The Challenge of an Open World

ESSAYS DEDICATED TO

NIELS BOHR

Munksgaard

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MUNKSGAARD

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agreements by increasing the risk of detection, and
The provision of timely warning of disturbing military activities.

Such inspections can be most effective if they are used to complement national technical means of information gathering.

In spite of inspections, it can be difficult to ensure strict compliance if a sovereign state wants to do something else. For example, consider post-World War I Germany, for which there were strict limitations and inspection required by treaty. There were in fact inspection officers, but the hated treaty agreements were regularly and to their knowledge circumvented, and it was deemed wise by surrounding European nations to not take any vigorous counteraction. Inspections provided knowledge, but not control, even in the presence of a written treaty.

The effectiveness of challenge inspections without a purpose common to all parties is still more questionable. In addition to delaying and circumventing inspections, a host country can deliberately provoke challenges, thus using up the opposing side's quota and subjecting it to embarrassing propaganda when nothing is found. Challenges are unlikely to find much that a country wants to keep hidden. Invited and cooperative inspections appear much more promising as a path to openness and reassurance.

Finally, particularly in the area of conventional military affairs, no theoretical openness arrangement can be very effective without its being wanted on all sides and without a commonness of purpose in carrying it out. And for this commonness of purpose and all-important good will, openness in other realms such as easy visitations back and forth across national boundaries, extensive trade and common joint enterprises which increase each nation's interests in having another nation successful can be crucially important. I have here paid most attention to those questions of openness having to do directly with weaponry and military action and must give too little attention to this general cultural and commercial openness. But I must at least note their importance and hope that others will be discussing them more extensively.

MATTHEW MESELSON

Prevention of Biological and Chemical Warfare

Chemical weapons is a subject on which there is a great deal of misinformation and sometimes even disinformation. In part this is because very few nations have experienced chemical warfare. Military officers of very few nations have first-hand knowledge about it. It's more than seven decades since the end of World War I, the last major use of chemical weapons between modern industrialized forces. Chemical warfare services, more than is typical for military services, have become significantly politicized, because they have had to fight for their lives, their weapons not being very popular. And the regular military generally is just not very interested in the subject. In the aca-

demic world there are very, very few people who make a full-time job of studying it. This is fortunate for me today, I'm the only one who doesn't have to share this platform.

I should begin with some technical background. Modern chemical warfare agents are quite few in number. Those stockpiled by the United States and those declared by the Soviet Union to be in its stockpile are mustard gas, first introduced in 1917, more than seventy years ago, and the nerve agents, riot control agents, and another blister agent rather like mustard. And that's it. Those are the modern chemical warfare agents. Even the nerve agents are not really new at all; these were first produced for military purposes fifty years ago.

Why so little change? Why such a stagnant field? It's not only that chemical weapons have not played a part in modern war. There has been a lot of research and development. There has been the screening of many compounds, very aggressively in several countries. The reason is at least in part that the number of different molecules that are good candidates for chemical weapons and agents is small. And it can be explored in a reasonably logical manner. This is not to say that someone might not come up with a new one, but fifty years of intensive screening of molecules, and in a field that is as systematic as organic chemistry, is pretty impressive.

What are the effects of these agents? About a milligram of nerve agent, if you inhaled it and absorbed it, would kill you. And about a milligram of mustard agent would cause a bad blister. But this is not to say that these tiny quantities are militarily significant, of course. In terms of military significance, the amount of a nerve agent that would have to be disseminated per square kilometer (let's choose that area) is about a ton, to be militarily effective. That is the amount that you will see in military field manuals. For mustard gas, five or ten times more. In terms of artillery projectiles, for nerve agent, a ton per square kilometer is about three hundred 155-millimeter artillery projectiles, about three per hectare. This is the amount that would kill about half of the people in that square kilometer if they're not wearing gas masks, and if the atmospheric conditions were mid-range atmospheric conditions.

A nerve agent like this is a few times more effective than high explosive against troops who are not dug in. So against forces who have not got gas masks or who are not wearing them, nerve agents and mustard are both superior under certain conditions to conventional high explosive weapons for causing casualties. They're about equal to so-called improved conventional munitions (these are munitions which distribute bomblets, or submunitions, munitions which are engineered to distribute shrapnel in a more effective way than conventional high explosives). Against those, nerve agents are approximately equally effective. However, the huge difference between chemical weapons on the one hand, and high explosive weapons or flame weapons on the other hand, is that, unlike with conventional weapons, there is an extremely effective defense against the direct casualty effects of chemical weapons. A gas mask reduces the concentration of chemical warfare agents in the air inhaled by people wearing them by a factor of 100,000. For this reason, and because protection can also be provided to the rest of the body against agents like mustard or nerve agents that can attack through the skin, chemical weapons are simply not competitive with high-explosive weapons or with plain weapons for direct production of casualties. This is a very fundamental

property; perhaps one could designate it as the axiom of chemical weaponry. They are quite effective against unprotected personnel. But to a degree simply not approached with conventional weapons, protected personnel are very effectively protected against the effects of chemical weapons.

Why is it, then, that modern industrial nations maintain chemical warfare stockpiles? We know of course that the United States has a stockpile; it's never been a secret. Recently the Soviet Union has declared the nature and size of its stockpile. Iraq, clearly, has chemical weapons and, until recently, it was thought that France has chemical weapons although President Mitterrand says they do not. It may be that their stockpile of chemical weapons is no longer considered militarily serviceable. One reason given for the maintenance of chemical weapons is that, although they may not be useful for directly causing casualties, if you force military units into gas masks, into protective clothing, their tempo is slowed down. The tempo of operations is slowed down for two kinds of reasons. First, wearing a suit, wearing a mask, wearing gloves has mechanical and optical effects. Second, above a temperature that cannot be specified precisely but above about 75 degrees Fahrenheit, or 25 degrees Centigrade for human beings who are engaged in very heavy work, the rate at which they are producing heat is greater than the rate at which they are shedding it. If they are wearing chemical protective clothing, this means of course their temperature must go up, as a function of time. And when their temperature goes up beyond roughly 104 degrees, most people become unconscious. This causes you to stop doing the heavy work, your heat production goes down, and nature has saved you from becoming a fatal heat casualty. But you are a casualty, you're horizontal, unconscious, nonfunctional for a while and for about 24 hours pretty weak. So, the wearing of chemical protected equipment slows down military forces. When it's hot you must work more slowly, and even when it's cool there's some slowing down.

But right away this tells us that these weapons would be useless, for example, if used against a reserve division, a reserve division waiting to be called into action. If the division waits more slowly, of course, there's no military utility. Only against very special units in combat that are operating in a manner for which tempo is critical would chemical weapons have any militarily useful effect.

How does one assess this in fact? There are three ways to do it. One is to look at actual experience which for us means World War I. I'll say something about Iraq-Iran also, but that was not a very informative experience. The second way is to build models. And the third way is to conduct troop exercises. In World War I about 100,000 tons of various chemicals starting with chlorine, and ending with mustard were used. In the West this caused about 500,000 casualties, a very small fraction of the total casualties in the West. The various evaluations fall into two categories: those written by people other than chemical warfare service officers, and those written by chemical warfare service officers. In the estimates of chemical warfare service authors, chemical weapons were rather effective. But in no other studies of which I'm aware is this the conclusion. The Imperial Defense Staff official history, the British official history of World War I, dismisses the effectiveness of chemical weapons in a footnote, saying all that they did was make warfare more uncomfortable but that they served no purpose. Basil Liddell-Hart wrote that chemical

weapons had a chance when they were first used, as you know, in April, 1915; they opened up a gap in the Allied lines, French territorial and Algerian forces, but, that was not exploited. Almost immediately thereafter, defensive doctrine and defensive equipment were developed, and chemical weapons never had a decisive affect on battles in War World I for that reason. This was what Liddell-Hart called the introduction of an antidote not a chemical antidote, but antidotes of doctrine and equipment, gas masks mainly. More recently a study done for the US Army by the Operations Research Office of Johns Hopkins University goes into great detail and concludes that chemical weapons were simply not decisive in any major battle of World War I.

Why were they not used in World War II? Well, they were used in Asia, before US entry into the war, but they were not used in the European theatre, and they played no major role in the Asian theatre either. It's often said that they weren't used in World War II because of deterrence. But when you look at the documents that are available, that's not an adequate summary. For example, here the commander of the German chemical warfare service, the smoke troops, Lieutenant General Oshner, says gas was not considered a useful weapon. This is from his debriefing in December of 1945, now declassified. Gas was not considered a useful weapon compared to other munitions: in the attack on France it would have been relatively valueless to the fast Panzer attacks. In the air attack on Britain it would not have been as effective as high explosives and incendiaries, and it would have added another item to production and supply. On the Eastern front, the intention was to shatter the Russian front by means of swift powerful thrusts, and then to envelope and annihilate entire army groups. The use of chemical agents could only have reduced the speed of operations: further, it would have strained supply services to the breaking point.

In the case of Great Britain, there were a few occasions when Winston Churchill asked his joint planning staff if chemical weapons might be useful. In one such case it was to strike back at the launching sites of the V-weapons. He got back in a memo dated 5 July, 1944, a report saying gas attacks are unlikely to be any more effective than bombing with high explosives. To that kind of commentary on the use of chemical weapons, what could one add about the role of deterrence? It's important to realize that those statements made by Allied leaders, those deterrence threats against the Axis voiced by Roosevelt and Churchill, were essentially threats to use gas on cities. "We will drench your cities with gas," that's exactly what Churchill said "if gas is used against us." The threat was not to use it on the tactical battlefield. Of course one might expect that it will also be used on the battlefield, because not only bombs but artillery projectiles were stored there. In the most recent case of the use of gas, in Iraq, Iranian reports say that use reached a maximum in 1983 and then began to decline. There is a report issued last November by the Assembly of the Western European Union which concludes on this issue that Iraq's use of gas had only slight tactical effects but constituted a further demoralizing factor for the enemy in that eight-year war. There is a good deal that can be said about Iraq's use of gas, and it's effectiveness, but I think it can be summarized by saying: used against the unprotected, used against the paramilitary forces without masks, without training 300,000 of them were mobilized in the attack against Iraq in 1983 and early 1984 it was probably to some degree effective. I

doubt very much that it would have been militarily effective against Iranian units with masks and with proper training. If we were to summarize, it appears as we would expect from the fact that the defense is so effective that against properly protected troops the utility of gas is marginal.

What about the second way of looking at this problem, models? I'll dismiss them by saying they're no good. They depend too much on what you put in them; you can get any result you want. Troop exercises, on the other hand, if they're done with reasonably large units, or company- (or better yet battalion) size; if they're done with soldiers who have received at least the standard modern training in operating in suits and masks; and if the soldiers involved in the exercises have reasonably good morale, then I think you can get a pretty good idea of the effectiveness on military operations of having to wear the chemical protective equipment. The studies that I'm aware of, of this nature deal only with mechanized, armored, combined-arms units. I don't know enough about air force bases to be able to say. But in the case of those field exercises that I have read of involving army units, the effects of wearing masks and suits, etc., are at best marginal. And of course only at temperatures below about 80 degrees.

But we come back to the effects of chemical weapons on those who are not protected. Against unprotected military forces, against civilians, as weapons of terror, of course chemical weapons could be exceedingly effective. One could calculate approximately how many square kilometers would be made lethal to the inhabitants, if a given amount of nerve agent were released according to reasonable assumptions about release patterns, in a war in Europe. And then if one assumes even a moderate population density in the general vicinity of a couple hundred people per square kilometer one calculates that millions of people would be exposed to the lethal effects chemicals cause if they were used in Europe. If people could be evacuated, if they could be provided with gas masks, there would not be lethal casualties. But doing that, removing them, providing them with gas masks, is certainly not anything that can be contemplated with certainty. In the case of the war in the Persian Gulf, the big burst of casualties came in March of 1988, from use, not against soldiers but against civilians, in the attack on the Iraqi Kurdistan village of Halabja, in which it appears that about 5,000 people died. Probably many of you have seen the television photos of families lying dead in the streets, clusters of people, perhaps 5,000 deaths.

So, there is an incentive for getting chemicals out of the world scene because they could be a very serious threat to civilians, because they could be a weapon of terror. And perhaps because the proliferation and use of chemical weapons might lead perhaps to a fall of the barriers against biological warfare. Biological weapons are different in one crucial respect, and in several other less crucial respects. The crucial respect is that very much less is sufficient to attack a large area perhaps by a factor of 10,000 less. This means that small, inconspicuous delivery means could nevertheless cover large areas, hundreds of square kilometers, with lethal concentrations of microorganisms. There is some incentive for chemical disarmament, and today there seems to be a considerable degree of political commitment to that objective. George Bush, during the election campaign in October 1988 said, "If I'm remembered for anything, it would be for a complete and total ban on chemical weapons." Vice President Bush said that, or words to that effect,

on many occasions. President Bush, in his address to the joint meeting of the Senate and House of Representatives in February of this year, in the section of his address dealing with arms control, spoke *only* of chemical weapons. He said chemical weapons must be banned from the face of the earth, never to be used again.

In January of this year, the so-called Paris Conference, to which the French government invited the nations of the world, was attended by 149 states, more than half of them represented by their most senior foreign affairs ministers. The final statement of the Paris Conference stated as one of the highest objectives of the states' representatives at that meeting the successful and early conclusion of an international ban on chemical weapons.

The Conference on Disarmament in Geneva, the forty-nation Conference on Disarmament, has been negotiating a chemical warfare disarmament treaty, which now is in an advanced phase of development. The so-called rolling text of that treaty, based to a considerable extent on the US draft treaty brought to Geneva by George Bush in 1984 (which was not accepted by most members of the CD then, not by the Soviet Union and her allies, not by some allies of the United States because of its very tough inspection provisions), has now been accepted. The US position has won out. There are still issues that haven't been settled, but the major conceptual issues have been. This treaty would prohibit the development, production, stockpiling, acquisition, and transfer of chemical weapons. It would not prohibit anti-chemical protection - gas masks and things like that.

The treaty would work in the following way: after coming into force, each state party would declare within thirty days its stocks of weapons, facilities, and also a record of any transfers it may have made of chemical weapons to the territory or possession of other states. Thereupon, international inspectors would verify the declarations of weapons, and of facilities, and would secure those weapons and facilities under surveillance until their eventual destruction. The destruction would take a long time. Unless someone comes up with a new technology for getting rid of chemical weapons, it is estimated it would take about ten years of steady destruction efforts to get rid of the US stockpile. Maybe it could be done in a little less time, but something like that is likely. Thereafter one would have two further problems. The problem of verifying what is declared is an easy problem. You go and look, take measurements, stay there until it's gone.

The harder part is verifying that nothing has been retained that was not declared, and verifying that nothing new is brought in or produced. Routine inspection would be applied to all facilities known to produce key precursors of chemical weapons. Thiodiglycol, key precursor of mustard gas, anything with a phosphorus-carbon bond. There are perhaps a few hundred such factories in the world today, the great majority of them are in the West. And the great majority of those are in the United States and the Federal Republic of Germany and Japan. Under the INF agreement, there are 133 sites under verification inspection. Under a chemical treaty, there might be on the order of a couple hundred factories known to produce key precursors of chemical weapons. In addition to that, there would be a system of challenge inspection. The most extreme form of which would be anytime, anyplace, and within 24 to 48 hours. There is also a concept now being discussed of something in between, the concept of so-called ad-hoc inspections.

What needs to be done to finish up the negotiations at Geneva? Detailed rules for verification have to be agreed upon, particularly protection for the challenge inspections so that they are not unduly intrusive in cases where the production of chemical weapons isn't really the issue. The British are doing something interesting about solving this problem of sensitivity of highly sensitive sites. They are inspecting highly sensitive establishments of their own with their own officials, to see exactly to what extent very secret facilities are compromised or not by the kind of verification inspections that would be required to show production of chemical weapons. They've done two of these. They've said in Geneva that the results are very encouraging.

I will skip over some things to name certain other problems that need to be dealt with at Geneva. One is the problem of securing essentially universal adherence. This has several components. One is representation on the Executive Council of the Chemical Weapons Convention; the developing countries are very sensitive to this issue. Another is to provide the possibility, in particular for developing countries who have raised this issue repeatedly, of assistance during the disruption phase. They have argued that, if we're going to renounce our option to have chemical weapons, as long as our neighbor might still have them (the treaty not having yet run its course), we would like to have some assurance that we could get assistance in case a chemical threat materializes. That is difficult to deal with, but it might be dealt with by the provision to states outside of the convention, on their own accord, of pools of gas masks and other things that could be made available.

And there is the question of linkage that has been raised by some of the developing countries. "Why should we give up our chemical option if a neighbor has a nuclear option?" To deal with this problem, it will be necessary to explain convincingly why there are benefits to all states, including the vast majority of states, which are non-nuclear, in having guarantees that their neighbors do not have chemical weapons. Finally, there are things that the Soviet Union and the United States must do bilaterally. There are different estimates for the size of the Soviet stockpile, and perhaps on the side of the Soviets, for the size of the US one. These questions need to be largely resolved before a treaty is signed, not afterwards. This can be done by a bilateral agreement in advance of a treaty to declare, inspect, and verify each other's holdings. This is under serious discussion by the two states, and probably will go forward. If these things are done, it seems reasonable to many observers in Geneva that such a treaty could be initialed in 1990 or 1991, with ratification going on throughout the next year or so, and with countries entering it for some time before 1994 or 1995. This would leave us with a mature treaty some time around the year 2004 or 2005, the destruction process taking 10 years. Failure to do this will probably result in a new wave of chemical proliferation, actually catalyzed by the failure to get the treaty. Success will not only mean chemical disarmament and a robust verification scheme in place; it may also mean a very large step towards making sure that the biomedical sciences as a whole are not applied to hostile purposes.

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