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Chemical and Biological Weapons: Developments In the Kuwait Crisis And in Arms Control

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Published in:

Critical Choices, Edited by Eric H. Arnett, Elizabeth J. Kirk and W. Thomas Wander, the American Association for Advancement of Science, Washington, DC, 1991. pp129-149.
ISBN 0-87168-395-4

Moderator's Comments

This morning we will examine the prospects of the multilateral negotiations aimed at achieving a complete and total ban on chemical weapons, the Chemical Weapons Convention (CWC). However, before turning to our panelists, I think it is important to remind ourselves that much has already been accomplished by the United States and the Soviet Union in the area of chemical arms control.

For example, in September 1989, Secretary of State Baker and Soviet Foreign Minister Shevardnadze signed an agreement, the Wyoming Memorandum of Understanding (MOU), which provides for the two countries to exchange data on their respective chemical weapons arsenals and to conduct bilateral verification experiments.

More recently, at the June 1990 summit between Presidents Bush and Gorbachev, an agreement was signed which requires the two countries to stop producing chemical weapons and to destroy the vast majority of the weapons in their respective arsenals.

This bilateral reduction agreement will have a major impact on the Soviet chemical weapons capability, as Moscow will assume a binding legal obligation to destroy some 40,000 tons of chemical warfare agent in its arsenal.

Both the Wyoming MOU and the bilateral reduction agreement are also important because of their impact on the multilateral negotiations. Chemical weapons data are being exchanged, visits to chemical weapons facilities are being carried out, and procedures for verifying the destruction of chemical weapons are being negotiated. All of this is helping to build confidence both in the United States and in the Soviet Union about entering into the multilateral treaty. These bilateral exercises are also providing us with an opportunity to test important provisions of the multilateral treaty before it is concluded.

As we turn to our discussion of the prospects of the Chemical Weapons Convention, it is worth bearing in mind the contributions these bilateral agreements have made to the multilateral process.

At one time, if we thought about the problem of chemical weapons at all, it was in the context of the major powers. The United States and the Soviet Union had the world's largest stocks of chemical agents by far. That is still true today. They also have the largest production facilities.

During the last few years, however, those two countries have made tremendous progress in efforts to bring their chemical weapons inventories under control and make progress toward reductions. We have seen data-sharing agreements, joint inspections, and agreements on destruction of agents. As a result, we can be optimistic about the ability of the two countries to resolve all of the significant differences that would prevent the elimination of stocks. Unfortunately, the significance of these agreements has been diminished by developments in the Third World.

The proliferation of chemical weapons, as well as the extensive employment of agents during the Iran–Iraq War, highlight the extent to which efforts to get a Chemical Weapons Convention are going to have to focus on resolving issues that arise not from the great powers as was once the case, but rather the Third World.

Officials in the United States say there are twenty or more countries around the world with chemical weapons capabilities, the majority in the Third World. There is reason to doubt that all of those countries have what could be considered militarily significant quantities, but there are a number of Third World countries, and especially countries in the Middle East, that have substantial offensive chemical weapons capabilities.

At one time, those countries that did have chemical weapons capabilities probably had fairly small programs, but that is no longer true. Countries like Iraq, Syria, and Libya appear to have acquired significant production capabilities.

As a result, it is possible that over time, countries in the Third World will come to possess some of the world's largest stocks of chemical agents, given the plans by the United States and Soviet Union to eventually destroy their existing inventories. In fact, if current trends continue, that probably would happen by the end of the decade. But that, of course, assumes that the United States and the Soviets are actually able to destroy their stocks and Third World countries continue on what appears to be the existing production level.

The transformation of the issue from one that is East–West to one that is North–South or South–South has profound implications both

for negotiation of the convention and for the security concerns of countries with interests that extend into the Third World.

In this context, I will focus on two issues. One is the Chemical Weapons Convention in the context of the Middle East; the second is U.S. policy towards chemical weapons in light of the lessons we may have learned during the last four months, when we have had to ponder the prospect of facing a military opponent in the Third World with an offensive chemical weapons capability.

When looking at the Middle East, one has to start with a very pessimistic view because political and diplomatic circumstances make the region a significant obstacle to negotiation and implementation of the global Chemical Weapons Convention. Earlier this year, the Iranian foreign minister said, "To be frank, if the convention were ready today, the chances of its success in our region would be somewhat near zero."

This pessimism probably resulted from a variety of factors, including the fact that a number of countries in the region appear to assign considerable importance to chemical weapons in their military doctrines and the complicated linkage that arose between chemical weapons in Arab arsenals and the Israeli nuclear program. Unfortunately, the issue got further muddied by the current crisis in the Persian Gulf.

There are at least six countries in the Middle East that have offensive chemical weapons programs. We know a lot about a few; we do not know much about the others.

Discerning the motivations for these programs is not always easy, because they are not often discussed. For several of the countries — particularly Egypt, Iran, and Israel — the chemical weapons exist primarily as a deterrent against other countries' chemical weapons. Accordingly, those three countries probably have little desire to retain operational chemical weapons capabilities, provided that their potential adversaries also give up their stocks.

With Iraq and Syria, the situation is different. Syria appears to have acquired a chemical weapons capability as a deterrent against Israeli military capabilities at two different levels. First, chemical weapons act as an escalatory tool. Should Israel execute strikes using conventional munitions against certain strategic targets, as it did in 1973 against power plants and oil refineries, the chemical weapons give Syria a retaliatory option. Accordingly, it is likely to make the Israelis more circumspect about attacks on such facilities.

Similarly, the chemical weapons also provide Syria with a limited deterrent against the Israeli nuclear threat. Clearly, chemical weapons are no match for nuclear weapons' destructiveness, a fact of which the

Syrians are well aware. Nevertheless, chemical warheads on missiles are likely to kill far more people than conventional warheads, giving them an edge that they would not otherwise have. Given Israeli sensitivity to civilian casualties, this extra lethality probably provides the kind of deterrent that they need in order to ensure that Israel will not use nuclear weapons except in extreme situations.

The situation is somewhat different in Iraq. Like Syria, the Iraqis assign a strategic role to their chemical weapons arsenal. The Iraqis threatened to employ chemical weapons against Iranian cities during the 1988 War of the Cities, a danger taken seriously by the Iranians in the wake of the attacks on the Kurdish city of Halabja. Some experts believe that fears of a chemical attack on cities played a role in the Iranian decision to end the war.

Unlike Syria, however, Iraq also has assigned a tactical and political role to its chemical weapons. Iraq has begun to integrate routine employment of chemical weapons into operational military planning and also has made extensive use of chemical weapons as a successful terror weapon against its Kurdish population, a highly disaffected minority group. As a result, the Iraqis have given a fairly important role to chemical weapons in their doctrine.

Any effort to induce countries in the Middle East to accept the Chemical Weapons Convention will have to address these motivations and uses that are assigned chemical weapons.

The more critical issue, is linkage between the Arab chemical arsenal and the Israeli nuclear one. Some in the Arab world have advanced three conditions for their acceptance of the Chemical Weapons Convention.

First, they would not give up chemical weapons unless Israel also agreed to adhere to the Non-Proliferation Treaty and give up its nuclear weapons. Arab countries have adhered to the Non-Proliferation Treaty; in contrast, Israel has not. Israel continued to develop nuclear capabilities while Arab countries joined that treaty.

Second, some Arab countries have argued that it would be impossible to adhere to the Chemical Weapons Convention absent significant progress in resolution of the Israeli–Palestinian dispute.

Third, Arab countries will only adhere to the Chemical Weapons Convention if Israel does. This again reflects the experience with the Non-Proliferation Treaty. Few would argue with the notion that Arab adherence to the Chemical Weapons Convention must be accompanied by an Israeli willingness to do the same. At the same time, it is doubtful that many in the international community would accept the linkage between the Chemical Weapons Convention and the Arab–Israeli peace

process. The area that will be of greatest concern and that will have to be dealt with most adroitly is the linkage with the Israeli nuclear program.

The notion of linkage is widely accepted in the Arab world across the spectrum of opinion. The hard-line position is that, absent a total dismantling of the Israeli nuclear program, no Arab state will accept the Chemical Weapons Convention. However, there is reason to believe that this view is not the position of all Arab countries. Most significantly, Egypt does not appear to accept such a strong linkage.

Rather, based on conversations with nongovernmental and governmental Egyptians, my impression is that what the Egyptians really want to do is take advantage of the opportunity offered by the Chemical Weapons Convention to force the opening of a dialogue on the Israeli nuclear capabilities with the intention of, at a minimum, trying to place a cap on future expansion of those capabilities, perhaps by having the Dimona reactor placed under international safeguards.

The Egyptian views on this matter are critical and should be taken seriously. Not only is Egypt an important player in the efforts to negotiate the Chemical Weapons Convention, but it is in a position to influence opinion in the Arab world.

It is impossible at this stage of the game to tell what impact the Gulf crisis will have on the Chemical Weapons Convention. We do not know how the crisis is going to turn out.

There is a lot of interest in coupling with the crisis an effort to develop security regimes in the Middle East. Unfortunately, it is too early to tell whether those ideas have any prospect for success or even if it is possible to get them started.

But there are opportunities that might be taken advantage of; at the same time, the crisis may make serious discussion impossible.

The extent to which certain notions which once were widely accepted have been turned on their heads has been striking as one looks at within the U.S. military's responses to the threat of chemical weapons facing them.

The crisis has demonstrated the logistical problems associated with reliance on a chemical deterrent. If Iraq had invaded Saudi Arabia following the seizure of Kuwait and employed chemical agents, the United States would not have been able to respond in kind simply because we would not have had chemical agents in place in time.

Conflicts in the Third World that the United States is involved in are likely to take place in remote areas and could erupt with little or no warning. Hence, it is unlikely that we would be able to establish

retaliatory stocks in theater. Militarily useful stocks probably could not be flown by air and would have to be sent by sea. They might take weeks or even months to reach distant areas of the world. As a result, it is unlikely that we will have chemical weapons in place in the event of a crisis of this kind.

Second, it is hard to see how our current inventory would be useful. The delivery of many of the older unitary munitions is problematic, given the predominance of older ordnance ill suited for employment in the presence of modern air defense systems. For example, it is hard to conceive of U.S. aircraft making use of spray tanks in a situation where a potential adversary possesses large numbers of hand-held anti-aircraft missiles and short-range antiaircraft guns. Even aircraft-delivered bombs will not be useful if they must be delivered using methods that make the aircraft extremely vulnerable to hostile air defenses.

Given that it is unlikely that the United States will modernize its chemical arsenal to include new weapons filled with old agent, one suspects that our ability to retaliate chemically will remain limited.

Third, the capabilities of U.S. air power suggest the availability of conventional retaliatory options that were not viable in the context of retaliation against the Soviet Union. So long as the United States maintains its air power, no country in the Third World will be able to counter it. As a result, the necessity of chemical weapons as a response is difficult to prove.

Finally, and most interestingly, the Gulf crisis has forced a great many people in the U.S. military who previously would never have thought about this issue to take it seriously. Many soldiers have concluded that conventional munitions, for example, field artillery and minefields, are of considerably greater concern than chemical weapons.

Unlike conventional munitions, soldiers have counters to chemical weapons, including defensive equipment and training. As a result, concern for Iraq's chemical weapons arsenal is far less than might otherwise have been expected.

These factors suggest that the value of retaining a security stockpile of chemical munitions because of Third World threats is much less than has sometimes been assumed.

In conclusion, the issue of the Third World and chemical weapons will have a profound effect on efforts to negotiate a Chemical Weapons Convention. While there are some countries that may not have an interest in a Chemical Weapons Convention, there are also a great many Third World countries that are enthusiastically committed to it.

As a result, the issue is not one of North–South or East–West, but rather of particular countries in particular parts of the world. It is those countries that appear to have a stake in retaining chemical weapons that are going to have to be the target of diplomacy.

In some cases where countries are adamant in retaining the capabilities, it may have to be coercive diplomacy. In other cases, there are parallel tracks that will have to be pursued, especially in dealing with the basic issues that the Arab countries have raised. Absent such parallel tracks, we may have great difficulty in inducing even moderate states to get on board. However, there are diplomatic paths that can and should be pursued because they have a prospect of success.

Matthew Meselson

In evaluating the Chemical Weapons Convention (CWC) — the multilateral ban on chemical weapons now being negotiated in Geneva — it is useful to consider the chemical arms limitation system it would create and to contrast it in broad outline with the present situation.

At present, in the absence of the international prohibition it is seeking in the Geneva negotiations, the United States is attempting to curb the spread of chemical weapons by means of restrictions on the export of dozens of chemicals with legitimate peaceful uses which could also serve as intermediates in the synthesis of certain chemical warfare agents. In addition, there are restrictions on the export of some types of equipment and technical data that could be of use in making chemical weapons.

If the numerous potential supplier states all apply such export restrictions, they can prevent countries with little or no chemical industry from acquiring the means to produce chemical weapons. But even if such unity can be achieved, there would be left many countries with sufficient industrial chemical capability to make chemical weapons by themselves. This is made evident when we recall that the production of mustard gas and its incorporation into munitions is a technology three-quarters of a century old. Even the organophosphorus nerve agents were first stockpiled for use in war nearly fifty years ago. And of course antiproliferation measures do nothing to eliminate the chemical weapons already in being, such as the large stockpile of the Soviet Union.

The CWC would largely or entirely replace the present relatively ineffective and politically and economically burdensome system of export prohibitions with a uniform international political and legal prohibition against the development, production, possession, and transfer of chemical weapons — where no such prohibitions exist today.

Of course, even the unprecedented verification procedures being considered for the CWC cannot be altogether certain of detecting a clandestine violation. But they will provide a serious risk of detection, exposure, and possible sanctions sufficient to constitute a strong deterrent when today there is none — and to provide a substantial degree of mutual confidence when today suspected or actual chemical weapons programs in some states may stimulate programs in others.

Even with the CWC, however, there will still be an important role for measures of antichemical protection. Antichemical protection —

masks, protective clothing, detectors, etc. — can act to strengthen a chemical disarmament treaty in three ways:

- First, the existence and availability of antichemical protection reduces the incentive that states may have for possessing chemical weapons. This is because the military effectiveness of chemicals is very much lower against a force provided with gas masks and other protective equipment and training than it is against a force without such protection.
- Second, antichemical protection increases the scale of chemical preparations that a potential violator must undertake in order to achieve military significance, making verification easier and detection more likely.
- Finally, should violations nevertheless occur, antichemical protection makes them much less dangerous.

Verification of compliance with the CWC will be carried out by a professional staff of international civil servants, under the direction of a technical secretariat established by the convention. The negotiators in Geneva, working in consultation with representatives of the chemical industry, have reached rather detailed agreement on a system of on-site verification that addresses three different problems: verification of the destruction of declared chemical weapons stocks and production facilities; verification of nonproduction of chemical weapons in declared facilities of the chemical industry; and verification of the absence of undeclared stocks and facilities. An outline of representative on-site verification tasks and methods is given in the accompanying table.

An important disagreement remaining to be resolved concerns challenge verification. Many nations represented at Geneva, including the Soviet Union, members of the former Warsaw Treaty Organization, the European members of NATO, and important non-aligned and developing states, support a broad interpretation of its scope — portrayed as "any time, anywhere, with no right of refusal." This was, in effect, the original U.S. position, embodied in the 1984 draft treaty presented at Geneva by George Bush when he was vice president. Recently, the U.S. position has changed, in the direction of limiting the scope of challenge rights. China, too, has spoken in favor of limiting challenge rights — to "relevant sites." It is not yet clear, perhaps not even to the Chinese, how to define relevance or who decides.

When the United States first proposed mandatory challenge inspection, the British were highly skeptical. Since that time, however, they have carried out a series of six trial challenge inspections of their own sensitive facilities. Using various procedures of managed access designed to protect legitimate secrecy, such as shrouding sensitive

Table 1. Representative CWC On-Site Verification Tasks and Methods

Facility	Task	Methods
Declared Weapons Storage Facilities	Secure the Facility	Visual surveillance Tamper-proof tags/seals Automated Surveillance
	Verify the Declaration • Identify	Inspect records and layout Visual Inspection Chemical Analysis Acoustic Interrogation Neutron Interrogation
	• Quantify	Count or Weigh
	Verify Destruction	Visual Inspection Automated Monitoring
Declared Weapons Production Facilities	Secure the Facility	(as above)
	Verify the Declaration	Inspect Records and Layout Chemical Analysis
	Verify Destruction	Visual Inspection Overhead Photography
Declared Schedule I Production Facilities	Verify One-Ton Annual Limit and Non-Diversion	Inspect Records and Layout Chemical Analysis Monitor Production Storage and Consumption
Declared Permitted Chemical Facilities	Designate Site for Short-notice Inspection	Selection by States Party or Int'l. Inspectorate
	Verify Absence or Non-Diversion of Controlled Substances	Inspect Records and Layout Chemical Analysis Acoustic Interrogation Neutron Interrogation Monitor or Spot-Check Operation
Any Facility	Designate Site for Short Notice Challenge Inspection	Selection by States Party
	Verify Compliance	Managed Access Visual Inspection Chemical Analysis

conduct and evaluate trial challenge inspections of its own. The knowledge gained will be of use not only in connection with the Chemical Weapons Convention but also in negotiating other arms limitation agreements and in improving and making more relevant our entire approach to issues of secrecy and openness.

It is in our interest to seek a wide scope for challenge inspection, in order to minimize or even eliminate grounds for refusing a challenge inspection. Refusals of inspection are bad for an arms limitation treaty. They undermine both official and public confidence in its effectiveness. Moreover, refusals weaken deterrence. Onlookers, seeking a refusal, may be encouraged to undertake clandestine violations. There are therefore strong reasons to try hard to find solutions to the important problem of protecting legitimate secrets while ensuring compliance with the ban on prohibited activities.

One technology that can facilitate such selective information gathering is high-sensitivity chemical analysis for prohibited substances, their precursors, and their breakdown products. Mass spectrometry, for example, can reliably detect less that a picogram of nerve agent, a trillionth of a gram. A militarily significant quantity of such a substance — say, even as little as one ton — is 10^{18} picograms. It is just not possible to produce militarily significant quantities of such a substance with any confidence that it would not be detected by inspection able to collect and properly analyze samples from building surfaces, waste streams, equipment, etc. Such analyses can be conducted selectively, providing information about the presence or absence only of prohibited substances and no others, thereby revealing nothing regarding process materials that may be proprietary or sensitive.

A different sort of problem still unresolved at Geneva concerns the U.S. proposal of a right to retain small residual stocks of chemical weapons beyond the ten-year period that had previously been agreed TO for total elimination of such weapons. The United States proposes to retain 2 percent of its stocks, about 500 agent tons of chemicals weapons, until the eighth year of the convention and only then to decide whether or not to eliminate them, depending on whether all other "chemically capable" states have by then joined the treaty. The same right of retention of 2 percent of their declared stocks would be granted to all other states initially party to the convention. The reason given for this "2 percent proposal" is to encourage holdouts to join the treaty, presumably because they would feel threatened by the residual U.S. and Soviet stocks and any others for which 2 percent is perceived to be militarily significant. For their part, the Soviets have joined with the United States in presenting the idea for consideration at Geneva, but they are clearly not in favor of it.

There is little point in arguing the two percent idea back and forth for the simple reason that it has no support from other nations. It will have to change — and it will change — perhaps in return for some trade-offs on other issues. Just as the earlier U.S. proposal for continued modernization of chemicals weapons stocks after entry into force of the convention was non-negotiable, so is the two percent proposal.

The United States has played a genuine leadership role in Geneva, but conclusion of the convention requires that we find positions on the remaining issues that can command the support of the majority of other states. When this happens, quite possibly in the near future, there can be rapid progress toward conclusion of the multilateral ban on chemical weapons.

Questions and Answers

Question: The Bush administration has been giving as one of the reasons for the U.S. military presence in the Persian Gulf the existence of the Iraqi chemical threat. There is a vague relationship between the existence of the Iraqi chemical threat and our need to be there. The implication is that somehow we have to bring about the removal of that threat.

Please briefly describe the key elements of the Iraqi chemical weapons establishment. Is it feasible to destroy it, or if not, what would it take to neutralize it?

Carus: Our reason for going into the Gulf did not have much to do with the existence of Iraqi chemical weapons. It was related to a variety of other concerns, primarily the conventional threat to Saudi security and the flow of oil. If it had not been for them, we would not have responded as we did, no matter how extensive the Iraqi chemical threat.

There are military options to destroy Iraqi chemical capabilities. However, they are more limited than often portrayed. For example, production facilities could be destroyed, but it would be much harder to destroy existing stocks. It is the existing stocks that we are immediately concerned about, not production capabilities for future stock.

In any case, destroying production capabilities is not a long-term solution. The facilities were produced covertly. If the Iraqis were committed to it, they could reproduce those facilities. Ultimately, the only solution is for Iraq to decide for their own reasons that it is not to their advantage to have chemical weapons. It is not a problem that can be solved militarily.

Question: The notion of a militarily useful stockpile is central to what the panelists have been discussing today. It is important from the perspective of the deterrent stockpile under the convention; it is important because Congress traditionally, in analyzing the effectiveness of a verification regime, has used the concept of militarily significant levels of cheating as a core of their analysis.

From the perspective of a military commander, such a judgment is going to turn on how good his intelligence is. If he does not know very well what they have, he is going to err on the side of caution. That means putting troops into protective gear, which can be debilitating if worn over periods of time. Certain activities are difficult when one has protective gear on.

Research in the future can focus on defensive gear which is not debilitating; which is effective against the entire range of systems, including some "novel systems"; which could be donned frequently and taken off after false alarms; and in which troops could operate for long periods of time and perform sophisticated, technical tasks. What is on the horizon?

Meselson: It would be good to make the protective gear absolutely perfect, but the realistic objective is to make it so good that a potential user sees that it costs him as much or more to maintain and use chemical weapons than he gains by doing so.

There will never be a time when wearing protective gear is exactly like not wearing it. However, more progress can be made. The U.S. suit and mask are good. There are better things coming along. There is better protective clothing for hot weather. The Israelis, the Germans, and our Marines have it. It is made from a kind of cloth which, instead of having charcoal in a thick foam base, has a much thinner layer of small charcoal spheres applied to the inner surface of the cloth. There are also improved protective gloves, with less perspiration buildup and improved hot wear, less awkward to wear. Better more useable detection equipment is also becoming available.

Question: The U.S. position on challenge inspections has been unraveling, and our negotiators have been backpedaling a bit. On the other hand, the present crisis has called into question the adequacy of the inspections carried out in nuclear facilities by the International Atomic Energy Agency and connected with the Nuclear Non-Proliferation Treaty (NPT). All of those inspections are by appointment only, in declared facilities only. That is not looking quite as comforting as it used to.

Are the CWC challenge inspections applicable to the NPT? Would there be national security problems if we have challenge inspections in a mended NPT?

Carus: The international community has come a long way since the NPT was signed. It is likely, given the changing focus of concern for proliferation away from the fuel cycle to alternate means of getting fissile material, that some of the ideas that have been generated should be looked at the renewal of the NPT that is coming up in 1995.

Harris: Some of the strongest opposition to our former position on challenge inspection has come from the Department of Energy and the intelligence community. There is a strong feeling in those quarters that certain types of facilities simply could not be opened up to Soviet inspectors.

I am somewhat less optimistic than Matt is about the United States moving away from the new position it has adopted on challenge inspection. I suspect that our position is fairly firm and that we will try to convince our allies in the Western group to accept it.

We will, though, have to have a common position in the Western group before it can be presented in the wider CD.

Question: What are your views of the accelerating developments in biotechnology and genetic engineering as they relate to weapon production?

Meselson: Biotechnology will do more to improve the defense than the offense. Production of vaccines, though it has yet to get very far, will be helped by modern bioengineering techniques.

But the organisms that you might use for weapons already exist. The United States, when we used to do that — we do not do it at all anymore — spent a lot of money and effort developing biological weapons. What we stockpiled is a matter of record, and those organisms have not gone away.

Biotechnology can facilitate the production of toxins, but in a number of respects toxins are less attractive militarily than existing chemical agents. Toxins do not readily penetrate the skin. They are more expensive to make and are less stable than existing chemical warfare agents.

Question: What about the possibility of the use of chemicals or toxins by nongovernmental groups, such as terrorist organizations?

Carus: The issue of possible use of chemical biological toxins by nongovernmental groups, terrorist groups, is one that people have been concerned about for a long time. What is striking, is how little such activity has taken place; and when it has taken place, it has been of a fairly pedestrian sort: poisoning of export fruits, for example. There have been several examples of that.

The question then becomes Why, given all of the terrorist activity that has taken place over the last several decades around the world, has there been so little interest by such groups in chemicals, biologicals, and toxins (CB agents)?

First, the traditional terror weapons like plastic explosives are very easy to handle and use. Any of the CB agents is much trickier, more problematic in that regard and probably less reliable as well.

The worst-case scenario is, say, poisoning water supplies to kill millions of people. Given the extensive programs for purifying water in developed countries, one would have to overcome defenses that are already in place for other reasons before one could have an impact.

As long as countries continue to maintain the kinds of emergency procedures that any country would maintain for public health reasons, there is no reason to be excessively concerned about this kind of terror threat.

Question: In donning protective gear, to what extent can one rely on the mask alone? How long does a soldier typically wear the protective gear in battle?

Mounted troops in tanks and personnel carriers like to see out. Does this increase their vulnerability to chemical agents?

Meselson: The mask is the most important thing for the simple reason that the lungs are much more sensitive than the skin to toxic substances. In exercises, soldiers have worn the mask for long periods of time, days.

If the agent is only volatile and not persistent or if you are inside a vehicle or shelter which prevents liquid drops from entering, the suit may not be needed.

U.S. tank crews have a special mask. It is a lighter-weight mask or facepiece. It can be plugged into a filtered air supply in the tank. This allows tank commanders to operate with open hatches for better visibility. If there is heavy conventional fire, however, the commander may operate with the hatch closed.

If the Army decides to adopt the doctrine that whenever there are chemicals around, you should close your hatch and depend on collective protection, that could be an important decision. It might be that it does not matter greatly to the chemical threat, but by restricting vision in mobile engagements, armored vehicles could become less effective and more vulnerable. That would not be an effect of the chemical protection; it would be an effect of the doctrine. The doctrine is an important thing to consider.

Question: There has been a lot of talk about Iraq delivering chemicals by way of their ballistic missiles, which seems a difficult technical challenge. Could you describe the nature of that challenge and assess whether Iraq is anywhere near dealing with it?

Carus: It is an intriguing question. Systems like the Scud, the rudimentary Soviet delivery systems, are quite satisfactory. They are not as good as a more sophisticated cluster munition delivery of the type that the United States eventually developed, but even with the fairly rudimentary system that just essentially relies on the air to disperse the agent after detonation of a warhead between 1,000 feet or 1,000 meters can be quite useful as a delivery means.

If you have the technology, you would prefer to have a cluster munition delivery in terms of getting better dispersal and a more controlled pattern. But it is not essential.

Fusing can be problematic. It is basically a question of reliability. Iraq may get the fusing that allows it to do it, but unless they are very good, it may not be as reliable as they would want, for example, with nuclear weapons. But chemical weapons, by and large, are used in greater masses. The exact reliability of an individual unit is not as important.

It is a serious mistake to underestimate the potential technical capabilities of scientists and engineers in the Third World. Without trying to exaggerate what they can do, I would be hesitant to say that a competent team of engineers in the Third World with a lot of resources could not duplicate today work that was done in the United States or the Soviet Union several decades ago.

There is reason to believe that the Iraqis may now have some chemical warheads for their missiles. On the other hand, it is difficult to conclude that those missiles would have any significant military impact.

By and large, chemical weapons are effective en masse. Missiles are not an ideal system for massive delivery of anything. It is more a harassment weapon than a decisive military system.

I would worry much more if they were able, for example, to use aircraft or rocket and artillery delivery. Conventional weapons are more worrisome, even for delivery of chemical munitions.

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