide them. So far, this question has tended to be answered more in terms of defense and response to low to mid-levels of attack, and emergency response capabilities are better trained and organized than medical services. There are serious variations in response capability, and it is not clear what standards need to be set for each urban area, or to deal with attacks on critical facilities in areas which lack the resources approaching those of major cities.

It is also clear from the testimony and briefings of both responders and medical professionals that public health capabilities have been steadily down-sized in ways which limit the ability to handle the patient loads from chemical attacks, much less the much high patient loads from biological and nuclear attacks. At present cost and capacity constraints are so severe that medical facilities often cannot participate effectively in exercises and training for Homeland defense. These problems may grow as more public spending is shifted to dealing with the aging, and they are compounded by a search for cost-effectiveness among medical professionals which is reducing emergency medical facilities and placing sharp limits on ICU units and respirators. These problems illustrate the fact that effective Homeland defense cannot be separated from national health policy, or from the overall problems in balancing out treatment cost, the need to provide continuing peacetime services, and changing priorities to meet an aging population and deal with welfare reform.

Improvements are clearly needed in some aspects of defense and response to chemical attacks, as well as to other forms of large-scale attacks. There is a need to provide some kind of cost-effective detection and characterization system that can be rapidly deployed before or after an attack, and which will provide an accurate picture of how much of what agent is present in what area. Models lack the accuracy to substitute for measurement. At present, more effort seems to be going into improving individual detectors than in to creating deployable and affordable systems that can be available for local use – a problem compounded by the need to provide biological and nuclear detection and characterization as well as chemical. This kind of real time information is critical not only to first responders, but to the efficient use and allocation of regional, state, and federal aid.

Another problem that begins to arise with large-scale chemical incidents is the potential conflict between the law enforcement priorities necessary to obtain evidence and convictions, the need to take every possible measure to prevent follow-on attacks, the need to provide immediate emergency services, and long-standing problems in using US intelligence assets to support defense and response inside US territory when it may involve US citizens Considerable progress has been made in improving such coordination at the federal, state, and local level but much of this progress seems tailored to dealing with low-level attacks where normally criminal procedures and civil rights can be given priority. There does not as yet seem to be a clear doctrine for dealing with escalating levels of crisis where the need to take immediate and urgent action may have higher priority.

Table 4.3

US Department of Defense Estimate of Potential National Threats Intentions Involving Chemical Weapons

China

Beijing is believed to have an advanced chemical warfare program including research and development, production, and weaponization capabilities. China's chemical industry has the capability to produce many chemicals, some of which have been sought by states trying to develop a chemical warfare capability. Foreign sales of such chemicals have been a source of foreign exchange for China. The Chinese government has imposed restrictions on the sale of some chemical pre-cursors and its enforcement activities generally have yielded mixed results. While China claims it possesses no chemical agent inventory, it is believed to possess a moderate inventory of traditional agents. It has a wide variety of potential delivery systems for chemical agents, including cannon artillery, multiple rocket launchers, mortars, land mines, aerial bombs, SRBMs, and MRBMs.

Chinese military forces most likely have a good under-standing of chemical warfare doctrine, and its forces routinely conduct defensive chemical warfare training. Even though China has ratified the CWC, made its declaration, and subjected its declared chemical weapons facilities to inspections, we believe that Beijing has not acknowledged the full extent of its chemical weapons program.

India

India is an original signatory to the CWC. In June 1997, it acknowledged that it had a dedicated chemical warfare production program. This was the first time India had publicly admitted that it had a chemical warfare effort. India also stated that all related facilities would be open for inspection, as called for in the CWC, and subsequently, it has hosted all required CWC inspections. While India has made a commitment to destroy its chemical weapons, its extensive and well-developed chemical industry will continue to be capable of producing a wide variety of chemical agent pre-cursors should the government change its policy. In the past, Indian firms have exported a wide array of chemical products, including Australia Group-con-trolled items, to several countries of proliferation concern in the Middle East. (Australia Group-controlled items include specific chemical agent precursors, microorganisms with biological warfare applications, and dual-use equipment that can be used in chemical or biological warfare programs.) Indian companies could continue to be a source of dual-use chemicals to countries of proliferation concern.

Iran

Iran has acceded to the Chemical Weapons Convention (CWC) and in a May 1998 session of the CWC Conference of the States Parties, Tehran, for the first time, acknowledged the existence of a past chemical weapons program. Iran admitted developing a chemical warfare program during the latter stages of the Iran-Iraq war as a "deterrent" against Iraq's use of chemical agents against Iran. Moreover, Tehran claimed that after the 1988 cease-fire, it "terminated" its program. However, Iran has yet to acknowledge that it, too, used chemical weapons during the Iran-Iraq War.

Nevertheless, Iran has continued its efforts to seek production technology, expertise and precursor chemicals from entities in Russia and China that could be used to create a more advanced and self-sufficient chemical warfare infrastructure. As Iran's program moves closer to self-sufficiency, the potential will increase for Iran to export dual-use chemicals and related equipment and technologies to other countries of proliferation concern. In the past, Tehran has manufactured and stockpiled blister, blood and choking chemical agents, and weaponized some of these agents into artillery shells, mortars, rockets, and aerial bombs. It also is believed to be conducting research on nerve agents. Iran could employ these agents during a future conflict in the region. Lastly, Iran's training, especially for its naval and ground forces, indicates that it is planning to operate in a contaminated environment.

Iraq

Since the Gulf War, Baghdad has rebuilt key portions of its industrial and chemical production infrastructure; it has not become a state party to the CWC. Some of Iraq's facilities could be converted fairly quickly to production of chemical warfare agents. Following Operation Desert Fox, Baghdad again instituted a rapid reconstruction effort on those facilities to include former dual-use chemical warfare-associated production facilities, destroyed by U.S. bombing. In 1999, Iraq may have begun installing or repairing dual-use equipment at these and other chemical war-fare-related facilities. Previously, Iraq was known to have produced and stockpiled mustard, tabun, sarin, and VX, some of which likely remain hidden. It is likely that an additional quantity of various precursor chemicals also remains hidden.

In late 1998, UNSCOM reported to the UN Security Council that Iraq continued to withhold information related to its chemical program. UNSCOM cited an example where Baghdad seized from inspectors a document discovered by UNSCOM inspectors, which indicated that Iraq had not consumed as many chemical munitions during the Iran-Iraq War as had been declared previously by Baghdad. This document suggests that Iraq may have an additional 6,000 chemical munitions hidden. Similarly, UNSCOM discovery in 1998 of evidence of VX in Iraqi missile warheads showed that Iraq had lied to the international community for seven years when it repeatedly said that it had never weaponized VX.

Iraq retains the expertise, once a decision is made, to resume chemical agent production within a few weeks or months, depending on the type of agent. However, foreign assistance, whether commercial procurement of dual-use technology, key infrastructure, or other aid, will be necessary to completely restore Iraq's chemical agent production capabilities to pre-Desert Storm levels. Iraqi doctrine for the use of chemical weapons evolved during the Iran-Iraq War, and was fully incorporated into Iraqi offensive operations by the end of the war in 1988. During different stages of that war, Iraq used aerial bombs, artillery, rocket launchers, tactical rockets, and sprayers mounted in helicopters to deliver agents against Iranian forces. It also used chemical agents against Kurdish elements of its own civilian population in 1988.

Libya

Libya has made progress with its chemical warfare effort. However, it remains heavily dependent on foreign suppliers for precursor chemicals, mechanical and technical expertise, and chemical warfare-related equipment. From 1992 to 1999, UN sanctions continued to limit the type and amount of support Tripoli receives from abroad. However, following the suspension of UN sanctions in April 1999, Libya wasted no time in reestablishing contacts with foreign sources of expertise, parts, and precursor chemicals for its program. Clearly, Tripoli has not given up its goal of reestablish-ing its offensive chemical warfare ability and continues to pursue an indigenous chemical warfare production capability.

Prior to 1990, Libya produced about 100 tons of chemical agents – mustard and some nerve agent – at a chemical facility at Rabta. However, it ceased production there in 1990 due to intense international media attention and the possibility of military intervention, and fabricated a fire to make the Rabta facility appear to have been seriously damaged. Libya main-tains that the facility is a pharmaceutical production plant and announced in September 1995 that it was reopening the Rabta pharmaceutical facility. Although production of chemical agents has been halted, the Rabta facility remains part of the Libyan chemical weapons program, and future agent production cannot be ruled out. After 1990, the Libyans shifted their efforts to trying to build a large underground chemical production facility at Tarhunah. However, the pace of activity there has slowed, probably due to increased international attention. The Libyans claim that the Tarhunah tunnel site is a part of the Great Man-made River Project, a nationwide irrigation effort. Libya has not become a state party to the CWC.

North Korea

Like its biological warfare effort, we believe North Korea has had a long-standing chemical warfare program. North Korea's chemical warfare capabilities include the ability to produce bulk quantities of nerve, blister, choking, and blood agents, using its sizeable, although aging, chemical industry. We believe it possesses a sizeable stockpile of these agents and weapons, which it could employ should there be renewed fighting on the Korean peninsula.

North Korea is believed to be capable of weaponizing such stocks for a variety of delivery means. These would include not only ballistic missiles, but also artillery and aircraft, and possibly unconventional means. In fact, the United States believes that North Korea has some long-range artillery deployed along the demilitarized zone (DMZ) and ballistic missiles, some of which could deliver chemical warfare agents against forward-based U.S. and allied forces, as well as against rear-area targets. North Korean forces are prepared to operate in a contaminated environment; they train regularly in chemical defense operations and are taught that South Korean and U.S. forces will employ chemical munitions. North Korea has not signed CWC, nor it is expected to do so in the near future.

Pakistan

Pakistan ratified the CWC in October 1997 and did not declare any chemical agent production or development. Pakistan has imported a number of dual-use chemicals that can be used to make chemical agents. These chemicals also have commercial uses and Pakistan is working towards establishing a viable commercial chemical industry capable of producing a variety of chemicals, some of which could be used to make chemical agents. Chemical agent delivery methods available to Pakistan include missiles, artillery, and aerial bombs.

Russia

Moscow has acknowledged the world's largest stock pile of chemical agents of 40,000 metric tons of agent. The Russian chemical warfare agent inventory consists of a comprehensive array of blister, choking, and nerve agents in weapons and stored in bulk. These agents can be employed by tube and rocket artillery, bombs, spray tanks, and SRBM warheads. In addition, since 1992, Russian scientists familiar with Moscow's chemical warfare development program have been publicizing information on a new generation of agents, sometimes referred to as "Novichoks." These scientists report that these compounds, some of which are binaries, were designed to circumvent the CWC and to defeat Western detection and protection measures. Furthermore, it is claimed that their production can be hidden within commercial chemical plants. There is concern that the technology to produce these compounds might be acquired by other countries.

As a state party to the CWC, Russia is obligated to declare and destroy its chemical weapons stockpile and to forego the development, production, and possession of chemical weapons. However, we believe that the Russians probably have not divulged the full extent of their chemical agent and weapon inventory. Destruction facilities are being planned at Shchuch'ye and Gornyy, two of the seven declared storage locations for the Russian chemical warfare stockpile; these efforts are being funded in large part by foreign assistance programs.

Nevertheless, Russia admitted it could not meet its first obligation to destroy one percent of its stockpile by April 2000. Subsequently, the Organization for the Prohibition of Chemical Weapons (OPCW) granted Russia an extension until April 2002, but with the stipulation that it must also meet 20 percent destruction deadline by the same date, as called for under the CWC. However, international experts agree that it will be extremely difficult for Russia to destroy its huge chemical arsenal by 2007 as mandated by the CWC. Even if Russia were to be granted a five-year extension by the OPCW, it is unlikely that Russia's declared stockpile will be completely destroyed because of serious technical, ecological, financial, and political problems.

Syria

Syria is not a state party to the CWC and has had a chemical warfare program for many years, although it has never used chemical agents in a conflict. Damascus already has a stockpile of the nerve agent sarin that can be delivered by aircraft or ballistic missiles. Additionally, Syria is trying to develop the more toxic and persistent nerve agent VX. In the future, Syria can be expected to continue to improve its chemical agent production and storage infrastructure. Damascus remains dependent on foreign sources for key elements of its chemical warfare program, including pre-cursor chemicals and key production equipment. For example, during 1999, Syria sought chemical warfare-related precursors and expertise from foreign sources.

Sudan

Sudan has been interested in acquiring a chemical war-fare capability since the 1980s and has sought assistance from a number of countries with chemical warfare programs. We believe that Iraq, in particular, has provided technical expertise to Khartoum. In addition, the finding of a known VX precursor chemical near a pharmaceutical facility in Khartoum suggests that Sudan may be pursuing a more advanced chemical warfare capability. Sudan acceded to the CWC in 1999, although allegations of Sudanese chemical warfare use against rebels in southern Sudan have persisted. These, and prior allegations of chemical warfare use, have not been confirmed. Further, Khartoum's desire to present a more moderate image and alleviate its international isolation will cause Sudan to proceed with its chemical warfare program with caution.

Source: Adapted by Anthony H. Cordesman from Department of Defense, Proliferation and Response, January 2001

Table 4.4

Key Chemical Weapons –Part One

NERVE AGENTS: Agents that quickly disrupt the nervous system by binding to enzymes critical to nerve functions, causing convulsions and/or paralysis. Must be ingested, inhaled, and absorbed through the skin. Very low does cause a running nose, contraction of the pupil of the eye, and difficulty in visual coordination. Moderate doses constrict the bronchi and cause a feeling of pressure in the chest, and weaken the skeletal muscles and cause filibration. Large doses cause death by respiratory or heart failure. Can be absorbed through inhalation or skin contact. Reaction normally occurs in 1-2 minutes. Death from lethal doses occurs within minutes, but artificial respiration can help and atropine and the oximes act as antidotes. The most toxic nerve agents kill with a dosage of only 10 milligrams be minute per cubic meter, versus 400 for less lethal gases. Recovery is normally quick, if it occurs at all, but permanent brain damage can occur:

Tabun (GA)
Sarin (GB) - nearly as volatile as water and delivered by air. A dose of 5 mg/min/m^3 produces casualties, a respiratory dose of 100 mg/min/m3 is lethal. Lethality lasts
1-2 days.
Soman (GD)
GF
VR-55 (Improved Soman) A thick oily substance which persists for some time.
VK/VX - a persistent agent roughly as heavy as fuel oil. A dose of 0.5 mg/min/m^3
produces casualties, a respiratory dose of 10 mg/min/m3 is lethal. Lethality lasts 1-16 weeks.

BLISTER AGENTS: Cell poisons that destroy skin and tissue, cause blindness upon contact with the eyes, and which can result in fatal respiratory damage. Can be colorless or black oily droplets. Can be absorbed through inhalation or skin contact. Serious internal damage if inhaled. Penetrates ordinary clothing. Some have delayed and some have immediate action. Actual blistering normally takes hours to days, but effects on the eyes are much more rapid. Mustard gas is a typical blister agent and exposure of concentrations of a few milligrams per meter over several hours generally at least causes blisters and swollen eyes. When the liquid falls onto the skin or eyes it has the effect of second or third degree burns. It can blind and cause damage to the lungs leading to pneumonia. Severe exposure causes general intoxication similar to radiation sickness. HD and HN persist up to 12 hours. L, HL, and CX persist for 1-2 hours. Short of prevention of exposure, the only treatment is to wash the eyes, decontaminate the skin, and treat the resulting damage like burns:

` Sulfur Mustard (H or HD) A dose of 100 mg/min/m^3 produces casualties, a dose of
1,500 mg/min/m3 is lethal. Residual lethality lasts up to 2-8 weeks.
Distilled Mustard (DM)
Nitrogen Mustard (HN)
Lewisite (L)
Phosgene Oxime (CX)
Mustard Lewisite (HL)

CHOKING AGENTS: Agents that cause the blood vessels in the lungs to hemorrhage, and fluid to build-up, until the victim chokes or drowns in his or her own fluids (pulmonary edema). Provide quick warning though smell or lung irritation. Can be absorbed through inhalation. Immediate to delayed action. The only treatment is inhalation of oxygen and rest. Symptoms emerge in periods after exposure of seconds up to three hours:

Phosgene (CG)
Diphosgene (DP)
PS Chloropicrin
Chlorine Gas

Table 4.4

Key Chemical Weapons –Part Two

BLOOD AGENTS: Kill through inhalation. Provide little warning except for headache, nausea, and vertigo. Interferes with use of oxygen at the cellular level. CK also irritates the lungs and eyes. Rapid action and exposure either kills by inhibiting cell respiration or it does not -- casualties will either die within seconds to minutes of exposure or recover in fresh air. Most gas masks has severe problems in providing effective protection against blood agents:

Hydrogen Cyanide (AC) A dose of 2,000 mg/min/m^3 produces casualties, a respiratory dose of 5,000 mg/min/m3 is lethal. Lethality lasts 1-4 hours.

Cyanogen Chloride (CK) A dose of 7,000 mg/min/m^3 produces casualties, a respiratory dose of 11,000 mg/min/m3 is lethal. Lethality lasts 15 minutes to one hour.

TOXINS: Biological poisons causing neuromuscular paralysis after exposure of hours or days. Formed in food or cultures by the bacterium clostridium Botulinum. Produces highly fatal poisoning characterized by general weakness, headache, dizziness, double vision and dilation of the pupils, paralysis of muscles, and problems in speech. Death is usually by respiratory failure. Antitoxin therapy has limited value, but treatment is mainly supportive:

Botulin toxin (A) Six distinct types, of which four are known to be fatal to man. An oral dose of 0.001 mg is lethal. A respiratory dose of 0.02 mg/min/m^3 is also lethal.

DEVELOPMENTAL WEAPONS: A new generation of chemical weapons is under development. The only publicized agent is perfluoroisobutene (PFIB), which is an extremely toxic odorless and invisible substance produced when PFIB (Teflon) is subjected to extreme heat under special conditions. It causes pulmonary edema or dry-land drowning when the lungs fill with fluid. Short exposure disables and small concentrations cause delayed death. Activated charcoal and most existing protection equipment offer no defense. Some sources refer to "third" and "fourth" generation nerve gasses, but no technical literature seems to be available.

CONTROL AGENTS: Agents which produce temporary irritating or disabling effects which in contact with the eyes or inhaled. They cause flow of tears and irritation of upper respiratory tract and skin. They can cause nausea and vomiting: can cause serious illness or death when used in confined spaces. CS is the least toxic gas, followed by CN and DM. Symptoms can be treated by washing of the eyes and/or removal from the area. Exposure to CS, CN, and DM produces immediate symptoms. Staphylococcus produces symptoms in 30 minutes to four hours, and recovery takes 24-48 hours. Treatment of Staphylococcus is largely supportive:

Tear
Chlororacetophenone (CN)
O-Chlorobenzyl-malononitrile (CS)
Adamsite (DM)
Staphylococcus

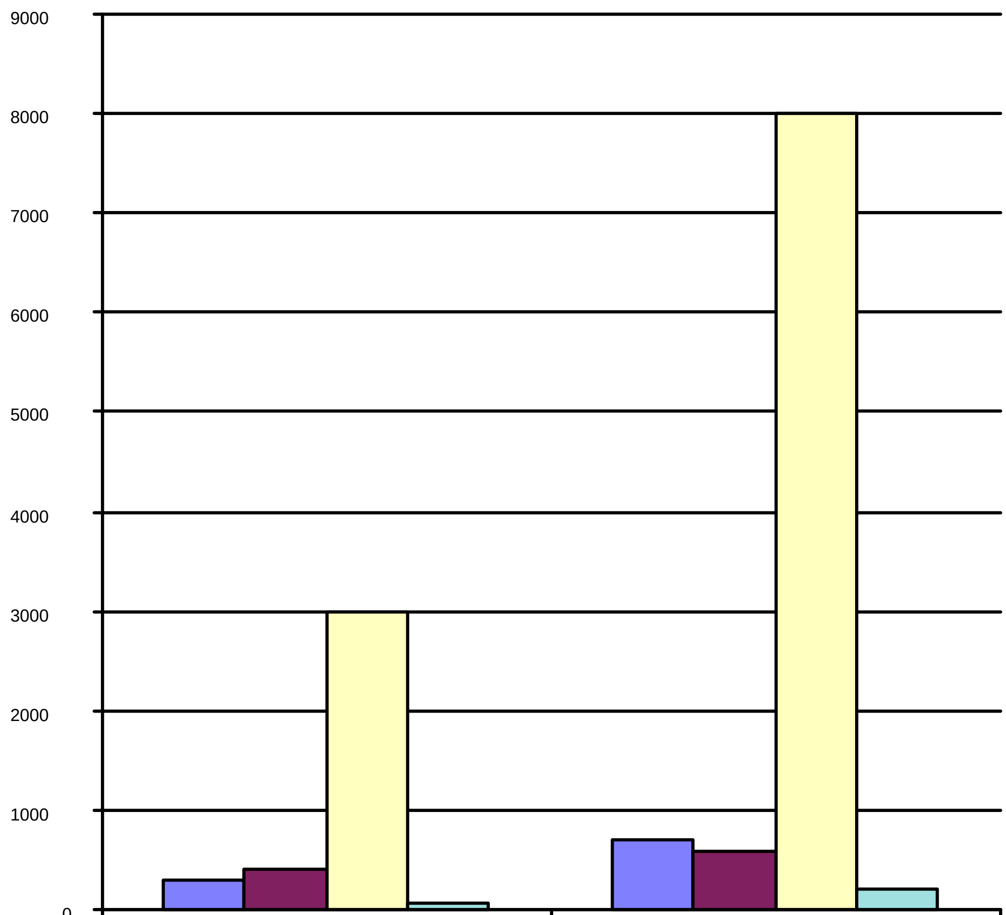
INCAPACITATING AGENTS: Agents which normally cause short term illness, psychoactive effects, (delirium and hallucinations). Can be absorbed through inhalation or skin contact. The psychoactive gases and drugs produce unpredictable effects, particularly in the sick, small children, elderly, and individuals who already are mentally ill. In rare cases they kill. In others, they produce a permanent psychotic condition. Many produce dry skin, irregular heart beat, urinary retention, constipation, drowsiness, and a rise in body temperature, plus occasional maniacal behavior. A single dose of 0.1 to 0.2 milligrams of LSD-25 will produce profound mental disturbance within a half hour that lasts 10 hours. The lethal dose is 100 to 200 milligrams:

BZ
LSD
LSD Based BZ
Mescaline
Psilocybin
Benzilates

Chart 4.1 –Part One

The Relative Killing Effect of Chemical Weapons Under Different Conditions of Aerosol Delivery

(Numbers of dead from delivery of 1,000 Kilograms)



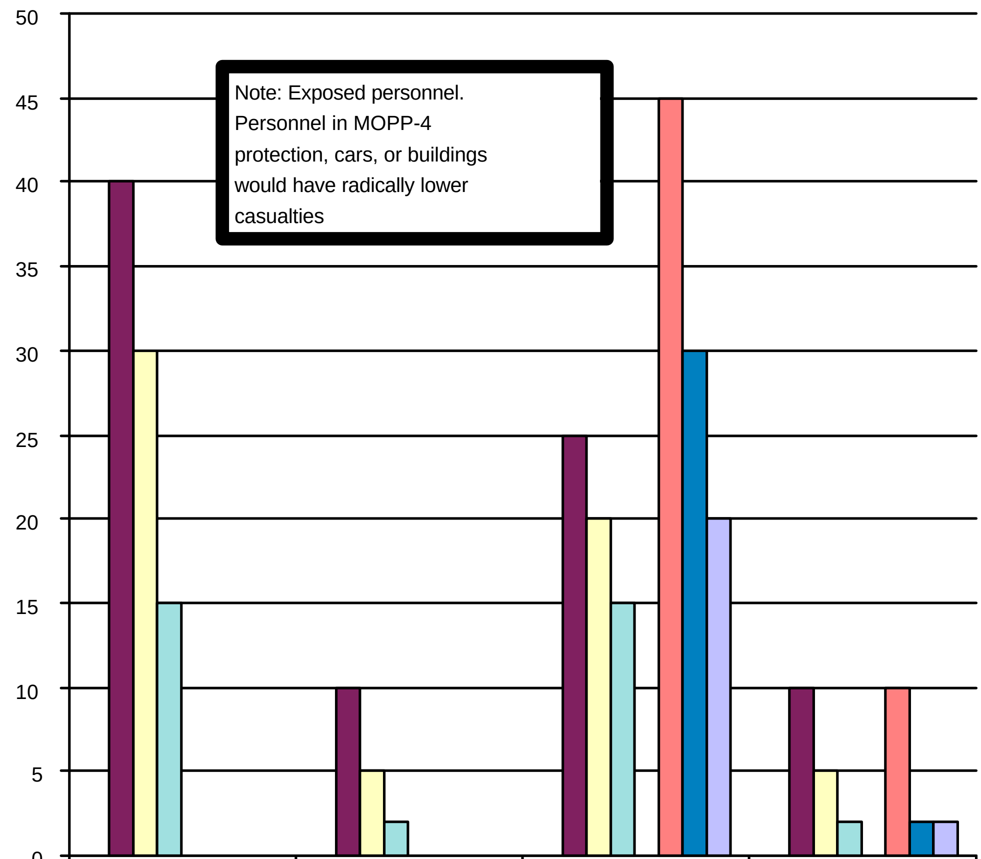
	Low	High
Sarin-Sun/Calm	300	700
Sarin-Shade/Wind	400	600
Sarin-Night/Shade	3000	8000
Bomb	60	200

Source: Adapted by Anthony H. Cordesman from Victor A. Utgoff, The Challenge of Chemical Weapons, New York, St. Martin's, 1991, pp. 238-242 and Office of Technology Assessment, Proliferation of Weapons of Mass Destruction: Assessing the Risks, U.S. Congress OTA-ISC-559, Washington, August, 1993, pp. 56-57.

Chart 4.1 – Part Two

The Relative Casualty Effect of Chemical Weapons Under Military Conditions

(Percent of Casualties)

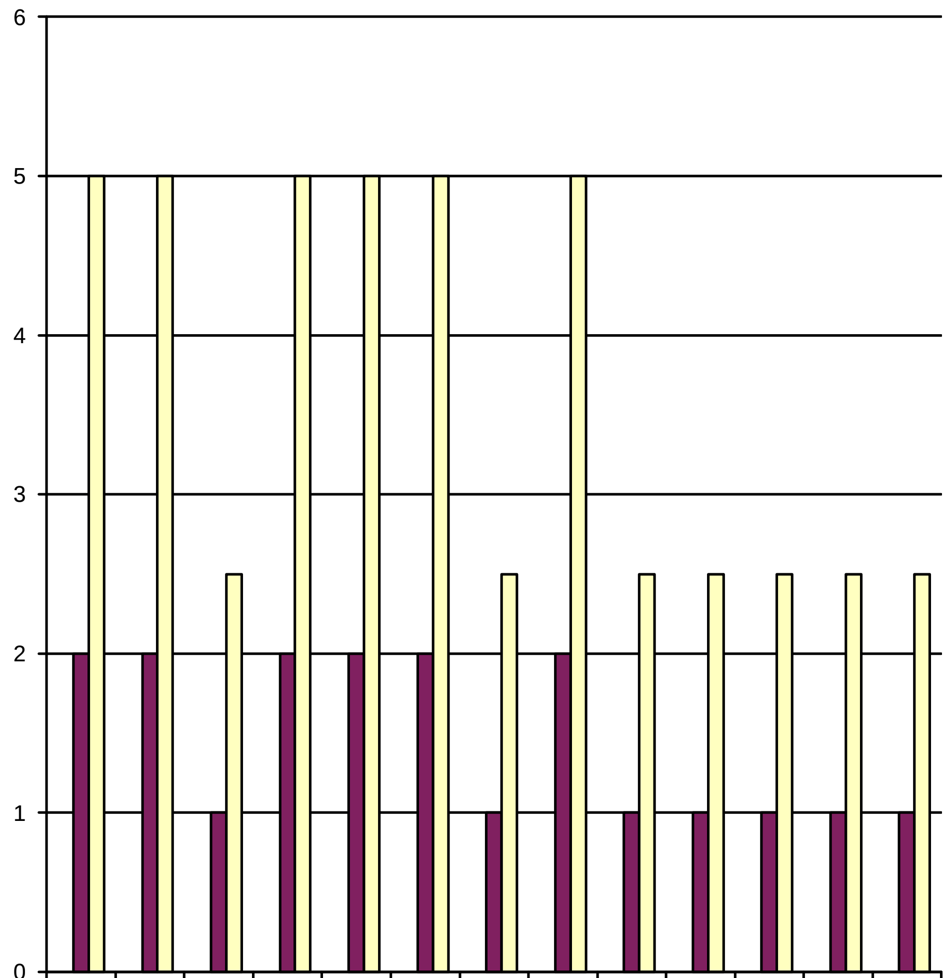


	Persistent Nerve	Non-Persistent Nerve	Persistent Blood	Non-Persistent Blister
Bursting Munitions				
150 M Radii	40	10	25	10
500 M Radii	30	5	20	5
1000 M Radii	15	2	15	2
Spray	.	.	.	.
150 M Radii			45	10
500 M Radii			30	2
1000 M Radii			20	2

Source: Adapted by Anthony H. Cordesman from Source: Adapted by Anthony H. Cordesman from Table 1-3 of FM-37 and USACHPPM, The Medical NBC Battlebook, USACHPPM Technical Guide 244, p. 5-7.

Chart 4.1 – Part Three

Exclusion Areas for Release from Bulk Tank of Hazardous Chemicals
(Quantity in Tons/Exclusion Area in Kilometers)



	Phosgene	Hydrogen Cyan	Hydrogen Cyan	Hydrogen Sulfi	Methyl Isocy	Chlorine	Ammonia	Ammonia	Sulfur Triox	Nitrogen Tetro	Bromine	Sulfur Dioxi	Acronitrile
Amount in Tons	*50	*50	*50	*50	*50	*100	*100	*500	*50	*50	*50	*50	*50
Daytime Exclusion Area in Kilometers	2	2	1	2	2	2	1	2	1	1	1	1	1
Nighttime Exclusion Area in Kilometers	5	5	2.5	5	5	5	2.5	5	2.5	2.5	2.5	2.5	2.5

Source: Adapted by Anthony H. Cordesman from JP 3-11, Draft and USACHPPM, The Medical NBC Battlebook, USACHPPM Technical Guide 244, p. 5-7.

Chemical Weapons as Means of Attack

Chemical weapons have not been used effectively in attacks on the American homeland. Reports that the bombers of the World Trade Center considered trying to add a chemical weapon like sodium cyanide to their explosives seem to be untrue, and led to an unsubstantiated assertion by the trial judge.[24] There have, however, been a number of attempts to use chemical weapons by domestic extremists and individuals. For example, in 1997, members of the KKK plotted to place an improvised explosive device on a hydrogen sulfide tank at a refinery near Dallas, Texas.[25] There is a well-established, low-level risk that such weapons will be used in the future, although there is no way to predict the frequency of such attacks, their scale, potential success, or lethality.

There are a wide range of countries involved in the development of chemical weapons. Table 4.3 provides a recent unclassified US intelligence summary chemical weapons activities by nation. It is only a partial list. The US intelligence community is tracking a total of approximately 25 nations which are believed to be carrying out some form of state-sponsored chemical and/or biological weapons development. As has been discussed earlier, at least two foreign terrorist groups are also believed to have active chemical and biological weapons efforts/

Effective planning for Homeland defense must consider the fact that the US currently has limited ability to properly characterize the impact of chemical weapons in any form of attack. Many terrorist uses of chemical weapons will not be inherently more lethal or more painful than the use of explosives. At the same time, it must consider the risk that chemical attacks can produce much larger levels of damage than nominal lethality estimates indicate and virtually any use of such weapons will have a far different psychological impact. Chemical weapons are weapons of terror and intimidation as well as a means of producing casualties and physical destruction.

The Impact and Variety of Possible Chemical Weapons

Experts like the Center for Disease Control have found that the US may faces a wide range of threats from different types of chemical weapons and toxic agents, many of which are not normally considered to be weapons. A CDC study notes that the chemical agents that might be used by terrorists range from sophisticated military agents to toxic chemicals commonly used in industry. The criteria the CDC suggested for determining priority chemical agents include:[26]

- chemical agents already known to be used as weaponry;
- availability of chemical agents to potential terrorists;
- chemical agents likely to cause major morbidity or mortality;
- potential of agents for causing public panic and social disruption; and
- agents that require special action for public health preparedness.

The CDC lists several categories of chemical agents as presenting enough of a threat to require active public health planning. These include nerve agents, such as tabun (ethyl N,N-dimethylphosphoramidocyanidate), Sarin (isopropyl methylphosphanofluoridate), soman (pinacolyl methyl phosphonofluoridate), GF (cyclohexylmethylphosphonofluoridate), and VX (o-ethyl-[S]-[2-diisopropylaminoethyl]-methylphosphonothiolate). They include blood agents such as hydrogen cyanide and cyanogen chloride; and blister agents such as lewisite (an aliphatic arsenic compound, 2-chlorovinyldichloroarsine), nitrogen and sulfur mustards, and phosgene oxime. And, they include pulmonary agents like phosgene, chlorine, and vinyl chloride; and incapacitating agents like BZ (3-quinuclidinyl benzilate);

Other agents on the CDC's list are more commercial in character. They include heavy metals like arsenic, lead, and mercury; and volatile toxins like benzene, chloroform, and trihalomethanes. Other agents include explosive nitro compounds and oxidizers, such as ammonium nitrate combined with fuel oil. They include pulmonary agents like phosgene, chlorine, and vinyl chloride; persistent and nonpersistent pesticides; and dioxins, furans, and polychlorinated biphenyls (PCBs). They include flammable industrial gases and liquids like gasoline, propane; and poison industrial gases, liquids, and solids, like the cyanides, and nitriles. Finally, they include corrosive industrial acids and bases like nitric and sulfuric acid.

Many of the items the CDC list are widely available on the US market and include commercial organo-phospates and parathion, and the military lists of possible agents is much longer and includes additional toxic smokes, herbicides, flame materials, and toxic industrial compounds[27]. As a result, it is hardly surprising that CDC studies also note that there was no way to predict precisely what chemicals might be used, particularly in low level attacks.

This creates major problems for response planning: "Because of the hundreds of new chemicals introduced internationally each month, treating exposed persons by clinical syndrome rather than by specific agent is more useful for public health planning and emergency medical response purposes. Public health agencies and first responders must render the most aggressive, timely, and clinically relevant treatment possible by using treatment modalities based on syndromic categories (e.g., burns and trauma, cardiorespiratory failure, neurologic damage, and shock). These activities must be linked with authorities responsible for environmental sampling and decontamination."

The Probable Lethality and Effectiveness of Chemical Attacks

Just as it is easy to underestimate the importance of conventional explosives, it is easy to exaggerate the lethality of most chemical weapons. Many forms of lower level attacks using chemical weapons might do no more or less damage than attacks using conventional weapons. For example, the World Trade Center bombing killed six and injured over 1,000, and could easily have killed hundreds if the bomb had been better placed.[28] Large high explosive weapons can easily be equal to both chemical and radiological weapons as "weapons of mass destruction."

It is also an illusion that the effects of chemical weapons are always radically worse or more repellant than the damage done conventional weapons. No one who has actually visited a battlefield and seen anyone with a fragmentation wound in the stomach and then seen a prisoner affected by a moderate dose of mustard gas is going to accept for a second that one casualty is somehow worse than another.[29]

The characteristics of a representative range of chemical weapons are summarized in

Parts One to Three of Chart 4.1, along with a rough comparison of their lethality to the lethality of a 1,000-pound bomb. It should again be noted that the relatively high lethality estimates the are based upon questionable military literature, and that there has been little historical correlation between such theoretical lethality models and real-world casualties.[30]

While there are good models as well as bad ones, much of the military effects data on chemical weapons in the unclassified literature is based on theoretical models whose inherent validity is suspect, and which do not track with either the historical data on the use of chemical weapons in World War I or Iraq's use of chemical weapons in the Iran-Iraq War. There are also extremely sharp variations in such estimates. Some estimates give nerve gas attacks near-nuclear lethalities, while others indicate that the effects could be highly localized and produce random concentrations with much more limited numbers of deaths.[31]

In many cases, the results of limited animal testing is generalized on tenuous grounds. The lethality data are then scaled-up using models of how weaponized chemical vapors are deposited. Some of these models ignore temperature, wind, and heat conditions and assume optimal scattering of the vapor evenly over large areas. These same problems affect the modeling of the lethality of biological and nuclear weapons as well as chemical weapons, but the higher estimates of lethality in chemical weapons effects modeling seem uniquely exaggerated. This is particularly true when the input data are drawn from unclassified estimates that are ultimately drawn from Soviet literature on missile warhead behavior, some of which seems to be little more than analytic nonsense.

The December 15, 1999 report of the Advisory Panel to Assess Domestic Response Capabilities for Terrorism Involving Weapons of Mass Destruction, also known as the Gilmore Commission, provides what seems to be a more accurate picture of the probably lethality of chemical attacks on the US homeland,[32]

> …developing a means to disseminate sarin effectively is likely to prove a far greater challenge to terrorists than is producing the agent itself. Although sarin's high volatility greatly simplifies weaponization, terrorists who may seek to cause mass casualties will need a fairly sophisticated means of spreading the agent in sufficiently large quantities over their intended target area. For wide coverage in an open area,

> such as a city, an airplane equipped with a suitable industrial or crop sprayer could be a satisfactory mechanism for dissemination. Alternatively, terrorists could equip a truck and drive through the target area, taking care, of course, to ensure that its passengers are properly sealed off from the chemical agent. Temperature, wind speed, inversion conditions, and other meteorological factors, however, would likely determine the effectiveness of any attack. For example, as sarin and other chemical agents are exposed to the environment, they tend to be dispersed by the wind, which necessitates the use of large amounts of material to ensure that a given target receives a sufficiently high dose. In fact, the need to produce and disperse sufficiently large amounts of sarin or other chemical agents to achieve the mass-casualty levels that may be sought by terrorists arguably drawn to chemical weapons in the first place ironically may be the biggest disincentive for their use.
>
> A U.S. Defense Department model illustrates the problem. Releasing ten kilograms (22 pounds) of sarin into the open air under favorable weather conditions covers about one-hundredth of a square kilometer with lethal effects. Since population densities in U.S. urban areas are typically around 5,000 people per square kilometer, such an attack would kill about 50 people.
>
> Releasing 100 kilograms (220 pounds) of sarin into the open air affects about ten times as much area and therefore would kill approximately 500 people. Releasing 1,000 kilograms (2,200 pounds) into the open air would cover several square kilometers, killing about 10,000 people. Thus, only in an open-air attack using amounts approaching 1,000 kilograms of sarin would the effects become distinctly greater than that attainable by such traditional terrorist means as conventional explosives. One way for terrorists to overcome these problems would be to carry out an attack in an enclosed space, such as a domed stadium, office building, or subway system.

The effectiveness data used by the US Army also are relatively conservative, and are summarized in Part Two of Table 4.4. Once again, however, such data are highly nominal and provide only a tenuous basis for predicting casualty effects. The same is true of a potential sabotage or terrorist release of toxic chemicals of the kind shown in Part Three of Table 4.4. Only nominal area of evacuation -- not lethality -- data are available.

These caveats in no way mean that chemical attacks cannot be highly lethal under some circumstances. In 1984, for example an incident took place in Bhopal, India, where a disgruntled employee at a pesticide plant precipitated an explosion in one of the storage tanks by adding water to it. This led to the massive release of methylisocyanate and the noxious fumes affected thousands of people living near the plant. Four months later, some 1,430 persons were reported to have died as a direct result of the leak—a figure that increased to the 3,800 reported by Indian officials seven years later. A total of 11,000 persons were disabled or harmed from exposure to the gas. This one case was serious enough to lead to laws that require public reporting on all similar industrial risks in the US.

Military estimates of lethality also generally assume prompt medical action and some assume rapid decontamination or evacuation of the area. Response can fail or be ineffective if it is not properly organized. Chemical weapons can have lingering effects as poisons, and act as contact or food poisons for days after they cease to be effective as mass agents. BVX, HD, HN, L, and HL are all persistent agents that can remain lethal for weeks.[33] Effective and timely decontamination could well be impossible. Casualty recognition can be difficult with some weapons, where there is either a psychomimetic agent or a quiescent period in terms of symptoms. In some cases, the use of antidotes like Atropine could create medical problems of their own. In others, severe exposure can require up to a week of intensive treatment for nerve gas, and months to years for inhaled blistering agents.[34]

Nevertheless, past estimates of chemical weapon lethality have borne little relation to either the actual lethality achieved in combat or the area actually covered with a given amount of agent. After more than five years of using chemical weapons for example, the Iraqis still found that even nerve gas was often more useful in area denial, forcing rapid withdrawals, or in creating panic than as a killing mechanism per se.[35] The tendency to estimate lethality in terms of neat wind-borne ellipses or “plumes” has also confused the lethality issue. Under most real world conditions, it is likely that small chemical weapons would have very limited areas of lethality, and that wide area coverage would require far larger amounts of agent than are likely to be feasible in state covert, proxy, terrorist, or extremist attacks on the US homeland.

One “wild card**”** that might change this situation is the potential existence of “fourth generation” chemical weapons. According to some reports, Russia developed far more lethal chemical weapons during the Cold War and brought them to production readiness. At least some experts believe that it is possible that far more lethal chemical weapons exist than are listed in unclassified studies. One thing is clear. It is possible to produce chemical weapons with the lethality of the nerve gases using precursors that are not controlled by the Chemical Weapons Convention, and there are intelligence indicators that some countries are developing such weapons or have produced them.

Methods of Delivery

Most chemical weapons are not easy to handle or deliver, and even nerve gas has to be used in large amounts to achieve high levels of coverage and lethality. Obtaining suitable delivery systems can be a real problem, although covert attacks can be conducted from fixed locations in an urban area, and suitable dual-use delivery systems are readily available in the form of crop duster aircraft and simple spray generators that can be readily adapted for delivery of a variety of agents.

At the same time, the quantities of chemical agent required to conduct low level attacks are relatively small when compared to industrial production of similar commercial chemicals, which poses problems for detection. Terrorists could employ same amounts of CW agents in a variety of means utilizing simple containers such as glass bottles**.** The lethality of any given chemical weapon would also increase strikingly if it was used in a closed environment like an office building with a forced air system, or disseminated under ideal conditions in an urban environment.

Lethality may also be only one consideration in choosing the means of delivery for a covert or chemical terrorist attack. Much would depend on the perceptions of the attacker of the full range of post-attack impacts of using a chemical weapon. It is far from clear, for example, that civilians would ever accept a building as safe where persistent chemical agents had been used, regardless of the success of contamination efforts. Gulf War syndrome and Agent Orange are one thing in the context of US military serving over seas; chemical attacks are quite another in the context of civilians living in America.

As is the case of virtually all forms of attack on the American homeland, the psychological and political impact of a given strike would also be as important as the resulting physical damage or body count. An attack on the US Capitol building with minor casualties would have far more symbolic and political impact that a high-casualty attack on a hotel. Attacks on targets with high media profiles and live new coverage can be important almost regardless of their effectiveness. The visible physical symptoms of chemical weapons, their horrifying reputation, and their alien nature will be a critical "effect," although many forms of fragmentation wounds cause at least as much suffering in practice.

Detection and Interception

Chemical weapons can impose serious problems in terms of detection. The flow of people and goods across the Canadian, Mexican, Alaskan, and Hawaiian borders, and the East and West Coast, is so intense that it is unclear that any detection system would find the amounts used in covert, proxy, and extremist/terrorist attacks – even assuming that truly cost-effective and reliable detection devices become readily available and could cover binary or trinary ingredients. Even if reliable, low cost detectors and detection systems do become readily available – as some experts assume – this does not mean that they will be able to cover enough areas and means of shipping to cope with the volume of commercial shipping into the US, and provide a reliable method of detection and defense. Any gaps in coverage are likely to be openly documented, and the details of US detection systems are likely to become part of the open literature – giving foreign attackers much of the information they need.

The domestic production of weapons will probably only be detectable by receiving a warning through human intelligence, or tracing the flow of key equipment and ingredients which may legally and physically impossible. Once a weapon is actually used, detection may also be too late. This would certainly be true in the case of an attack exploiting a closed air system, and might well be true of a modified drone or crop sprayer. Even if an antidote or safe area is available, it is unclear that anyone would have the time and capacity to react to a first use, or that defense would be affordable.

The problems in developing effective interception, defense, and response measures can be compounded by using more than one group of attackers, and by mixing agents that require different kinds of protection and decontamination. They can be compounded by the use of persistent agents, near simultaneous attacks in a number of areas, and sequential attacks designed to target those who respond to initial attacks. Furthermore, it is far from clear whether the detection and sensor systems necessary to cover entire urban areas, and provide detection and characterization of an attack, will be cost-effective.

Acquiring Chemical Weapons

Many experts believe that most terrorists will find it difficult would be to obtain the necessary chemical weapons, in the necessary amounts, and develop an effective delivery system or device.[36] Acquiring chemical weapons would not be a problem for most governments, but the ease with which most domestic or foreign terrorists can obtain or manufacture such weapons has sometimes been exaggerated. The December 1999 report by the Advisory Panel to Assess Domestic Response Capabilities for Terrorism Involving Weapons of Mass Destruction makes the following points:[37]

> It has sometimes been claimed that producing Sarin and other nerve agents is a relatively easy process, to the extent, according to one authority, that "ball-point pen ink is only one chemical step removed." While Sarin may be less complicated to synthesize than other nerve agents, the expertise required to produce it should not, however, be underestimated. The safety challenges involved would, at a minimum, require skill, training, and special equipment to overcome. For this reason, the level of competency required for producing sophisticated chemical nerve agents, including Sarin, will likely be on the order of a graduate degree in organic chemistry and/or actual experience as an organic chemist—not simply a knowledge of college-level chemistry, as is sometimes alleged.
>
> Moreover, as with biological weapons, developing a means to disseminate Sarin effectively is likely to prove a far greater challenge to terrorists than is producing the agent itself. Although sarin's high volatility greatly simplifies weaponization, terrorists who may seek to cause mass casualties will need a fairly sophisticated means of spreading the agent in sufficiently large quantities over their intended target area. For wide coverage in an open area, such as a city, an airplane equipped with a suitable industrial or crop sprayer could be a satisfactory mechanism for dissemination.
>
> Alternatively, terrorists could equip a truck and drive through the target area, taking care, of course, to ensure that its passengers are properly sealed off from the chemical agent. Temperature, wind speed, inversion conditions, and other meteorological factors, however, would likely determine the effectiveness of any attack. For example, as Sarin and other chemical agents are exposed to the environment, they tend to be dispersed by the wind, which necessitates the use of large amounts of material to ensure that a given target receives a sufficiently high dose.
>
> In fact, the need to produce and disperse sufficiently large amounts of Sarin or other chemical agents to achieve the mass-casualty levels that may be sought by terrorists arguably drawn to chemical weapons in the first place ironically may be the biggest disincentive for their use. A U.S. Defense Department model illustrates the problem. Releasing ten kilograms (22 pounds) of Sarin into the open air under favorable weather conditions covers about one-hundredth of a square kilometer with lethal effects. Since population densities in U.S. urban areas are typically around 5,000 people per square kilometer, such an attack would

kill about 50 people.

Releasing 100 kilograms (220 pounds) of Sarin into the open air affects about ten times as much area and therefore would kill approximately 500 people.[38] Releasing 1,000 kilograms (2,200 pounds) into the open air would cover several square kilometers, killing about 10,000 people. Thus, only in an open-air attack using amounts approaching 1,000 kilograms of Sarin would the effects become distinctly greater than that attainable by such traditional terrorist means as conventional explosives. One way for terrorists to overcome these problems would be to carry out an attack in an enclosed space, such as a domed stadium, office building, or subway system.

A similar GAO analysis of the ease with which attackers could obtain chemical weapons found that,[39]

Experts from the scientific, intelligence, and law enforcement communities we spoke with agreed that toxic industrial chemicals can cause mass casualties and require little if any expertise or sophisticated methods. Generally, toxic industrial chemicals can be bought on the commercial market or stolen, thus avoiding the need to manufacture them. Chlorine, phosgene, and hydrogen cyanide are examples of toxic industrial chemicals. DOD classified further details concerning the use of toxic industrial chemicals.

Experts believe that unlike toxic industrial chemicals, for various reasons, most G and V chemical nerve agents are technically challenging for terrorists to acquire, manufacture, and produce. Examples of the G-series nerve agents are tabun (GA), Sarin (GB), and soman (GD). VX is an example of a V- series nerve agent. According to chemical experts, developing nerve agents requires synthesis of multiple precursor chemicals. On the basis of our review of a technical report, 11 we concluded that some steps in the production process are difficult and hazardous. Although tabun production is relatively easy, containment of a highly toxic gas (hydrogen cyanide) is a technical challenge. Production of Sarin, soman, and VX requires the use of high temperatures and generates corrosive and dangerous by- products. Moreover, careful temperature control, cooling of the vessel, heating to complete chemical reactions, and distillation could be technically infeasible for terrorists without a sophisticated laboratory infrastructure. Blister chemical agents such as sulfur mustard, nitrogen mustard, and lewisite can be manufactured with ease or with only moderate difficulty. However, experts told us that buying large quantities of the precursor chemicals for these agents is difficult due to the Chemical Weapons Convention.

…Chemical experts believe that chemical agents need to be in vapor or aerosol form (a cloud of suspended microscopic droplets) to cause optimal inhalation exposure and to cause an effect. Vapors and aerosols remain suspended in the air and are readily inhaled deep into the lungs. Another method is to spray large droplets or liquid for skin penetration. A chemical agent could be disseminated by explosive or mechanical delivery. Further, chemical agents can be disseminated in vapor, aerosol, or bulk droplet form from delivery devices.

According to the experts, terrorists could disseminate chemical agents using simple containers such as glass bottles with commercial sprayers attached to them or fire extinguishers. However, the chemical agent would need to withstand the heat developed if disseminated by explosives. Moreover, according to chemical experts, the successful use of chemical agents to cause mass casualties requires high toxicity, volatility (tendency of a chemical to vaporize or give off fumes), and stability during storage and dissemination. Rapid exposure to a highly concentrated agent in an ideal environment would increase the number of casualties. These experts agree that disseminating a chemical agent in a closed environment would be the best way to produce mass casualties. Weather affects exterior dissemination, particularly sunlight, moisture, and wind. Some chemical agents can be easily evaporated by sunlight or diluted by water. The experts stated that it is also difficult to target an agent with any precision or certainty to kill a specific percentage of individuals outdoors. For example, wind could transport a chemical agent away from

> the designated target area.
>
> …The 1995 attack by Aum Shinrikyo, an apocalyptic religious sect, in the Tokyo subway using the chemical nerve agent Sarin elevated concerns about chemical and biological terrorism. Twelve people were killed and many more were injured as a result of that incident. Some experts have noted that despite substantial financial assets, well-equipped laboratories, and educated scientists working in the laboratories, Aum Shinrikyo did not cause more deaths because of the poor quality of the chemical agent and the dissemination technique used.

It should be noted, however, that these views again reflect the tendency to see the threat of "terrorism" as being separate from the more sophisticated threats that could be posed by proxy attacks and state actors. The risks would change radically if states became involved and used or provided the chemical weapon. There has also been at least one successful terrorist use of chemical weapons without state aid. The Tamil Tigers used commercially obtained chlorine gas on a besieged Sri Lankan special forces group at East Kiran in June 1990. The attack worked, although all the Tigers did was take drums of the chemical from a nearby paper plant, wait for the right prevailing wind, and open the drums.[40] It is also dangerous to rule out industrial sabotage. Sabotage by one man at a plant at Bophal in 1984 did, after all, kill far more people than the attacks of Aum Shinrikyo.

At the same time, the GAO analysis ignores the availability of a wide range of commercial poisons which can be used to produce limited numbers of casualties, but which are described in detail in the unclassified military literature issued by the US Army. It should also be noted that the Advisory Panel drew most of its database from models tailored to the use of chemical weapons in largely open-air conditions. It is not clear that such models are valid in built-up or urban areas. Tanker trucks could be used to deliver the chemicals needed to deliver an agent in office buildings. Some lethal gases or chemicals rise, but all current chemical weapons are actually vapors that are heavier than air. An attacker could exploit these characteristics in those buildings with large open spaces or forced air systems, or by the use of elevator shafts and other vertical corridors.

The dissemination and persistence of chemical weapons in attacks launched from outside a closed air system like a large office building would be a function of heat, wind patterns, and terrain obstruction. Even under military conditions, real world dissemination never follows the neat, predictable elliptical patterns used in military models. Concentrations vary sharply over the dissemination area, and "skip effects" can blow lethal concentrations substantial distances down wind.

An attack on an urban area using a delivery system like a commercial aircraft or aircraft modified as a drone, and either crashed into an urban area or uses as a line source sprayer, would deposit chemical weapons over the complex surface of urban "canyons." Depending on the time of year, temperature, etc., such an agent might either be remarkably persistent near the ground or be deposited over a large vertical areas with little lethality. At present, the open literature simply does not provide a useful basis for drawing any conclusions, and this presents major problems in both assessing risk, and the value of given detection, characterization, and response measures.

The Impact of Technological Change

Finally, it is not clear from open sources how changes in chemical technology and production over the coming twenty-five years will affect the ways in which state actors, proxies, and terrorist/extremist groups can attack the United States. Key issues include:

- Advances in the way chemical weapons can be manufactured and used – including changes in related technologies like remote controlled crop sprayers, etc.
- The possible existence of "4th generation" weapons far more lethal than existing nerve gases.
- Whether control regimes and regulatory/safety controls will outpace any advances in the ability to make chemical weapons and use new commercially available ingredients.
- The level of security the US can develop to prevent the transit of chemical weapons or precursors into the United States.
- The capability and cost of new detection and characterization systems, and the ability to cost-effectively deploy them.
- Advances in protection and treatment.

It should be noted in this regard that the GAO has repeatedly cited the lack of comprehensive risk assessments as a problem in federal programs.[41] The unclassified literature the federal government issues on the risk posed by chemical weapons tends to ignore the need to forecast changes in risk, just as it tends to use generic lethality data of uncertain provenance and value.

The Aum Shinrikyo Case Study

Aum Shinrikyo makes an interesting case study of what a terrorist organization can do. It is somewhat misleading for GAO to state that Aum Shinrikyo did not cause more deaths “despite substantial financial assets, well-equipped laboratories, and educated scientists working in the laboratories…because of the poor quality of the chemical agent and the dissemination technique used.”[42] Aum experimented with a wide range of chemical weapons, including nerve agents like Sarin, tabun, soman, and VX, and considered hydrogen cyanide, and possibly phosgene and mustard. Aum selected Sarin precisely because it was relatively easy to manufacture, and any problems with the result are more a reflection on Aum’s peculiar internal structure and lack of effective organization than the technical problems in manufacturing chemical weapons per se.[43]

Aum does seem to have been successful in buying the formula for Sarin from a Russian and in getting all of the necessary equipment to make it successfully. It is also important to note that Iraq produced its first mustard gas in small lots at a university affiliated facility in less than six months, and initially rejected rushing forward with the manufacture of Sarin because it was not persistent and was unstable under heat and daylight conditions, and not because of the difficulty in making small amounts.

Aum attempted several different chemical attacks. It evidently staged its first attack on a rival religious leader in 1993, but its first successful attack was on the judges in a civil suit against Aum in Matsumoto in June 1994, where a heating element, fan, and sprayer on a refrigeration truck were used to kill seven people and injure 144. The Tokyo subway attack that took place in March 1995 killed only 12 people but injured more than 1,000. The delivery mechanism consisted of plastic bags of Sarin punctured in subway cars, where puddles of diluted Sarin were allowed to evaporate. This was an extremely crude delivery method, and even so the Japanese authorities reported some effects for as many as 5,000 people, and the prosecutors claimed 3,398 were injured.

Better tactics in using the same dissemination technique could easily have produced far more lethal results, and there are a number of simple and more effective dissemination techniques.[44] For example, Aum Shinrikyo could have achieved high lethality efforts introducing the same agent into the closed air systems in many high rise office buildings, or simply by releasing pools of Sarin over wide areas in the floor of the Kasumigaseki subway station, rather than leaving it in bags in subway cars. Aum planned similar attacks for May 5, 1995 and July 4, 1995, and it is still unclear why they failed.

There are different descriptions of what Aum did, and some illustrate how the risk could have been much greater. Reporting by Chris Bullock and Kyle Olson describe the Aum attacks as follows:[45]

> Kyle Olson: On a warm June evening (in 1994), a group of cult members drove a truck similar to one illustrated in this picture into the city (Matsumoto, north of Tokyo) on a mission, a very explosive mission, a mission to kill three judges who were about to hand down a ruling in a land dispute, which it was believed by the cult, they were going to lose. The decision had been made that they could not afford to lose that ruling, they had to prevent it from being issued. Moreover it provided an opportunity to field test Sarin gas, a weapon that the cult had been experimenting with for some time. In fact a weapon which they had actually tested on animals on a station in Western Australia in 1993.
>
> The device was designed around the notion of a truck that would carry a container of Sarin, would be preheated, raised to a vapor point and released as a cloud, an aerosol, literally a poison gas. Now the original plan was to attack the judges at their offices in downtown Matsumoto, however the cult miscalculated, in fact the leader of the group overslept that day. They got on the road late, they got to the target city late, and they had to improvise, and unfortunately Aum Shinrikyo had something of a genius for improvisation. They determined that the three judges were all living in the same dormitory in a residential neighborhood. They waited until dark, drove their truck into a parking lot adjacent to the development, and released a cloud of Sarin gas. The cloud very quickly swept up, taken by the winds essentially in what was a courtyard, moved up into open windows of various apartments and dormitories throughout the area, and in a very short time, seven people were dead and more than 500 people were taken to hospitals in this very quiet town.
>
> Now the event stands out historically for several reasons: first of all, this was the first use of nerve agent in a terrorist setting; it was a use not by a state but by a private group of individuals against civilians; and of particular note was that by and large the rest of the world paid absolutely no attention. This was a major story in Japan and in a few other pacific nations; it captured no attention in Western Europe nor in the United States. As a result, when the cult drove away, they were effectively invisible, and by the way, no ruling has ever been handed down in that land dispute.
>
> Chris Bullock: Nine months later, Aum used Sarin again, this time in the Tokyo subway, killing a dozen people and making 3-and-a-half-thousand people ill. Kyle Olson says the lessons from Aum Shinrikyo's actions are clear.

Kyle Olson: First of all the Tokyo subway attack, the objective of the attack, was not to kill hundreds or thousands of random strangers in the Tokyo subway. It had a very specific purpose: the cult had learned that the police in Tokyo had been trained the week before in chemical protective gear and tactics by the military, in anticipation of raids against cult facilities that were set to begin on Monday, March 20th, 1995. The reason the cult decided to attack the Tokyo subway on Monday March 20th, was to kill as many policemen on their way to work as possible. You see all of those trains converged at Kasumigaseki station, which serves the headquarters of the Japanese police agency.

You see, Aum's actions I would argue, were perfectly logical. We've heard them characterized as an insane cult, an end-of-the-world cult, a group of mad scientists in Buddhist monk clothing. Well actually I would argue that Aum's actions were perfectly logical. They had established their own value system. They essentially set themselves up as a society in conflict with larger society. A self-legitimized group that rejected and ultimately was going to have to confront that society at some level. Given that they didn't have enough men, enough guns, enough bullets to fight society and fight the police, let alone the military, they had to go with an asymmetric option, they had to find a trump card, and to this end it made perfect sense to think about weapons of mass destruction. Once they knew the police were about to attack, a pre-emptive strike was by their thinking, forced upon them. They could not afford to have their plans derailed.

Political and Psychological Effects

Casualties would not be of critical importance in attacks where the main consequence was intended to be psychological and/or political. It should also be noted that a number of multiple, near simultaneous small attacks could have a major impact in causing public fear and panic, forcing the US into a massive defensive response, and dominating media coverage. For example, out of the 5,010 Japanese that reported to hospitals after the Aum attack on the Tokyo subway during the first 24 hours, some 74% showed no symptoms of nerve agent exposures and were diagnosed as "worried well." By this standard, there were three to four times more psychological victims of the attack than physiological victims. Israel exhibited a similar pattern in response to Iraq's Scud attacks during the Gulf War, as did Iran during Iraq's Scud attacks on its cities during the Iran-Iraq War.[46]

Once again, there is no reason to tie perceptions of the seriousness of the use of weapons of mass destruction to actual mass destruction or mass casualties. If anything, attackers might feel they could make more political or psychological gains by demonstrating the ability to attack without creating the political backlash that would come from large numbers of deaths.

The Problem of Response

In spite of these uncertainties, chemical weapons are the weapon of mass destruction that most first responders and law enforcement agencies feel they are best prepared to deal with. They feel that most chemical attacks present many of the same problems and uncertainties as dealing with the shipment of similar hazardous materials (HAZMAT), or large-scale industrial accidents. They already have to prepare for such HAZMAT incidents, and the estimated total casualties from most chemical attacks are unlikely to put an impossible burden on medical services. The law enforcement aspects, and forensics, of dealing with chemical attacks present challenges, but law enforcement experts believe most incidents will have a clear location and clear chains of evidence.

The US has made advances in chemical weapons attack detection, at least at the military level. The Army and Marine Corps have fielded the M21 Remote Sensing Chemical Agent Alarm (RSCAAL) to provide standoff detection of nerve and blister agents. The hand-held Improved Chemical Agent Monitor (ICAM) provides all deployable units with a rapid, chemical agent monitoring and identification capability for nerve and blister agent vapors. There is a broad consensus, however, that there are still major problems in rapid detection and characterization, and in training and equipping suitable emergency medical personnel and facilities. These problems would be least significant if a chemical weapon was used in a single closed area. They could be more serious if a chemical weapon was combined with an explosive device in attacking a building or facility, and responders had to characterize and deal with two sets of destructive effects at the same time.

Serious response problems could occur if a chemical attack could be conducted in enough volume to cover a large area. A truly successful attack against a crowded subway could, for example, saturate response services and present major problems in determining the area covered by the agent and how many people were actually exposed and with what effect. The number of false reports, and people seeking cautionary or panic medical treatment would rise sharply. The fear of sequential or follow-on attacks would grow, and so would the problems in decontamination.

Such "military-level attacks" present problems very similar to those the Department of

Defense is now planning to defend against overseas, and recent DoD reporting on these attacks provides considerable insight into both the current problems in such defense and some of the new options the US is trying to develop. It is also clear that any major defense and response effort would be very intrusive and could have major side-effects:

> The greatest chemical warfare threats to our forces are agents that affect the central nervous system and cause convulsions and respiratory failure (nerve agents), and those that have a blistering effect (e.g., mustard). The U.S. Army Medical Research Institute for Chemical Defense provides a department focus to improve warfighter protection against chemical weapons.
>
> Protective clothing and protective masks with appropriate filters will afford protection to service personnel by preventing exposure. If an individual were to be exposed to a nerve agent, the MARK I Nerve Agent Antidote Kit with its two autoinjectors, one containing atropine and the other 2-PAM chloride, are effective counters against the physiological effects of various nerve agents and are issued to deployed forces. Three MARK I kits are issued to each individual with specific instructions on usage following exposure. A disposable autoinjector with an anticonvulsant drug (Convulsant Antidote for Nerve Agents, or CANA) is also issued to troops and is administered by a buddy following the administration of the third MARK I kit when the three MARK I kits are used. In addition, personal skin decontamination kits (M291), to be used by the individual in the event of exposure to chemical agents, are issued to the troops.
>
> When faced with a soman or tabun nerve agent threat, another drug, known as pyridostigmine bromide (PB), is available and would be employed at the direction of the military Commander in Chief following established procedures. Soman and tabun bind very quickly and irreversibly in the body to the enzyme necessary for nerve conduction. This rapid and irreversible binding phenomenon, known as “aging,” can be lessened if PB is already circulating in the body through pretreatment. PB can and does interfere with the permanent binding of these agents, and can, therefore, improve the chances for survival of exposed individuals who have not had enough time to don full protective gear with masks or were unaware of the presence of soman. DoD is seeking FDA approval to use PB, coupled with the standard post-exposure treatment using the MARK I kits, as a pretreatment adjunct when forces are faced with the soman or tabun threat. PB has been approved for human use by the FDA as a safe and effective treatment of certain neuromuscular disorders, such as myasthenia gravis (a disease that affects neuromuscular control); however, PB has not yet been approved in the United States for human use as a nerve agent pre-treatment. While it would be unethical to test PB in humans for efficacy against nerve agents, the effectiveness of PB against soman and tabun has been well-documented in animal models.
>
> Critical issues of medical chemical defense include the ability to protect… from the very rapidly acting nerve agents and persistent blistering agents, as well as choking and respiratory agents. A Joint Medical Chemical Defense Research program seeks to maintain the technological capability to meet present requirements and counter future threats, pro-vide individual-level prevention and protection to pre-serve fighting strength, and provide medical management of chemical casualties to enhance individual survival and return to duty…Medical chemical defense R&D materiel solutions under evaluation or development include:

- CW Agent (CWA) Scavengers —Human enzymes that have been genetically engineered to destroy nerve agents are being developed.
- Advanced anticonvulsants that are water-soluble and long-acting are being evaluated for control of nerve agent-induced seizure activity.

- Reactive topical skin protectant creams are being developed that not only prevent penetration of CWA but will also destroy them.

- Antivesicants are countermeasures that provide reduction in mustard-induced tissue swelling, ocular opacity, and skin damage. Effects of Exposure to Non-Lethal Levels of CWA—The incidence and probability of chronic medical effects of single and multiple low-level exposures to CWA are being investigated. Novel Threat Agents —Current medical regimens used for protection against the conventional nerve agents are being evaluated as a countermeasures for novel threat agents.

- Cyanide Countermeasures —Medical compounds (e.g., methemoglobin formers and sulfide donors) are being evaluated for safety and efficacy as pretreatments for cyanide poisoning. An external, noninvasive, personal exposure monitor is being transitioned for development and fielding to track the levels of these cyanide pretreatment compounds.

- Chemical Casualty Management —Technologies to assist in the diagnosis, prognosis, and management of chemical casualties in a medical treatment facility are being developed.

- Respiratory Agent Injury —Mechanisms of respiratory agent injury are being determined and medical countermeasures for respiratory agent casualties are under investigation.

A medical chemical defense product coming out of the R&D program for which an FDA license is pending is the Topical Skin Protectant (SERPACWA), a barrier cream effective against nerve and vesicant agents.

Large scale, open air attacks would present additional problems if very large amounts of ifagent could be broadly disseminated, or industrial sabotage -- a Bophal-like incident -- produced the same effect. No currently deployed detection system can accurately measure the plume or area coverage of such an attack, and most detection systems would present problems in reliably characterizing the exact weapon used and/or the amount of the weapon present in given areas. In many cases, little is also known about what constitutes a lethal dose, symptomology, treatment, and long-term effects.

While sophisticated individual detection and characterization devices are available and much more reliable and advanced systems are completing development, there as yet are no rapidly deployable arrays that can be used in urban environments, and must responders have no funds to acquire them. There are no current plans to broadly disseminate gas masks or the antidote to nerve gas before a crisis – even if warning occurs – and there are severe limits on the ability to treat large numbers of gas victims even in urban areas.

While most urban responders have plans for handling the public relations aspects of chemical accidents, it is far from clear that these plans would work in dealing with major chemical attacks or sequential attacks. It is also clear that national and local media at best have token preparations to report on such attacks, and to perform a civil defense role. The psychological dimension presents problems because it is not clear that the normal decontamination of areas, facilities, and buildings will not leave trace problems or that the public can be convincingly reassured of what is and is not safe. More broadly, the long-term medical effects of a large-scale attack are very difficult to characterize, and the Gulf War has shown how the resulting uncertainties can create major medical, psychological, and political problems.

Fortunately, under most conditions these problems may prove moot. Although some models indicate that limited amounts of sophisticated chemical weapons can produce thousands of casualties, it is more likely that a serious chemical attack or incident would produce 1,000 casualties or less. It would take a highly sophisticated group to launch multiple attacks and produce large amounts of highly lethal agent. As a result, it seems unlikely that either defenders or responders will have to deal with the kind of chemical attack(s) that could cripple a significant part of the economy, paralyze a city, vastly over-saturate available response and medical facilities, cause lasting panic and a loss of faith in political institutions, or threaten the fabric of American society, In this sense, chemical weapons differ fundamentally from biological and nuclear weapons.

Nevertheless, the threat posed by chemical weapons illustrates the need to be able to measure the existing capabilities of federal, state, and local defenders and responders, to determine what can be done to improve their capabilities with minimal or no additional resources, and then to expressly address what level of additional capability the nation is and is not willing to fund. At present, federal efforts are just beginning to develop a detailed picture of existing national capabilities, and much of the governmental effort at every step is concerned with basic endeavors to understand the problem, coordinate, and train. There is no question that this is producing real progress, but it does not create a system or architecture for Homeland defense, and no one has seriously addressed the question of “how much is enough?”

One key problem is that defense and response against chemical, biological, and radiological attacks must generally begin at the local level, and state and federal aid will normally come hours or days after the event. Local law enforcement, emergency services, and medical services must bear the brunt of trying to stop or contain an incident if there is warning and ameliorate the consequences if it succeeds. In the case of most chemical attacks, like most high explosive attacks, local and regional capabilities will be decisive in determining the outcome. Regional and federal resources cannot be brought to bear in time without extensive and precise warning.

This, however, raises the question of what local resources are needed, and what federal role if any is needed to provide them. So far, this question has tended to be answered more in terms of defense and response to low to mid-levels of attack, and emergency response capabilities are better trained and organized than medical services. There are serious variations in response capability, and it is not clear what standards need to be set for each urban area, or to deal with attacks on critical facilities in areas which lack the resources approaching those of major cities.

It is also clear from the testimony and briefings of both responders and medical professionals that public health capabilities have been steadily down-sized in ways which limit the ability to handle the patient loads from chemical attacks, much less the much high patient loads from biological and nuclear attacks. At present cost and capacity constraints are so severe that medical facilities often cannot participate effectively in exercises and training for Homeland defense. These problems may grow as more public spending is shifted to dealing with the aging, and they are compounded by a search for cost-effectiveness among medical professionals which is reducing emergency medical facilities and placing sharp limits on ICU units and respirators. These problems illustrate the fact that effective Homeland defense cannot be separated from national health policy, or from the overall problems in balancing out treatment cost, the need to provide continuing peacetime services, and changing priorities to meet an aging population and deal with welfare reform.

Improvements are clearly needed in some aspects of defense and response to chemical attacks, as well as to other forms of large-scale attacks. There is a need to provide some kind of cost-effective detection and characterization system that can be rapidly deployed before or after an attack, and which will provide an accurate picture of how much of what agent is present in what area. Models lack the accuracy to substitute for measurement. At present, more effort seems to be going into improving individual detectors than in to creating deployable and affordable systems that can be available for local use – a problem compounded by the need to provide biological and nuclear detection and characterization as well as chemical. This kind of real time information is critical not only to first responders, but to the efficient use and allocation of regional, state, and federal aid.

Another problem that begins to arise with large-scale chemical incidents is the potential conflict between the law enforcement priorities necessary to obtain evidence and convictions, the need to take every possible measure to prevent follow-on attacks, the need to provide immediate emergency services, and long-standing problems in using US intelligence assets to support defense and response inside US territory when it may involve US citizens Considerable progress has been made in improving such coordination at the federal, state, and local level but much of this progress seems tailored to dealing with low-level attacks where normally criminal procedures and civil rights can be given priority. There does not as yet seem to be a clear doctrine for dealing with escalating levels of crisis where the need to take immediate and urgent action may have higher priority.

Table 4.3

US Department of Defense Estimate of Potential National Threats Intentions Involving Chemical Weapons

China

Beijing is believed to have an advanced chemical warfare program including research and development, production, and weaponization capabilities. China's chemical industry has the capability to produce many chemicals, some of which have been sought by states trying to develop a chemical warfare capability. Foreign sales of such chemicals have been a source of foreign exchange for China. The Chinese government has imposed restrictions on the sale of some chemical pre-cursors and its enforcement activities generally have yielded mixed results. While China claims it possesses no chemical agent inventory, it is believed to possess a moderate inventory of traditional agents. It has a wide variety of potential delivery systems for chemical agents, including cannon artillery, multiple rocket launchers, mortars, land mines, aerial bombs, SRBMs, and MRBMs.

Chinese military forces most likely have a good under-standing of chemical warfare doctrine, and its forces routinely conduct defensive chemical warfare training. Even though China has ratified the CWC, made its declaration, and subjected its declared chemical weapons facilities to inspections, we believe that Beijing has not acknowledged the full extent of its chemical weapons program.

India

India is an original signatory to the CWC. In June 1997, it acknowledged that it had a dedicated chemical warfare production program. This was the first time India had publicly admitted that it had a chemical warfare effort. India also stated that all related facilities would be open for inspection, as called for in the CWC, and subsequently, it has hosted all required CWC inspections. While India has made a commitment to destroy its chemical weapons, its extensive and well-developed chemical industry will continue to be capable of producing a wide variety of chemical agent pre-cursors should the government change its policy. In the past, Indian firms have exported a wide array of chemical products, including Australia Group-con-trolled items, to several countries of proliferation concern in the Middle East. (Australia Group-controlled items include specific chemical agent precursors, microorganisms with biological warfare applications, and dual-use equipment that can be used in chemical or biological warfare programs.) Indian companies could continue to be a source of dual-use chemicals to countries of proliferation concern.

Iran

Iran has acceded to the Chemical Weapons Convention (CWC) and in a May 1998 session of the CWC Conference of the States Parties, Tehran, for the first time, acknowledged the existence of a past chemical weapons program. Iran admitted developing a chemical warfare program during the latter stages of the Iran-Iraq war as a “deterrent” against Iraq's use of chemical agents against Iran. Moreover, Tehran claimed that after the 1988 cease-fire, it “terminated” its program. However, Iran has yet to acknowledge that it, too, used chemical weapons during the Iran-Iraq War.

Nevertheless, Iran has continued its efforts to seek production technology, expertise and precursor chemicals from entities in Russia and China that could be used to create a more advanced and self-sufficient chemical warfare infrastructure. As Iran's program moves closer to self-sufficiency, the potential will increase for Iran to export dual-use chemicals and related equipment and technologies to other countries of proliferation concern. In the past, Tehran has manufactured and stockpiled blister, blood and choking chemical agents, and weaponized some of these agents into artillery shells, mortars, rockets, and aerial bombs. It also is believed to be conducting research on nerve agents. Iran could employ these agents during a future conflict in the region. Lastly, Iran's training, especially for its naval and ground forces, indicates that it is planning to operate in a contaminated environment.

Iraq

Since the Gulf War, Baghdad has rebuilt key portions of its industrial and chemical production infrastructure; it has not become a state party to the CWC. Some of Iraq's facilities could be converted fairly quickly to production of chemical warfare agents. Following Operation Desert Fox, Baghdad again instituted a rapid reconstruction effort on those facilities to include former dual-use chemical warfare-associated production facilities, destroyed by U.S. bombing. In 1999, Iraq may have begun installing or repairing dual-use equipment at these and other chemical war-fare-related facilities. Previously, Iraq was known to have produced and stockpiled mustard, tabun, sarin, and VX, some of which likely remain hidden. It is likely that an additional quantity of various precursor chemicals also remains hidden.

In late 1998, UNSCOM reported to the UN Security Council that Iraq continued to withhold information related to its chemical program. UNSCOM cited an example where Baghdad seized from inspectors a document discovered by UNSCOM inspectors, which indicated that Iraq had not consumed as many chemical munitions during the Iran-Iraq War as had been declared previously by Baghdad. This document suggests that Iraq may have an additional 6,000 chemical munitions hidden. Similarly, UNSCOM discovery in 1998 of evidence of VX in Iraqi missile warheads showed that Iraq had lied to the international community for seven years when it repeatedly said that it had never weaponized VX.

Iraq retains the expertise, once a decision is made, to resume chemical agent production within a few weeks or months, depending on the type of agent. However, foreign assistance, whether commercial procurement of dual-use technology, key infrastructure, or other aid, will be necessary to completely restore Iraq’s chemical agent production capabilities to pre-Desert Storm levels. Iraqi doctrine for the use of chemical weapons evolved during the Iran-Iraq War, and was fully incorporated into Iraqi offensive operations by the end of the war in 1988. During different stages of that war, Iraq used aerial bombs, artillery, rocket launchers, tactical rockets, and sprayers mounted in helicopters to deliver agents against Iranian forces. It also used chemical agents against Kurdish elements of its own civilian population in 1988.

Libya

Libya has made progress with its chemical warfare effort. However, it remains heavily dependent on foreign suppliers for precursor chemicals, mechanical and technical expertise, and chemical warfare-related equipment. From 1992 to 1999, UN sanctions continued to limit the type and amount of support Tripoli receives from abroad. However, following the suspension of UN sanctions in April 1999, Libya wasted no time in reestablishing contacts with foreign sources of expertise, parts, and precursor chemicals for its program. Clearly, Tripoli has not given up its goal of reestablish-ing its offensive chemical warfare ability and continues to pursue an indigenous chemical warfare production capability.

Prior to 1990, Libya produced about 100 tons of chemical agents – mustard and some nerve agent – at a chemical facility at Rabta. However, it ceased production there in 1990 due to intense international media attention and the possibility of military intervention, and fabricated a fire to make the Rabta facility appear to have been seriously damaged. Libya main-tains that the facility is a pharmaceutical production plant and announced in September 1995 that it was reopening the Rabta pharmaceutical facility. Although production of chemical agents has been halted, the Rabta facility remains part of the Libyan chemical weapons program, and future agent production cannot be ruled out. After 1990, the Libyans shifted their efforts to trying to build a large underground chemical production facility at Tarhunah. However, the pace of activity there has slowed, probably due to increased international attention. The Libyans claim that the Tarhunah tunnel site is a part of the Great Man-made River Project, a nationwide irrigation effort. Libya has not become a state party to the CWC.

North Korea

Like its biological warfare effort, we believe North Korea has had a long-standing chemical warfare program. North Korea’s chemical warfare capabilities include the ability to produce bulk quantities of nerve, blister, choking, and blood agents, using its sizeable, although aging, chemical industry. We believe it possesses a sizeable stockpile of these agents and weapons, which it could employ should there be renewed fighting on the Korean peninsula.

North Korea is believed to be capable of weaponizing such stocks for a variety of delivery means. These would include not only ballistic missiles, but also artillery and aircraft, and possibly unconventional means. In fact, the United States believes that North Korea has some long-range artillery deployed along the demilitarized zone (DMZ) and ballistic missiles, some of which could deliver chemical warfare agents against forward-based U.S. and allied forces, as well as against rear-area targets. North Korean forces are prepared to operate in a contaminated environment; they train regularly in chemical defense operations and are taught that South Korean and U.S. forces will employ chemical munitions. North Korea has not signed CWC, nor it is expected to do so in the near future.

Pakistan

Pakistan ratified the CWC in October 1997 and did not declare any chemical agent production or development. Pakistan has imported a number of dual-use chemicals that can be used to make chemical agents. These chemicals also have commercial uses and Pakistan is working towards establishing a viable commercial chemical industry capable of producing a variety of chemicals, some of which could be used to make chemical agents. Chemical agent delivery methods available to Pakistan include missiles, artillery, and aerial bombs.

Russia

Moscow has acknowledged the world’s largest stock pile of chemical agents of 40,000 metric tons of agent. The Russian chemical warfare agent inventory consists of a comprehensive array of blister, choking, and nerve agents in weapons and stored in bulk. These agents can be employed by tube and rocket artillery, bombs, spray tanks, and SRBM warheads. In addition, since 1992, Russian scientists familiar with Moscow’s chemical warfare development program have been publicizing information on a new generation of agents, sometimes referred to as “Novichoks.” These scientists report that these compounds, some of which are binaries, were designed to circumvent the CWC and to defeat Western detection and protection measures. Furthermore, it is claimed that their production can be hidden within commercial chemical plants. There is concern that the technology to produce these compounds might be acquired by other countries.

As a state party to the CWC, Russia is obligated to declare and destroy its chemical weapons stockpile and to forego the development, production, and possession of chemical weapons. However, we believe that the Russians probably have not divulged the full extent of their chemical agent and weapon inventory. Destruction facilities are being planned at Shchuch’ye and Gornyy, two of the seven declared storage locations for the Russian chemical warfare stockpile; these efforts are being funded in large part by foreign assistance programs.

Nevertheless, Russia admitted it could not meet its first obligation to destroy one percent of its stockpile by April 2000. Subsequently, the Organization for the Prohibition of Chemical Weapons (OPCW) granted Russia an extension until April 2002, but with the stipulation that it must also meet 20 percent destruction deadline by the same date, as called for under the CWC. However, international experts agree that it will be extremely difficult for Russia to destroy its huge chemical arsenal by 2007 as mandated by the CWC. Even if Russia were to be granted a five-year extension by the OPCW, it is unlikely that Russia’s declared stockpile will be completely destroyed because of serious technical, ecological, financial, and political problems.

Syria

Syria is not a state party to the CWC and has had a chemical warfare program for many years, although it has never used chemical agents in a conflict. Damascus already has a stockpile of the nerve agent sarin that can be delivered by aircraft or ballistic missiles. Additionally, Syria is trying to develop the more toxic and persistent nerve agent VX. In the future, Syria can be expected to continue to improve its chemical agent production and storage infrastructure. Damascus remains dependent on foreign sources for key elements of its chemical warfare program, including pre-cursor chemicals and key production equipment. For example, during 1999, Syria sought chemical warfare-related precursors and expertise from foreign sources.

Sudan

Sudan has been interested in acquiring a chemical war-fare capability since the 1980s and has sought assistance from a number of countries with chemical warfare programs. We believe that Iraq, in particular, has provided technical expertise to Khartoum. In addition, the finding of a known VX precursor chemical near a pharmaceutical facility in Khartoum suggests that Sudan may be pursuing a more advanced chemical warfare capability. Sudan acceded to the CWC in 1999, although allegations of Sudanese chemical warfare use against rebels in southern Sudan have persisted. These, and prior allegations of chemical warfare use, have not been confirmed. Further, Khartoum’s desire to present a more moderate image and alleviate its international isolation will cause Sudan to proceed with its chemical warfare program with caution.

Source: Adapted by Anthony H. Cordesman from Department of Defense, Proliferation and Response, January 2001

Table 4.4

Key Chemical Weapons –Part One

NERVE AGENTS: Agents that quickly disrupt the nervous system by binding to enzymes critical to nerve functions, causing convulsions and/or paralysis. Must be ingested, inhaled, and absorbed through the skin. Very low does cause a running nose, contraction of the pupil of the eye, and difficulty in visual coordination. Moderate doses constrict the bronchi and cause a feeling of pressure in the chest, and weaken the skeletal muscles and cause filibration. Large doses cause death by respiratory or heart failure. Can be absorbed through inhalation or skin contact. Reaction normally occurs in 1-2 minutes. Death from lethal doses occurs within minutes, but artificial respiration can help and atropine and the oximes act as antidotes. The most toxic nerve agents kill with a dosage of only 10 milligrams be minute per cubic meter, versus 400 for less lethal gases. Recovery is normally quick, if it occurs at all, but permanent brain damage can occur:

Tabun (GA)
Sarin (GB) - nearly as volatile as water and delivered by air. A dose of 5 mg/min/m^3 produces casualties, a respiratory dose of 100 mg/min/m3 is lethal. Lethality lasts
1-2 days.
Soman (GD)
GF
VR-55 (Improved Soman) A thick oily substance which persists for some time.
VK/VX - a persistent agent roughly as heavy as fuel oil. A dose of 0.5 mg/min/m^3
produces casualties, a respiratory dose of 10 mg/min/m3 is lethal. Lethality lasts 1-16 weeks.

BLISTER AGENTS: Cell poisons that destroy skin and tissue, cause blindness upon contact with the eyes, and which can result in fatal respiratory damage. Can be colorless or black oily droplets. Can be absorbed through inhalation or skin contact. Serious internal damage if inhaled. Penetrates ordinary clothing. Some have delayed and some have immediate action. Actual blistering normally takes hours to days, but effects on the eyes are much more rapid. Mustard gas is a typical blister agent and exposure of concentrations of a few milligrams per meter over several hours generally at least causes blisters and swollen eyes. When the liquid falls onto the skin or eyes it has the effect of second or third degree burns. It can blind and cause damage to the lungs leading to pneumonia. Severe exposure causes general intoxication similar to radiation sickness. HD and HN persist up to 12 hours. L, HL, and CX persist for 1-2 hours. Short of prevention of exposure, the only treatment is to wash the eyes, decontaminate the skin, and treat the resulting damage like burns:

` Sulfur Mustard (H or HD) A dose of 100 mg/min/m^3 produces casualties, a dose of
1,500 mg/min/m3 is lethal. Residual lethality lasts up to 2-8 weeks.
Distilled Mustard (DM)
Nitrogen Mustard (HN)
Lewisite (L)
Phosgene Oxime (CX)
Mustard Lewisite (HL)

CHOKING AGENTS: Agents that cause the blood vessels in the lungs to hemorrhage, and fluid to build-up, until the victim chokes or drowns in his or her own fluids (pulmonary edema). Provide quick warning though smell or lung irritation. Can be absorbed through inhalation. Immediate to delayed action. The only treatment is inhalation of oxygen and rest. Symptoms emerge in periods after exposure of seconds up to three hours:

Phosgene (CG)
Diphosgene (DP)
PS Chloropicrin
Chlorine Gas

Table 4.4

Key Chemical Weapons –Part Two

BLOOD AGENTS: Kill through inhalation. Provide little warning except for headache, nausea, and vertigo. Interferes with use of oxygen at the cellular level. CK also irritates the lungs and eyes. Rapid action and exposure either kills by inhibiting cell respiration or it does not -- casualties will either die within seconds to minutes of exposure or recover in fresh air. Most gas masks has severe problems in providing effective protection against blood agents:

Hydrogen Cyanide (AC) A dose of 2,000 mg/min/m^3 produces casualties, a respiratory dose of 5,000 mg/min/m3 is lethal. Lethality lasts 1-4 hours.

Cyanogen Chloride (CK) A dose of 7,000 mg/min/m^3 produces casualties, a respiratory dose of 11,000 mg/min/m3 is lethal. Lethality lasts 15 minutes to one hour.

TOXINS: Biological poisons causing neuromuscular paralysis after exposure of hours or days. Formed in food or cultures by the bacterium clostridium Botulinum. Produces highly fatal poisoning characterized by general weakness, headache, dizziness, double vision and dilation of the pupils, paralysis of muscles, and problems in speech. Death is usually by respiratory failure. Antitoxin therapy has limited value, but treatment is mainly supportive:

Botulin toxin (A) Six distinct types, of which four are known to be fatal to man. An oral dose of 0.001 mg is lethal. A respiratory dose of 0.02 mg/min/m^3 is also lethal.

DEVELOPMENTAL WEAPONS: A new generation of chemical weapons is under development. The only publicized agent is perfluoroisobutene (PFIB), which is an extremely toxic odorless and invisible substance produced when PFIB (Teflon) is subjected to extreme heat under special conditions. It causes pulmonary edema or dry-land drowning when the lungs fill with fluid. Short exposure disables and small concentrations cause delayed death. Activated charcoal and most existing protection equipment offer no defense. Some sources refer to "third" and "fourth" generation nerve gasses, but no technical literature seems to be available.

CONTROL AGENTS: Agents which produce temporary irritating or disabling effects which in contact with the eyes or inhaled. They cause flow of tears and irritation of upper respiratory tract and skin. They can cause nausea and vomiting: can cause serious illness or death when used in confined spaces. CS is the least toxic gas, followed by CN and DM. Symptoms can be treated by washing of the eyes and/or removal from the area. Exposure to CS, CN, and DM produces immediate symptoms. Staphylococcus produces symptoms in 30 minutes to four hours, and recovery takes 24-48 hours. Treatment of Staphylococcus is largely supportive:

Tear
Chlororacetophenone (CN)
O-Chlorobenzyl-malononitrile (CS)
Adamsite (DM)
Staphylococcus

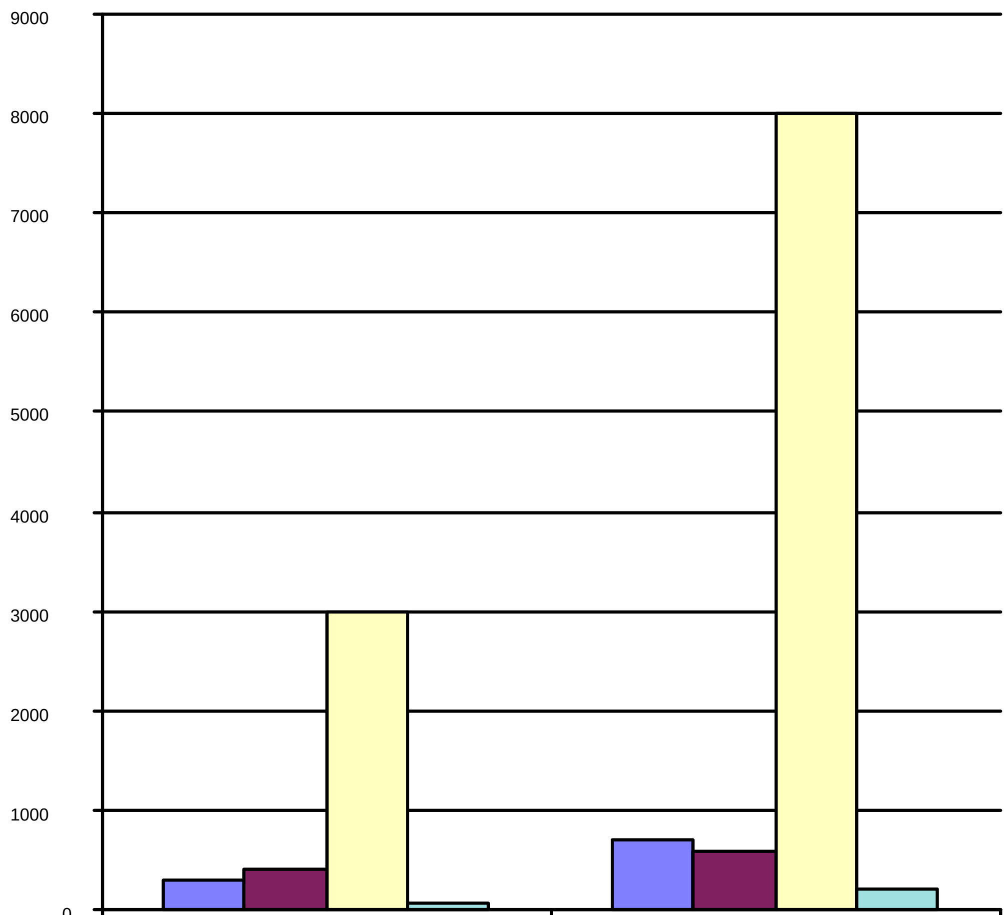
INCAPACITATING AGENTS: Agents which normally cause short term illness, psychoactive effects, (delirium and hallucinations). Can be absorbed through inhalation or skin contact. The psychoactive gases and drugs produce unpredictable effects, particularly in the sick, small children, elderly, and individuals who already are mentally ill. In rare cases they kill. In others, they produce a permanent psychotic condition. Many produce dry skin, irregular heart beat, urinary retention, constipation, drowsiness, and a rise in body temperature, plus occasional maniacal behavior. A single dose of 0.1 to 0.2 milligrams of LSD-25 will produce profound mental disturbance within a half hour that lasts 10 hours. The lethal dose is 100 to 200 milligrams:

BZ
LSD
LSD Based BZ
Mescaline
Psilocybin
Benzilates

Chart 4.1 –Part One

The Relative Killing Effect of Chemical Weapons Under Different Conditions of Aerosol Delivery

(Numbers of dead from delivery of 1,000 Kilograms)



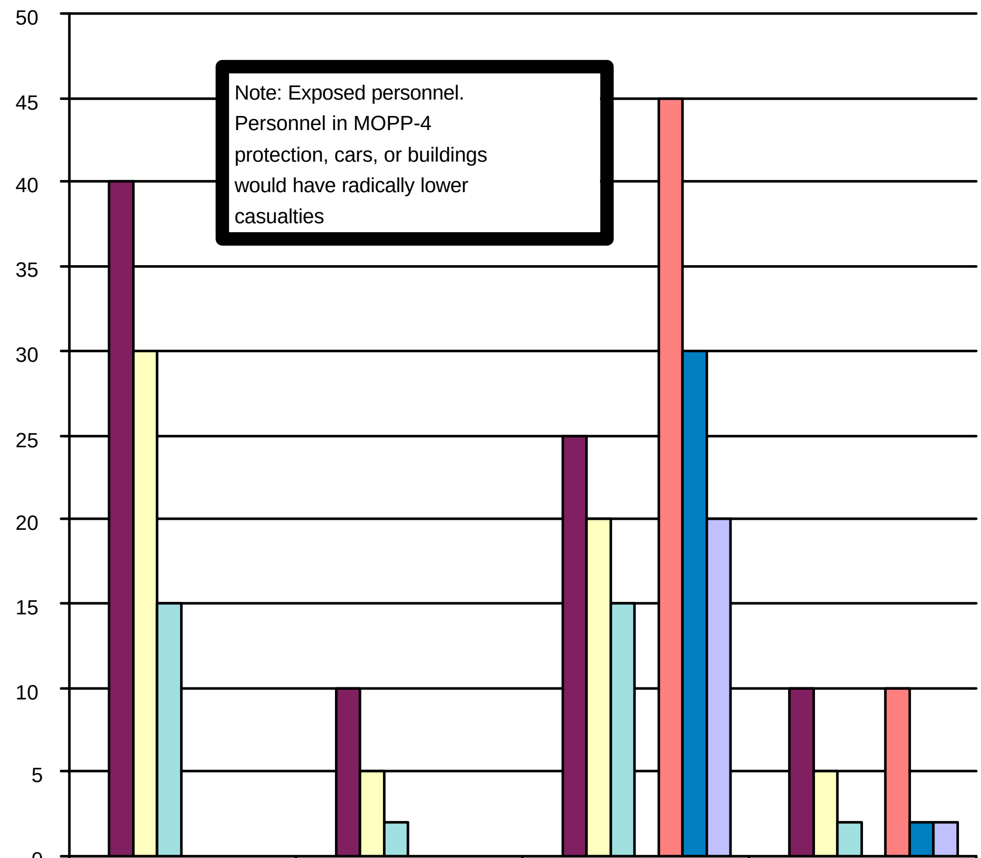
	Low	High
Sarin-Sun/Calm	300	700
Sarin-Shade/Wind	400	600
Sarin-Night/Shade	3000	8000
Bomb	60	200

Source: Adapted by Anthony H. Cordesman from Victor A. Utgoff, The Challenge of Chemical Weapons, New York, St. Martin's, 1991, pp. 238-242 and Office of Technology Assessment, Proliferation of Weapons of Mass Destruction: Assessing the Risks, U.S. Congress OTA-ISC-559, Washington, August, 1993, pp. 56-57.

Chart 4.1 – Part Two

The Relative Casualty Effect of Chemical Weapons Under Military Conditions

(Percent of Casualties)



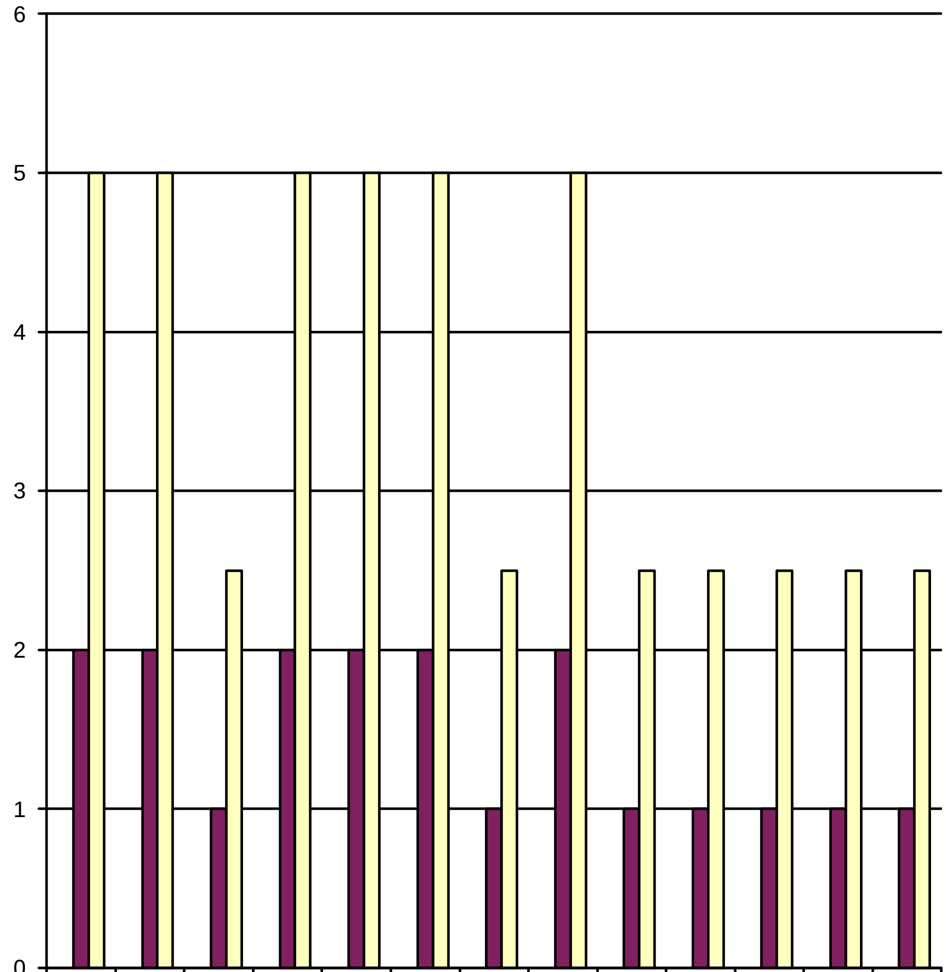
	Persistent Nerve	Non-Persistent Nerve	Persistent Blood	Non-Persistent Blister
Bursting Munitions				
150 M Radii	40	10	25	10
500 M Radii	30	5	20	5
1000 M Radii	15	2	15	2
Spray	.	.	.	.
150 M Radii			45	10
500 M Radii			30	2
1000 M Radii			20	2

Source: Adapted by Anthony H. Cordesman from Source: Adapted by Anthony H. Cordesman from Table 1-3 of FM-37 and USACHPPM, The Medical NBC Battlebook, USACHPPM Technical Guide 244, p. 5-7.

Chart 4.1 – Part Three

Exclusion Areas for Release from Bulk Tank of Hazardous Chemicals

(Quantity in Tons/Exclusion Area in Kilometers)



	Phosgene	Hydrogen Cyan	Hydrogen Cyan	Hydrogen Sulfi	Methyl Isocy	Chlorine	Ammonia	Ammonia	Sulfur Triox	Nitrogen Tetro	Bromine	Sulfur Dioxi	Acronitrile
Amount in Tons	*50	*50	*50	*50	*50	*100	*100	*500	*50	*50	*50	*50	*50
Daytime Exclusion Area in Kilometers	2	2	1	2	2	2	1	2	1	1	1	1	1
Nighttime Exclusion Area in Kilometers	5	5	2.5	5	5	5	2.5	5	2.5	2.5	2.5	2.5	2.5

Source: Adapted by Anthony H. Cordesman from JP 3-11, Draft and USACHPPM, The Medical NBC Battlebook, USACHPPM Technical Guide 244, p. 5-7.

[1] See John V. Parachini, "The World Trade Center Bombers (1993)," in Jonathan B. Tucker, ed, Toxic Terror, Assessing Terrorist Use of Chemical and Biological Weapons, Cambridge, Belfer Center for Scientific and International Affairs, 2000, pp. 185-207.

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[3] Ali S. Khan, M.D..Alexandra M. Levitt, M.A., Ph.D. Michael J. Sage, M.P.H. and others, Center for Disease Control, Biological and Chemical Terrorism:Strategic Plan for Preparedness and Response Recommendations of the CDC Strategic Planning Workgroup, April 21, 2000 / 49(RR04);1-14, http://www.cdc.gov/epo/mmwr/preview/mmwrhtml/rr4904a1.html.

[4] See USACHPPM, The Medical NBC Battlebook, USACHPPM Technical Guide 244, pp. 5-43 to 5-54.

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Chemical agents are either persistent or nonpersistent. Persistent agents may last from hours to days. Nonpersistent agents last minutes to hours. Agents can be lethal or non-lethal. The effects induced can include blistering, choking, blocking the ability of body tissue to absorb oxygen, convulsions, and paralysis. Reports indicate that the 1995 Japanese subway incident involved Sarin, an agent that attacks the nervous system.

The precursor chemicals and intermediate stages in the production process for two classical CW agents, nerve and blister agents, have both agricultural and industrial uses. For example, Thiodiglycol, which has been used to produce ball-point pen ink, can be converted to mustard agent by a simple (single) chlorination step. The technology and most of the production equipment, moreover, even the military hardware necessary for delivery and dissemination, are dual-use. Detection and discrimination between legitimate and illegal production are difficult. Facilities producing pesticides, insecticides, and fire retardant chemicals could be converted to CW production. There are strong external similarities between civilian and military facilities, although the latter may have observable security measures such as restricted access areas and fences, and possibly storage areas used for chemical munitions. Knowledgeable personnel are readily available; a relatively small number of chemical engineers and technicians are needed for production of chemical weapons.

CW THREATS DURING THE GULF WAR

"While the defensive capabilities of U.S. and other Coalition forces improved rapidly, CW/BW defensive readiness at the outset of the crisis was quite low. Coalition forces embarked on extraordinary measures to correct these weaknesses, largely by building up the preparedness of individuals to protect themselves in the event of CW/BW attack. On balance, these gains did lead to a significant potential for U.S. forces to operate on a contaminated battlefield. While the outcome would have been unaffected, the tempo of the Operation Desert Storm campaign could have been hindered had U.S. troops been forced to remain fully protected by masks and suits. Temperatures during Operation Desert Storm were comparatively cool; data indicate that risks of heat exhaustion would have been sharply higher in the summer, making protracted use of personal protective gear impractical. Studies have also shown that protective equipment dramatically impedes crew performance. The masks hinder communications, and the suits impair the ability to operate equipment. High-speed combat requiring close coordination between crews manning complex systems becomes quite difficult.

THE IRAQI THREAT. Iraq had developed a substantial CW capability including research and development facilities; stockpiles of CW munitions; a variety of delivery systems; and the doctrine and training to employ integrated CW and conventional fire effectively on the battlefield. Iraq was the first nation to use nerve agents on the battlefield -- attacking unprepared Iranian troops in 1984. By 1990, Iraq had the largest CW agent production capability in the Third World, annually producing thousands of tons of blister and nerve agents..."

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CW-suitable dual-use delivery systems are readily available ranging from SCUD missiles and unmanned aerial vehicles to sophisticated cruise and ballistic missiles. If need be, crop duster aircraft and simple spray generators can be readily adapted for delivery of a variety of agents. The quantities of chemical agent required are relatively small when compared to industrial production of similar commercial chemicals, which poses significant problems for detection. The low technology required lends itself to proliferation and even potential terrorist use. Terrorists could employ CW agents in a variety of means utilizing simple containers such as glass bottles, commercial compressed gas bottles, or propane tanks.

Military Significance

Chemical weapons are the only NBC munitions that have been used in post-World War II large-scale conflicts, most recently during the Iran-Iraq war. Consequently, there is cause for concern that proliferators may perceive that international responses (ranging from sanctions to military action) are less likely, given the use of CW.

CW impacts military operations in a number of ways. Large numbers of people (combatants and civilians) can be killed if suitable protective equipment or shelters are not available and properly utilized. There may be large numbers of nonfatal casualties. This was the characteristic experience when CW was employed during World War I. The volume of injured personnel can overwhelm the military medical evacuation and treatment system, impacting operations.

If CW employment is anticipated, forces are required to operate in protective ensembles that degrade operational performance, especially under adverse climatic conditions. Even though forces using appropriate protective equipment may be immune to CW effects, their ability to accomplish tasks is greatly reduced. Furthermore, equipment, facilities, and territory are contaminated. This impacts the ability of forces to maneuver. It also can have a major effect on ports, airfields, and other essential facilities that support operations.

Once CW use occurs, decontamination operations are required. These operations can be time-consuming. They may require forces to be diverted from other missions. In some instances, current technology decontamination equipment damages equipment. Perhaps most significantly, psychological effects impacting the ability of personnel to perform their missions can occur.

CW employment involves a number of factors, including agent type; the dissemination method (and its dispersion efficiency); droplet size; and meteorological conditions, including temperature, wind speed and direction, and inversion conditions. Agent dispersion can be very dependent on environmental factors, such as wind direction and speed.

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