should also be designed to deal with the consequences of new defense spending as well as the curtailment of spending. In short, I am suggesting that such a high-level Commission should be designed to deal not only with the economic problems associated with a reduction in defense spending but also with all phases of the relationship between the ongoing military-industrial complex and the economy. In regards to the general question of conversion to a peacetime economy, I was pleased to hear President Nixon state in his inaugural address:

> We shall plan now for the day when our wealth can be transferred from the destruction of war abroad to the urgent needs of our people at home.

Following up on this pledge, the President has asked a subcommittee of the Council for Economic Policy chaired by Dr. Herbert Stein, to initiate policy planning for converting our economy to a peacetime basis.

Mr. President, over the past few months the military-industrial complex, its meaning and its dangers, has been the subject of far ranging, searching discussion and analysis. On the whole I think this has been healthy. I hope that the debate will continue. However, I also believe that we have reached the stage where we should do more than talk and debate. We should begin to act. And in this respect there are a number of measures which the Congress could adopt in the near future. I have pointed to several such possible measures today. I again urge their favorable consideration by the Senate.

And in closing I would return to President Eisenhower's message. In citing the dangers of the military-industrial complex, President Eisenhower also stressed the fact that the complex was the product of necessity. Thus we cannot control these dangers by destroying the complex as some would seem to suggest. The military-industrial complex is a fact of modern American life. No amount of wishing will make it go away. At the same time all must recognize that although there are dangers inherent to the military-industrial complex these dangers are not inherently uncontrollable. In other words we must keep the military-industrial complex in a proper perspective. We must see both its essentiality and also its potential for abuse. We must have it, but we must control it. We must be vigorous in our efforts to see to it that it is a servant of peace and prosperity rather than the servant of war and destruction.

Mr. DOLE. Mr. President, will the Senator yield?

Mr. PEARSON. I am very pleased to yield to my colleague from Kansas.

Mr. DOLE. Mr. President, first of all, I commend my colleague from Kansas for a general review of the so-called military-industrial complex.

I feel that most of us will agree with many things said. I wish to add that we are fortunate in this administration to have a man like Melvin Laird as Secretary of Defense. I know of no one who has gone to the Cabinet level so well equipped.

As my colleague knows, Mr. Laird for 14 years was a member of the House Defense Appropriations Subcommittee. Mr. Laird was a prober. He was a critic. He was a questioner. But, above all, he understood the Defense Department. He understood its responsibility, he tried to make the Department responsive and responsible when he could do so.

At the outset of this administration, both Secretary Laird and Under Secretary Packard had expressed the philosophy that we should take a close look at all of the programs and reexamine our military requirements and validate the need for any new major weapons system.

I would hope my colleague would agree that in the span of 6, 7, or 8 months, progress has been made by Secretary Laird. I would cite only a few examples of responsible progress under Mr. Laird.

First, Mr. Laird has established a Defense Systems Acquisition Review Council within the office of the Secretary of Defense to advise the Secretary of the current status and the readiness of each major system to proceed to the next phase of efforts in its life cycle.

Second, and I think this very important, there has been the appointment of a blue ribbon defense panel by the Secretary. This is a matter that he pursued with vigor while a Member of the House of Representatives. A blue ribbon defense panel has been appointed to reappraise the Defense Establishment. There has been the cancellation of the manned orbital laboratory. There has been the termination of the Cheyene helicopter program.

There have been new, frank, and candid reports to both the Senate and House Armed Services Committees on major weapons acquisitions.

Mr. Laird has attempted to provide Congress with more information. He has done an excellent job getting facts so that the Senate and the House can make valid adjustments. He has also endorsed as recently as July 31 the establishment of a Commission on Government Procurement. He views the Commission as another positive step in reporting on the methods of military procurement.

There have been numerous improvements in the management of weapons acquisition process.

As recently as Saturday we find the Secretary concurring in the judgment of the Senate concerning chemical and biological weapons. As an addition to the remarks of my colleague from Kansas, I want the record to show that we have a Secretary of Defense who is just as dedicated as anyone in the Senate or anyone in Congress in saving the taxpayers' money, and just as concerned about any so-called military-industrial complex.

The PRESIDING OFFICER (Mr. GRAVEL in the chair). Under the prior unanimous-consent agreement, the Senate will now proceed to other business.

Mr. PEARSON. Mr. President, I ask unanimous consent that I may continue for an additional 5 minutes.

Mr. BYRD of West Virginia. Mr. President, I am constrained to object. This unanimous-consent request was made last week, as I understand, and Senators were put on notice that debate on the pending McIntyre amendment would be controlled and would last for 1 hour after the unfinished business was laid down.

Mr. PEARSON. Mr. President, I will withdraw the request. I do appreciate the situation of the leadership in this respect, and they were very gracious to give me time this morning. I can respond at another time.

AUTHORIZATION OF APPROPRIATIONS FOR FISCAL YEAR 1970 FOR MILITARY PROCUREMENT, RESEARCH AND DEVELOPMENT, AND FOR THE CONSTRUCTION OF MISSILE TEST FACILITIES AT KWAJALEIN MISSILE RANGE, AND RESERVE COMPONENT STRENGTH

The PRESIDING OFFICER. Under the previous order, the Chair lays before the Senate the unfinished business, which will be stated.

The ASSISTANT LEGISLATIVE CLERK. A bill (S. 2546) to authorize appropriations during the fiscal year 1970 for procurement of aircraft, missiles, naval vessels, and tracked combat vehicles, and to authorize the construction of test facilities at Kwajalein Missile Range, and to prescribe the authorized personnel strength of the Selected Reserve of each Reserve component of the Armed Forces and for other purposes.

The PRESIDING OFFICER. The question is on agreeing to the amendment of the Senator from New Hampshire.

Mr. GOLDWATER. Mr. President, will the Senator yield for a question?

Mr. BYRD of West Virginia. I yield 1 minute to the Senator.

Mr. GOLDWATER. Mr. President, this is getting to be a rather unusual procedure, to request unanimous consent for a specific time for a speech and then nobody can make a rebuttal.

The Senator made an excellent speech. I do not agree with it in its entirety. He used President Eisenhower's quotations but he did not use enough of them. If I have to wait until tomorrow or September, the point I want to make will have lost its effectiveness.

I think I am going to start opposing all unanimous-consent requests for this type of presentation.

Mr. BYRD of West Virginia. I thank the Senator.

Mr. President, I ask unanimous consent that a brief quorum call may be had at this time.

Mr. STENNIS. Mr. President, will the Senator withhold his request for a quorum call?

What was the unanimous-consent request? Did the Senator make a unanimous-consent request about limitation?

Mr. BYRD of West Virginia. No. That was made last week.

Mr. STENNIS. I thank the Senator.

Mr. BYRD of West Virginia. Mr. President, I ask unanimous consent that there be a brief quorum call, the time to be equally divided between both sides.

The PRESIDING OFFICER. Without objection, it is so ordered.

Mr. BYRD of West Virginia. Mr. President, I suggest the absence of a quorum.

The PRESIDING OFFICER. The clerk will call the roll.

The assistant legislative clerk proceeded to call the roll.

Mr. BYRD of West Virginia. Mr. President, I ask unanimous consent that the order for the quorum call be rescinded.

The PRESIDING OFFICER. Without objection, it is so ordered.

Mr. BYRD of West Virginia. Mr. President, I ask unanimous consent that, at the conclusion of the vote on the pending amendment, the able chairman of the Committee on Armed Services be recognized.

The PRESIDING OFFICER. Without objection, it is so ordered.

Who yields time?

Mr. NELSON. Mr. President, how much time does the Senator desire?

Mr. McINTYRE. Ten minutes or so.

Mr. NELSON. I yield 10 minutes to the Senator from New Hampshire.

CHEMICAL AND BIOLOGICAL WARFARE

Mr. McINTYRE. Mr. President, the Senate today will consider amendment No. 131, which I introduced last Friday together with Senators YARBOROUGH, PROXMIRE, HARTKE, PELL, NELSON, MONDALE, STEVENS, GOODELL, and HUGHES.

Had more time been available after the introduction, I am certain many other Senators would have joined in its sponsorship.

On an associated point, Mr. President, may I say that I was particularly pleased with Defense Secretary Melvin Laird's statement Saturday. This statement, expressing his concurrence with the goals of this amendment, reflects an admirable understanding on the part of the Secretary of the need for improved management and control of chemical and biological warfare programs.

Secretary Laird also deserves commendation for recommending a National Security Council study of these matters, and President Nixon deserves much praise for ordering the study.

Most helpful, too, in the present examination of CBW programs has been the consistent, progressive leadership of the distinguished chairman of the Committee on Armed Services, the Senator from Mississippi (Mr. STENNIS).

We are considering today a coordinated effort to deal with a highly complex and unpopular part of our defense structure in such a way as to achieve the kind of congressional control and national understanding we feel is needed, while, at the same time, avoiding involvement of the Senate in the lengthy procedure which would be required were we to take up a number of separate amendments.

Moreover, by bringing together in a single package a number of proposals involving chemical and biological warfare programs, our consideration can be all the more comprehensive.

The amendment introduced Friday did not include a section covering one particular area. The proposal dealing with this particular area was originally put forth by the distinguished Senator from Indiana (Mr. HARTKE). I am happy to say that since Friday we have reached agreement on the language for this section, a section relating to the subject of so-called "back-door financing" of CBW programs.

Mr. President, I send this section to the desk and ask unanimous consent to have it added to amendment No. 131, together with technical changes that have been made to the original amendment, No. 131; and I ask unanimous consent to have it printed at this point in the RECORD.

The PRESIDING OFFICER. Is there objection? The Chair hears none, and it is so ordered.

The modification is as follows:

At the end of amendment No. 131 add a new subsection as follows:

"(g)(1) Except as provided in subsection (g)(2) of this section, no funds authorized to be appropriated by this, or any other later enacted Act may be expended for research, development, test, evaluation, or procurement of any chemical or biological weapon, including any such weapon used for incapacitation, defoliation, or other military operations.

"(g)(2) The prohibition contained in subsection (g)(1) of this section shall not apply with respect to funds authorized to be appropriated by this Act."

On page 4, line 3, insert "will" between "agents" and "be".

On page 4, line 6, change "subsections (e)(1)" to "subsections (d)(1)".

On page 4, line 7, change "(e)(2)" to "(d)(2)".

On page 4, line 21, change "or an other" to "or any other".

On page 5, line 2, insert "of the Public Health Service" after "Surgeon General".

On page 5, line 3, delete "President" and insert "Secretary of Defense".

On page 4, line 22, insert "or any" after "lethal chemical agents,".

Mr. McINTYRE. Mr. President, a word must be said at this point about the excellent work done by each of the Senators who have contributed sections of this amendment. Their individual research, the honing of their proposals to a remarkable precision of language, and the spirit of cooperation exhibited in their willingness to consolidate their proposals into a single amendment is in the finest tradition of this great body.

As we take up consideration of the amendment, let us keep in mind that already included in the overall legislation before us is a $16 million reduction in the Defense Department's budget for research and development in lethal offensive chemical and biological warfare. This reduction was recommended by my Subcommittee on Research and Development and accepted by the full Armed Services Committee.

I raise this thought so that, as we take up consideration of the amendment, we have a comprehensive picture of the action we can take in regard to CBW programs.

Now let me identify each of the sections of this amendment. I will not go into detail because I know other Members intend to do that.

The first section (402)(a), also developed by our able colleague the Senator from Indiana (Mr. HARTKE), calls for a full and complete semiannual report by the Secretary of Defense to the Congress setting forth in detail the total CBW research, development, test evaluation, and procurement program.

This, of course, would provide Congress with the kind of detailed information Congress and the public need in order to understand the programs and to determine future direction.

The second section (402)(b), developed by the able Senator from Wisconsin (Mr. NELSON), and the able Senator from New York (Mr. GOODELL), provides that no funds can be used for the procurement of any delivery system which is specifically designed to disseminate lethal agents.

This section, Mr. President, makes clear our opposition to the use of lethal CBW agents as offensive weapons and prohibits expenditure of funds for any device designed to deliver these agents.

The third section, (402)(c), expresses the concern of many about the deployment or storage of lethal agents and microorganisms outside the United States. Recent accounts of unfortunate incidents involving such deployment or storage have prompted new congressional interest in what we may be doing in this area of CBW activity.

This section will provide for a full range of reports to the interested Congressional committees, and will also insure consultation with foreign nations before we deploy CBW agents on their soil.

Mr. President, I believe that in general we accomplish the substance of this proposal, but the section makes unmistakably clear Congress' interest and desires.

This section is another developed by the Senator from Wisconsin, (Mr. NELSON) and the Senator from New York (Mr. GOODELL).

The next section, (402)(d), also proposed by the Senator from Indiana (Mr. HARTKE), relates to recent fears of many about the possible dangers inherent in the rail shipment of lethal chemcial and biological agents.

Basically, this section covers three areas. It requires the Surgeon General of the Public Health Service to assure that shipment will not be detrimental to the public health.

It would give advance notice of such shipments to the Congress and civilian agencies.

And finally, it will bring about the detoxification of lethal agents before they are shipped off for disposal. Again, some of this already is being done, but this section makes clear the Congress interest and intent.

I would like to say at this point that while I am completely in agreement with this section I think we should always keep before us the fact that it is not the chemical and biological warfare service alone that transports biological agents around the country, nor is this service the principal shipper of such agents. The National Institute of Health and other public and private health agencies transport an enormous amount of such agents.

We are not dealing with such agencies in this particular legislation, to be true, but we may want to consider this in other legislation. I think a study would show that the amount of potentially dangerous biological agents shipped by CBW is relatively small when measured against the total shipment by all agencies.

The able Senator from Rhode Island (Mr. PELL), proposed the next section 402(e). While the previous section dealt with transportation of lethal chemical and biological agents within the United States, the section of the Senator from Rhode Island, deals with transportation of such agents outside the United States.

It also includes the matter of testing, development, storage and disposal of such agents outside the United States, and it asks for the full consideration of U.S. international responsibilities when lethal CBW agents are moved, tested, disposed of, or developed in foreign areas.

This section places certain responsibilities in the hands of the Secretary of State to assure that we are not likely to violate international law.

The succeeding section 402(f), an additional section developed by the Senator from Wisconsin (Mr. NELSON) and the Senator from New York (Mr. GOODELL) is, perhaps, one of the most significant in the proposal.

I am sure we have all been concerned about incidents of the past several years where outdoor testing of lethal agents and micro-organisms have jeopardized both animal and human life.

This particular section of the amendment would eliminate open air testing except in those instances when the Secretary of Defense, under the direction of the President of the United States, would declare that our national security required such testing, and the Surgeon General of the Public Health Service determined that the public's health would not be endangered.

Furthermore, this section would require that appropriate committees of the Congress would be informed of all proposed open air tests at least 30 days prior to the date on which it is proposed to hold them.

The final section of the amendment, added by unanimous consent today, would become section 402(g) (1) and (2). This section, proposed by the Senator from Indiana (Mr. HARTKE) is another step in congressional control over funds that can be used in CBW efforts.

It would restrict the reprograming of funds from other programs into CBW. I am not aware that so-called backdoor financing of CBW is presently taking place, Mr. President, but with the adoption of this section we would assure that it does not.

In summary, this amendment will serve the obvious public need to better know and understand our chemical and biological programs.

It will provide in-depth information to the Congress in its continuing consideration of this broad, complex, and frequently distasteful matter.

And it comes directly to grips with those incidents that have so disturbed the Nation recently—the severe illness of two dozen CBW workers in Okinawa, the death of the sheep at Dugway, Utah, and the dangers inherent in moving deadly CBW agents across the country.

I conclude, Mr. President, by pledging my determination to make the chemical and biological warfare program a principal item on the agenda of the Research and Development Subcommittee of the Armed Services Committee during the coming year.

We will want to examine in detail every facet of the program.

We will be briefed by a full range of scientists and other experts and receive pertinent material from them.

We will want to hear from other Members of the Senate who have a particular interest in CBW.

And we will want to survey the effects of the actions proposed in this amendment and in other sections of the current authorization bill.

In short, when we return next year to consider the 1971 version of the authorization bill I sincerely believe that the recommendations we will make will enable the Senate to meet problems that may still exist in this program.

In the interim, Mr. President, I strongly urge the adoption of this amendment.

The PRESIDING OFFICER. Who yields time?

Mr. STENNIS. Mr. President, under the agreement, who controls time?

The PRESIDING OFFICER. The minority leader and the majority leader or their designee.

Mr. NELSON. Mr. President, how much time does the Senator from New York desire?

Mr. GOODELL. Mr. President, will the Senator yield to me for 10 minutes.

Mr. NELSON. I yield 10 minutes to the Senator from New York.

Mr. GOODELL. Mr. President, before I begin my formal remarks I wish to offer my commendations to the distinguished Senator from New Hampshire.

I would like to ask the Senator from New Hampshire a question to make sure a technical correction has been made in the amendment. I refer to page 4, line 22, of amendment 131.

Mr. McINTYRE. Is the Senator referring to the technical amendments I offered this morning to the original amendment?

Mr. GOODELL. Yes. I refer to that point where reference is made to "lethal chemical agents, disease-producing biological micro-organisms, or biological toxins." It was my understanding there might be some misinterpretation here because of the words which should read "or any other."

Mr. McINTYRE. Does the Senator refer to page 4, line 22, where the amendment reads, "None of the funds authorized to be appropriated by this or any other act shall be used for the open-air testing of lethal chemical agents, disease-producing biological micro-organisms, or biological toxins"?

What is the question?

Mr. GOODELL. That is the way the amendment reads?

Mr. McINTYRE. That is the way the amendment reads at the present time.

Mr. GOODELL. I simply wanted to clarify that point. I think it is a crucial point. We are requiring this procedure of lethal chemical agents that are tested and all disease-producing biological microorganisms, or biological toxins. Is that correct?

Mr. McINTYRE. The Senator is correct.

Mr. GOODELL. Mr. President, the omnibus anti-CBW amendment we are presenting here today represents an important break with secrecy over chemical and biological weapons. It is a modest measure to check the vast destruction potential of our CBW arsenal. Still, it is a significant measure.

It is significant for it opens up the secrecy which has cloaked the spiraling gas and germ weapons program. It checks the weapons spiral. It minimizes international repercussions over CBW. It provides for public health and safety by guarding against the perils in transport, storage, and disposal of CBW. It puts up a barrier to future outdoor testing of CBW. It encourages congressional review.

The distinguished chairman of the Committee on Armed Services has called this omnibus anti-CBW amendment a solid start on the problem, and he is quite certainly right.

I should like to commend Senator STENNIS and the members of the Armed Services Committee for taking the first major step in controlling the CBW program. The committee cut $16 million from the Pentagon's request for funds earmarked for research and development on offensive lethal chemical and biological weapons. This significant step has set in motion other steps to control the CBW program.

I would like to start today by considering open-air testing of deadly gas and disease-producing germs. It was with great reluctance that I agreed to modify the "flat ban" amendment originally introduced by the Senator from Wisconsin (Mr. NELSON) and myself. A flat ban on outdoor CBW testing would eliminate the threat that a test cloud of deadly gas and germs might drift from the test site to our cities and towns. The moratorium postpones but does not eliminate this threat. We felt we could make a significant step forward at this time.

On the assurance of the Senator from New Hampshire that his subcommittee was going to look intensively at this entire program we have great confidence he will do so and that we can move forward in the future with greater restrictions consistent with national security.

There are pluses and minuses in the test ban revision. The minus side leaves the option open for future tests. The plus side puts congressional control over testing. The burden of proof is on the Pentagon if any further tests are to take place due to national security. I believe there is agreement here today that no longer will these tests take place on a routine basis. There must be a high-level determination that such tests are directly involved with the national security. That determination must be made by the Secretary of Defense under guidelines prescribed by the President and must be agreed to by the Surgeon General with reference to the procedures to be followed.

It is my view that it should be unnecessary in the future for us to engage in any outdoor testing, but we do leave the door open for the very unusual—

and I emphasize very unusual—situation that might arise in the national security.

While we are studying this problem in the next year, such tests might take place under very careful regulations and safeguards. The burden of assurance that no health hazard will result from any test rests with the U.S. Surgeon General. In each case, Congress will have the opportunity for hard questioning. On balance, then, the moratorium is acceptable at this beginning stage of CBW review.

If the moratorium is to be meaningful, we simply must be guided by the principle that the security of this Nation begins with the health and safety of our people. Pentagon requests based on national security simply must be viewed in this context. If not, the moratorium on outdoor testing would be relatively meaningless. If CBW tests are requested, every effort must be made to confine them to the laboratory. This point cannot be emphasized enough. We all know the example at Dugway Proving Grounds in Utah where thousands of sheep were killed. Had the wind shifted farther a large city in the United States would have been engulfed by deadly nerve gas, VX—odorless and colorless. What a disaster that would have been. We must not engage in such tests without the highest priority given the safety of our people.

One example suffices to explain why CBW testing should be confined to the laboratory. It is an example which clearly demonstrates that hazards from open air tests of chemical and biological weapons are not vague speculations, but grim realities. The example is the now well-known sheep-killing accident last year, caused by an open air test of VX at the Army's Dugway Proving Grounds in Utah. Some say that safety rules for CBW testing are sufficient. Safety rules, they may say, are enough to protect against the fatal results possible when deadly nerve gas is tested in the air. Before the sheep-killing incident and since that time, the Army has announced safety regulations for CBW open air testing.

Are safety rules at the test site sufficient for public safety? I simply cannot accept that they are. A freakish wind shift or a poorly supervised test may never occur. Let us consider, then, what might otherwise happen.

In the 1968 sheep-killing incident, the test at Dugway was to determine how nerve gas VX distributes itself downwind 5 to 25 miles per hour to the northeast. This was the information sought. Under today's safety rules at Dugway, the test would be limited to winds 15 miles per hour. Even so, would this prevent another nerve gas accident? Consider what happened in the sheep-killing incident. The test started. The jet opened its tanks and began spraying nerve gas over the test area. After a few seconds, the tanks were to close and the plane pull up. But the tanks did not close; the tanks stayed open. The plane pulled up with nerve gas still spraying. Then over 6,000 sheep were killed.

Regardless of safety regulations, field testing of biologicals at Dugway, has produced land designated as "permanent biocontaminated area."

What next is in store from such CBW open air testing?

As we debate the wisdom of banning open air testing of lethal gas and any disease-producing bacteria or toxin, the very testing of deadly nerve gasses continues. It is of little comfort to me to hear from the Defense Department that there are no immediate plans to conduct outdoor tests of lethal biological agents. It is of little comfort that the Q-fever field tests at Dugway have been completed and now research will shift to the laboratory to evaluate results.

While the specter of future open air tests for disease-producing bacteria hangs over us; while outdoor testing of such deadly nerve gasses as VX, Tabun—GA—Sarin—GB—and Soman—GD—continues; when any open air test of deadly gas or any disease-producing bacteria takes place, the issue of public safety remains of grave concern.

If just one accidental release of deadly nerve gas or disease-producing bacteria spreads to our cities and towns, the toll in death and sickness would be indefensible. Every precaution must be taken to assure the health and safety of our people. Animals must be protected. Environment must be preserved. All these things must be done regardless of how slight the danger.

Consider the deadly effect of these chemical agents. Consider the vast destruction potential of the disease-producing biologicals. Let us take a look at these agents in deciding whether in terms of public safety alone, we should ban lethal CWB from being tested outdoors.

Mr. President, I ask unanimous consent to have printed in the RECORD a table of chemical and biological agents, together with a table on planned open air testing at various sites including the site at Dugway Proving Ground, Utah, the Deseret Test Center in Utah, and at Edgewood Arsenal in Maryland.

There being no objection, the tables were ordered to be printed in the RECORD, as follows:

TABLE OF CHEMICAL AND BIOLOGICAL AGENTS

THE CHEMICAL AGENTS

Nerve gases

GB: An odorless, colorless, volatile gas that can kill in minutes in dosages of 1 milligram, approximately 1/50 of a drop. In the U.S. arsenal since the late 1940's, it is also known as Sarin. The gas kills by paralyzing the nervous system.

VX: Another odorless gas that, unlike GB, does not evaporate rapidly or freeze at normal temperatures. Becausee of its low volatility, it is effective for a longer period of time. VX also is capable of killing in 1 milligram doses and, like GB, paralyzes the nervous system in minutes.

Incapacitating agents

BZ: A gas that is either a psychochemical or a strong anesthetic which can produce temporary paralysis, blindness, or deafness in its victims. BZ has also been known to cause maniacal behavior. Its precise makeup is secret.

Riot control gases

CN: A non-lethal gas with a deceptive, fragrant odor similar to apple blossoms. The agent, now in use in Vietnam, is a fast-acting tear gas that also acts as an irritant to the upper respiratory system.

CS: An improved, more toxic tear gas that quickly causes tearing, coughing, breathing difficulty, and chest tightness. Can temporarily incapacitate men in twenty seconds. Heavy concentrations cause nausea. It is now used in Vietnam.

Harassing agents

DM: A pepper-like arsenical gas that causes headaches, nausea, vomiting, chest pains for up to two or three hours. It can be lethal in heavy doses and has been blamed for some deaths since its first use in Vietnam in 1964. DM is widely known as adamsite and was used in World War I.

HD: A pale yellow gas with the odor of garlic, popularly known as mustard gas. Causes severe burns to eyes and lungs and blisters skin after exposure, but onset of symptoms is delayed from four to six hours. Can kill in heavy concentrations. Mustard, like VX, is not volatile and is usually effective for days after its use. It caused one-fourth of the U.S. gas casualties in World War I.

Defoliants and herbicides

2,4-D: A weed-killing compound known as dichlorophen-oxyacetic acid that has relatively short persistence in the soil and a relatively low level of toxicity to man, if properly dispersed. Heavier concentrations can cause eye irritations and stomach upsets, however. Dangerous to inhale. Usually used in Vietnam along with 2,4,5-T (trichlorophenoxyametic acid), which has similar—although somewhat more toxic—properties. Effective against heavy jungle.

Cacodylic Acid: An arsenic-base compound used against rice plants and tall grass. Strong plant killer that gives quick results. One serious restriction on its use is the possibility that heavy concentrations will cause arsenical poisoning in humans. Widely used in Vietnam. It is composed of 54.29 per cent arsenic.

BIOLOGICAL AGENTS

Anthrax: An acute bacterial disease that is usually fatal if untreated when it attacks the lungs (pulmonary anthrax). Death can result in twenty-four hours. Found naturally in animals, which must be buried or burned to prevent contamination. Symptoms include high fever, hard breathing, and collapse. Also known as woolsorters' disease.

Brucellosis: Bacterial disease usually found in cattle, goats, and pigs. Marked by high fever and chills in humans. Also known as undulant fever. Fatal in up to 5 per cent of untreated cases. Symptoms can linger for months.

Encephalomyelitis: Highly infectious viral disease that appears in many forms and gradations: it can be simply debilitating or fatal. Venezuelan equine encephalomyelitis (VEE) kills less than 1 per cent of its victims and lasts as few as three days; Eastern equine encephalomyelitis (EEE) is fatal about 5 per cent of the time, if untreated, and can seriously cripple the central nervous system of survivors.

Plague: Acute, usually fatal, highly infectious bacterial disease of wild rodents found in two forms—bubonic and pneumonic. Sypmptoms of bubonic plague include small hemorrhages, and the black spots that led the disease to be commonly known as the "black death" during the massive epidemics of the past. Pneumonic plague is highly infectious because it is spread from man to man via coughing. Symptoms include, fever, chills, rapid pulse and breathing, mental dullness, coated tongue, and red eyes.

Psittacosis: Viral infection in birds that is transmissible to man, with symptoms of high fever, muscle ache, and disorientation. Disease can be mild, and last less than a week, or can cause death in upwards of 40 per cent of those afflicted. Complete convalescence may take months.

Q-fever: Acute, rarely fatal rickettsial disease usually found in ticks, but also found in cattle, sheep, goats, and some wild animals. The Q-fever organism can remain alive and infectious in dry areas for years. Rarely fatal but the resulting fever may last up to three months.

Rift Valley Fever: Viral infection of sheep, cattle, and other animals that can be transmitted to humans, usually to the male. Symptoms include nausea, chills, headaches, and pains, but the disease is mild: despite the severity of symptoms deaths are rare and acute discomfort lasts only a few days. Also believed to be more virulent among Asians.

Rocky Moutnain Spotted Fever: An acute rickettsial disease transmitted to man by the tick. One of the most severe of all infectious diseases. Can kill within three days. Fevers range up to 105 degrees F. Often found in northwestern United States, but susceptibility to the disease in general. Highly responsive to treatment.

Tularemia: A bacterial disease marked by high fever, chills, pains, and weakness. Acute period can last two to three weeks. Sometimes causes ulcers in mouth or eyes, which multiply. Untreated, its mortality rate is between 5 and 8 per cent. Highly infectious, and usually found in animals, fowls, and ticks. Also known as rabbit fever.

Source: Chemical and Biological Warfare, America's Hidden Arsenal, by Seymour H. Hersh (Doubleday Co. 1969).

PLANNED OPEN AIR TESTING—MARCH 1968–MAY 1969, DUGWAY PROVING GROUND, UTAH

Item	Agent	Agent amount	Quantity
M139 bomblet	GB		1 round per trial (5 trials).
E139 bomblet	GB		1 item per trial (8 trials).
105 milimeter projectile	GB	1.5 pounds per round	1 round per trial (3 trials).
BLU 19/B23	GB		1 round per trial (1 trial).
M55 rocket	GB		1 round per trial (4 trials).
Spray boom (truck)	GB	2 gallons per trial	3 trials.
8-inch howitzer shell	VX	14½ pounds per round	1 round per trail (5 trials).
Spray boom (truck)	VX	2 gallons per trail	2 trials.

PLANNED TESTING, FOURTH QUARTER, FISCAL YEAR 1969: APRIL–JUNE 1969

Item	Agent	Agent quantity per item	Number of items to be teste
Deseret Test Center, Uteh (Dugway Proving Ground, Utah):			
United States Army:			
8 inch shell, 50 foot release	VX	15.4 pounds	4
E139 bomblet	GB		4
Do	GB		4
M55 rocket warhead	GB		4
M23 land mine	VX		6
Test fixture, ground release [1]	VX	10 pounds	3
Test fixture, ground release [1]	HD	do	3
155-millimeter shell, ground release [1]	GD	12.5 pound	10
Test fixture, ground release [1]	GA	1.2 pounds	16
United States Navy:			
Bomblet	G-type	3 pounds	6
Defense system challenge, ground release [1]	GB or VX	do	3
United States Air Force: BLU–19 bomblet	GB		4

Item	Agent	Agent quantity per item	Number of items to be tested
Edgewood Arsenal, Md.—all Army:			
155 mm shell, ground release [1]	VX	6.5 pounds	[2] 8
Test fixture	EA 1356	100 grams	[2] 24
Do	GB	50 grams	[2] 20
E139 bomblet (EOD test)	GB		1
M23 land mine	VX		3
E139 bomblet	GA		[2] 14
	GB		8
	GD		[2] 30
Test munition	VX	10 pounds	2
Fort McClellan, Ala: [3]			
Bulk agent, poured on a suitable surface for detection and decontamination exercises.	HD	2 gallons	1
	HD	1 gallon	5
	HD	160 centimeters	1
	HD	120 centimeters	1
	HD	80 centimeters	6
	HD	40 centimeters	5
	GB	42 centimeters	5
	VX	42 centimeters	5
	VX	42 centimeters	8

LETHAL AGENT, OPEN-AIR TESTS SCHEDULED, FIRST QUARTER, FISCAL YEAR 1970—JULY–SEPTEMBER 1969

Item	Height of release	Agent	Agent quantity per item	Quantity of item to be tested
Deseret Test Center, Utah (Dugway Proving Ground):				
United States Navy: V Bomblet	Ground	VX	1 pound	3
United States Army:				
55-gallon drum—portable water	do	GB	Less than 2 pounds.	5
		HD		
		VX		
M2XR		XR		75
155 M121 projectile		GB		28
155 M121 projectile		VX		28
155 M121 projectile		GB		6
155 M121 projectile		VX		6
4.5-inch mortar	Ground	HD	6 pounds	148
		HT		
155	do	G	12 to 14 pounds	30
M23 Land mine		VX		12
M56 Warhead (M55 rocket)		GB		10
United States Air Force:				
Test fixture	Ground	HD	8 pounds	7

Item	Height of release	Agent	Agent quantity per item	Quantity of item to be tested
Edgewood Arsenal, Md. (All Army tests):				
155 Howitzer shell	Ground	VX	6.5 pounds	7
Test fixture	do	EA1356	100 grams	24
Do	do	EA1356	11 pounds	3
Do	do	GB	50 grams	20
E139 bomblet (EOD) test)		GB		1
Test bomblet	do	VX	1 pound	8
M23 land mine		VX		3
155 Howitzer canister	do	VX	3 pounds	9
Test spray	1 meter	GA	1.3 pounds	16
Fixture		GB	1.3 pounds	8
		GD	1.3 pounds	16
		VX	10 pounds	2
		GB		4
E139 bomblet		GD		8

[1] Ground releases are statically detonated or functioned.
[2] To be conducted this quarter or next quarter, depending on availability of facilities.
[3] Chemical agent decontamination and detection exercises are conducted to train chemical specialists in techniques for these operations. The specialists are subsequently assigned to Army divisions and decontamination teams.

Source: Subcommittee on Conservation and Natural Resources, Committee on Government Operations, U.S. House of Representatives.

Note: Recent exchanges between Representative Henry Reuss, chairman of the House Conservation and Natural Resources Subcommittee and Army Secretary Stanley Resor give some idea of the scheduling of open air tests of chemical agents, including nerve gas.

The unclassified data above lists item-by-item outdoor testing for the periods March 1968 to May 1969 at Dugway Proving Ground, Utah; April to June 1969 at Deseret Test Center, Utah (Dugway Proving Ground, Utah); at Edgewood Arsenal, Md.; and at Fort McClellan, Ala.; July to September 1969 at Deseret Test Center, Utah (Dugway Proving Ground, Utah) and at Edgewood Arsenal, Md.

Mr. GOODELL. Mr. President, let us suppose that VX again escaped from a testing site. Suppose instead of drifting to a field of sheep, the nerve gas drifted to a city or town of people. The deadly nerve gas VX is colorless and odorless. The protection required against its very rapid fatal effect is a gas mask and protective clothing. First aid suggested is atropine. What chances under these circumstances would our people have of surviving?

A ban on outdoor testing of lethal chemical agents, including VX, would prevent such circumstances from arising.

I simply cannot accept accidental death, contaminated land, and the spread of disease as a price for adding still more to the already vast offensive capability of our CBW arsenal.

Mr. President, on Saturday, Secretary of Defense Laird said that a chemical warfare deterrent and a biological research program are essential to national security. He said that research and testing of CBW agents should continue.

If I rightly understand, we can expect Pentagon requests to break the proposed "moratorium" on CBW open air tests. If such Pentagon requests be made and agreed to, I fear we will be back again where we started. That is, we will be back with peril to the public health and peril *from a spiraling* CBW program.

Mr. President, why, in view of the nuclear, and other deterrents, are chemical warfare deterrence and an offensive biological research program essential to national security?

To date, research in biological warfare has already produced biological warheads for the Sergeant; research has brought germ warfare to the missile age.

Chemical deterrence has also found shelter in the Sergeant. Still, we are told by the Pentagon that research and testing should continue.

What are we really contributing to when we stockpile munitions filled with lethal gas and disease-producing bacteria? Do we not contribute to that eerie sense of doomsday? What do we mean to accomplish with gas and germ weapons? To prevent use? But what if the net result is to proliferate use?

Mr. President, anything so infamous as germ warfare should be deterred ultimately by eliminating germ weapons. Some will say that this is a dream. Some will say that it cannot be achieved. I cannot accept this reasoning to justify germ weapons. Today, I call for the day when we will dismantle our germ arsenal. I look forward to the day, when the United States will eliminate the means by which civilizations of the world could plunge into the abyss of epidemic and mass death. I urge today, that we fight germs with medicine; not with germ weapons. Medical protection against germs is reasonable, it is sane. To protect against germs with germ weapons is folly; it is madness.

Deterrence with defensive equipment, such as gas masks and vaccines, is more reasonable than the deterrence offered by military science and by hardware which places gas and germs in grenades and in nuclear warheads. Deterrence with defensive equipment has the added advantage of beneficial "spin-offs" for peacetime medical applications gained by gas and germ research. It is still unclear to me *why* medical research of this kind is done by the Defense Department when such research can be done by the Public Health Service.

Deterrence with weapons has the negative side effect of arms race competition with other nations or indeed, with our own self. Unilateral armament may be the net effect, or perhaps is the goal of our CBW program. Still, we cannot ignore our contributions to proliferation of CBW throughout the world.

Mr. President, how does our national security benefit from CBW proliferation? We have spent years to check nuclear proliferation to nonnuclear nations. If we succeed in nuclear nonproliferation, then few nations will pose a nuclear threat to the cities of this country. Chemical and biological weapons are a way that many nations can threaten our cities.

Do we and should we encourage foreign nations to build up gas and germ weapons as a deterrent to a potential enemy? Should we train foreign officers in gas and germ warfare? Should we have CBW courses at Fort McClellan and invite foreign officers to attend?

Mr. President, many people are unaware that in the past 20 years, concerning CBW, and prior to 1951, we even had a foreign officer training program which trained military officers from Egypt and Yugoslavia in the use of chemical and biological agents. It has been charged that, subsequent to that time, Egypt used deadly gases in Yemen. We have a share of the responsibility for this tragic development in the history of mankind.

Some 35 nations have received foreign officer training in how to use CBW weapons. This is truly a significant rung up the balance-of-terror ladder for the world, because chemical and biological agents can be produced cheaply by countries with very small resources.

Unlike nuclear weapons, chemical and biological weapons which can wipe out mankind can be produced by small countries. We must move forward—certainly our country must—and should not be a party to escalating an arms race in this area of CBW.

Certainly it is difficult to look back at different countries' activities in the past 20 years with any confidence that we have done anything but contribute to greater escalation.

It is particularly distressing to me that our CBW program includes a foreign officer training program in CBW. The Army offers two courses in CBW open to foreign officers at Fort McClellan. One course is for a period of 9 weeks. The other is for a period of 9 months. Since 1951, the Pentagon has provided CBW training to officers from over 35 foreign countries.

Mr. President, I ask unanimous consent to have printed in the RECORD two charts showing the countries which have participated in the Army's CBW training program.

There being no objection, the charts were ordered to be printed in the RECORD, as follows:

ARMY'S CBW FOREIGN OFFICER TRAINING PROGRAM—PARTICIPATING COUNTRY LIST, FROM 1951 TO PRESENT

FOREIGN OFFICERS TRAINING PROGRAM—9 WEEK COURSE

	Fiscal year—	
	1969	1970
Japan		
Korea		
Philippines		
Taiwan		
Thailand		
South Vietnam		
Iran		1
Lebanon		
Pakistan		
Saudi Arabia	5	4
France		
Germany	2	2
Greece	5	4
Italy		
Netherlands		
Norway		
Spain		
Sweden		
United Kingdom	3	3
Yugoslavia		
Canada	1	2
Argentina		
Mexico		
Australia	2	

Source: Department of Defense

FOREIGN OFFICERS TRAINING PROGRAM—36 WEEK COURSE

	Fiscal year	
	1969	1970
Australia		1
Japan		
Korea	2	1
Phillipines		1
Taiwan	1	
Thailand	1	1
South Vietnam		2
Iran		
Iraq		
Jordan		
Lebanon		
Pakistan		
Egypt [1]		
Austria		
Denmark		1
Germany		
Greece		
Italy		
Norway		
Switzerland		
Turkey		
Yugoslavia [1]		
Canada		
Argentina		
Brazil		
Venezuela		
Israel		1

[1] Terminated since early 1950's.

Source: Department of Defense.

Mr. GOODELL. Mr. President, officers have come here to learn about CBW. They have come from Europe, from Latin America, from the middle East and from Southeast Asia. This year, emphasis has been given to training officers from Vietnam, Thailand, Korea, Taiwan, and the Philippines.

I am concerned that such training of foreign officers could inspire an appetite for acquisition of these insidious weapons of war. I am disturbed that knowledge and acquisition of CBW could propel nations of the world to use CBW in war. Have we learned nothing from Yemen? Indeed, sharp review of this foreign officers training program in CBW is long overdue.

I urge that the Senate Armed Services Committee make a complete review of this aspect of the CBW program. The question to be faced is whether these study courses should be continued or abandoned in the name of reason.

If we fail to halt chemical and biological weapons spread and build-up now, what will be in store for future generations? While we now pause on the present rung of the CBW balance-of-terror ladder, we see that we are in a near perfect model of weapons escalation. If we have "overkill" in nuclear weapons; we have "superkill" in chemical and biological weapons. If the Pentagon has asked us to deploy an ABM for defense against nuclear attack, it is just a matter of time that the Pentagon will ask us for funds to deploy an ACBM, an anti-chemical and biological monitoring system?

We simply must guard against the dangers inherent in the very existence of chemical and germ weapons. There is danger in any outdoor testing of lethal gas and any disease-producing bacteria and toxin. There is danger in CBW escalation and proliferation. There is danger in the use of gas and germs in warfare.

Today, we can start to check the dangers posed by CBW by acting favorably on the omnibus anti-CBW amendment. We can begin today with what promises to be a very long and difficult road to additional review and further control of chemical and biological weapons both in this country and throughout the world.

Yet to be done is a review by the whole Congress of many general areas of inquiry:

Why do we have a gas and germ arsenal? Is the Pentagon's retaliation in kind a valid justification given the nuclear deterrent?

How does our CBW program contribute to the proliferation of CBW throughout the world?

What is the U.S. policy on use of these weapons in combat?

What steps are the United States willing to take in CBW arms control?

Let us give deep consideration to the grave moral issues which arise when we stockpile munitions filled with lethal gas and disease-producing bacteria. Let us think deeply on this as we move further in our review of CBW from the standpoints of deterrence, proliferation, use in combat, and targets for further disarmament.

More steps can be taken to control chemical and biological weapons. These include:

Presentation of the Geneva Protocol by the President to the Senate for ratification. The United States signed, but never ratified, the 1925 Protocol outlawing use of gas and germs in war.

A report by a nongovernmental Scientific and Medical Advisory Committee on CBW. This report could focus on scientific, medical, and arms-control aspects of chemical and biological weapons. The report should be presented to both the President and to Congress. Paralleled with congressional examination and that of the National Security Council, such a report could be an important contribution in options for charting a long-range course of action on gas and germ weapons.

These are some more steps we can take to control CBW in addition to the omnibus anti-CBW amendment we are considering today.

Mr. President, I am not completely satisfied with the compromise, but I think it is a significant breakthrough.

I want to commend particularly the Senator from Wisconsin (Mr. NELSON) for his cooperation in working with me and others in developing these amendments, particularly the three originally cosponsored by us. I would also like to commend the Senator from New Hampshire for his continuing concern and interest in this area, and for his cooperation in working out the amendment which we expect will be carried through in conference and not diluted further.

Mr. McINTYRE. Mr. President, will the Senator from Wisconsin yield me 1 minute?

Mr. NELSON. Mr. President, how much time remains to me?

The PRESIDING OFFICER. Four minutes remain to the Senator from Wisconsin.

Mr. NELSON. I yield 1 minute to the Senator from New Hampshire.

The PRESIDING OFFICER. The Senator from New Hampshire is recognized for 1 minute.

Mr. McINTYRE. Mr. President, I should like to respond to the Senator from New York and commend him for the fine work he has done in this area of CBW, and to commend also the Senator from Wisconsin (Mr. NELSON) and others, and their staffs, for their close cooperation and the fine work they have done in trying to bring together and consolidate the thinking on control matters concerning the CBW program.

To this point I would say that all of these Senators have cooperated. The compromise may not please everyone; but, as the Senator from New York stated, it represents a beginning of control that Congress should have over this program.

Mr. NELSON. Mr. President, I thank the Senator from New Hampshire. As chairman of the subcommittee, along with other Senators and their staffs, they did a superb job in working out the combined amendment.

I should like to mention that a number of us have offered amendments of various kinds to the budget. It is appropriate to mention that the original budget on January 14 was $23,151,660,000. That was reduced by Secretary Laird's recommendations to $21,963,060,000. And then through the efforts of the chairman, the Senator from Mississippi (Mr. STENNIS), the budget was cut another almost $2 billion, down to $20,059,500,000.

It should not go unnoted that the chairman and his committee did an excellent job in reducing the budget. The fact that a number of us have other amendments should not cause us to ignore the fact that the chairman did a fine and conscientious job.

Mr. President, I ask unanimous consent to have printed in the RECORD a news story from the Washington Post of yesterday, Sunday, August 10, 1969, on a statement by the Secretary of Defense, Mr. Laird, as well as the statement by Mr. Laird made on August 9, 1969, regarding the CBW amendment pending.

There being no objection, the news article and statement were ordered to be printed in the RECORD, as follows:

[From the Washington (D.C.) Post, Aug. 10, 1969]

CBW CURB ENDORSED BY LAIRD

The Defense Department announced unexpectedly yesterday that it would support efforts for strict congressional controls on the testing and production of chemical and germ warfare weapons.

The announcement by Defense Secretary Melvin R. Laird virtually insures Senate approval Monday of a revised but still broad amendment drawn up by critics of the Pentagon's past activities in the CBW field. It would, among other restrictions, ban most open air testing of the lethal agents.

If approved, the CBW amendment would be the second major victory for critics of the Pentagon since they failed by two votes last week to block initial deployment of the Safeguard anti-ballistic missile system.

The Senate's liberal bloc won approval Thursday of a potentially far-reaching amendment that would give the General Accounting Office greater powers to audit defense contracts.

"I am in agreement with the goals of the (CBW) amendment," Laird said yesterday in a statement released by the Pentagon.

"I believe this revised amendment will allow us to maintain our chemical warfare deterrent and our biological research program, both of which are essential to national security," the statement said.

Senate Armed Services Committee Chairman John Stennis (D-Miss.) said Friday he would probably support the amendment and predicted its approval.

The compromise language, which the original supporters—said would not harm the amendment, would allow open air testing of CBW agents only when the Secretary of Defense certified that it was necessary for national security, the U.S. Surgeon General certified that it would not be hazardous to health or the environment and congressional committees had been notified in advance.

There are no restrictions on such testing now. The original amendment would have flatly banned it.

The compromise version was worked out Friday in a meeting between Dr. John S. Foster, Pentagon research director, and Sen. Thomas J. McIntyre (D-N.H.), chairman of an Armed Services subcommittee that had already recommended deletion of all funds for development of offensive CBW weapons.

CONCERN CITED

Laird said that when he took office in January he "became concerned with the management and control of our chemical warfare and biological research programs" and "felt that improvements were needed in the management and control of these programs."

On result of this concern, he said, was President Nixon's directive in April ordering the National Security Council to make a thorough study of CBW activities.

"Pending the completion of the NSC study," Laird said, "I believe it is prudent that we act jointly with Congress and take actions, wherever possible, to improve the management and control of chemical warfare and biological research programs."

Laird emphasized that research and testing of CBW agents should continue even though the United States has stated it would use them only in self-defense, because "failure to maintain an effective chemical warfare deterrent would endanger national security."

The amendment would also require semi-annual reports to Congress on CBW spending and would bar procurement of further CBW delivery systems, CBW activities found by the Secretary of State to violate with international law, most shipments of CBW agents within the United States and transport to foreign countries without approval of the foreign nation and notification to Congress.

$2.5 BILLION SPENT

Since 1960, the Pentagon has spent about $2.5 billion on CBW activities with little congressional scrutiny or public knowledge.

The amendment would be attached to the $20-billion military procurement bill, which has been on the Senate floor for five weeks. Nearly a dozen other amendments are awaiting action and Senate leaders said Friday the bill would probably not come to a final vote until September.

Sen. Gaylord Nelson (D-Wis.), a sponsor of the CBW amendment, released this list of colleges and universities engaged in Pentagon CBW contracts:

"Boston Univ., Brooklyn College, Buffalo Univ., Univ. of California at Berkeley, Univ. of California at Los Angeles, Univ. of Chicago, Univ. of Connecticut, Cornell Univ., Delaware, George Peabody College, George Washington Univ., Georgia Institute of Technology, Hahnemann Medical College, Harvard, Univ. of Illinois at Urbana, Illinois Institute of Technology.

Also, Indiana Univ. Foundation, Iowa State Univ., Johns Hopkins, Kansas State Univ., Univ. of Maryland and its medical and dental schools, Univ. of Massachusetts, Massachusetts Institute of Technology, Univ. of Michigan, Univ of Minnesota, Univ. of North Carolina, Ohio State Univ., Univ. of Oklahoma, Univ. of Oregon, Univ. of Pennsylvania, Univ. of Pittsburgh, Polytechnic Institute of Brooklyn.

"Also, Rutgers, St. Louis Univ., Stanford Research Institute, Univ. of Tennessee, Univ. of Texas at Austin, Texas A&M, Univ of Utah, Utah State Univ., Medical College of Virginia, Univ. of Washington, Washington State Univ., Western Reserve Univ., College of William and Mary, Univ. of Wisconsin and Yale."

MEMORANDUM FOR CORRESPONDENTS, AUGUST 9, 1969

Secretary of Defense Melvin R. Laird today issued the following statement in response to queries about the DoD position on the pending McIntyre amendment.

On assuming the office of Secretary of Defense in January, I became concerned with the management and control of our chemical warfare and biological research programs. I felt that improvements were needed in the management and control of these programs. That is why in April I requested and the President ordered a National Security Council study of these matters. This study is in progress.

Pending the completion of the NSC study, I believe it is prudent that we act jointly with Congress and take actions, wherever possible, to improve the management and control of chemical warfare and biological research programs.

Members of my staff, principally Dr. John S. Foster, Jr., Director of Research and Engineering, have been working in recent days with Senator Thomas J. McIntyre of New Hampshire, and with other members of the Senate Armed Services Committee, on a revised amendment to the pending Defense Authorization Bill.

I am in agreement with the goals of the new amendment, which the Senate is scheduled to consider on Monday.

I believe this revised amendment will allow us to maintain our chemical warfare deterrent and our biological research program both of which are essential to national security.

The history of the use of lethal chemical warfare agents has demonstrated on three notable occasions in this country that the only time military forces have used these weapons is when the opposing forces had no immediate capability to deter or to retaliate. This was true early in World War I, later in Ethopia and more recently in Yemen. Clearly, failure to maintain an effective chemcial warfare deterrent would endanger national security.

Because it would not always be possible to determine the origin of attack by biological agents, the deterrent aspects of biological research are not as sharply defined. A continued biological research program, however, is vital on two other major counts.

First, we must strengthen our protective capabilities in such areas as vaccines and therapy.

Secondly, we must minimize the dangers of technological surprise.

It is important that the American people be informed of why we must continue to maintain our chemical deterrent, conduct biological research, and how we propose to improve the management and control of these programs.

Mr. NELSON. Mr. President, how much time do I have left?

The PRESIDING OFFICER. The Senator from Wisconsin has 2 minutes remaining.

Mr. NELSON. Mr. President, I ask unanimous consent to have printed in full in the RECORD the report of the Secretary General on chemical and bacteriological weapons and the effects of their possible use.

There being no objection, the report was ordered to be printed in the RECORD, as follows:

LETTER OF TRANSMITTAL

JUNE 30, 1969.

DEAR MR. SECRETARY-GENERAL: I have the honour to submit herewith a unanimous report on chemical and bacteriological (biological) weapons which was prepared in pursuance of General Assembly resolution 2454 A (XXIII).

The Consultant Experts appointed in accordance with the General Assembly resolution were the following:

Dr. Tibor Bakacs, Professor of Hygiene, Director-General of the National Institute of Public Health, Budapest.

Dr. Hotse C. Bartlema, Head of the Microbiological Department of the Medical-Biological Laboratory, National Defense Research Organization TNO, Rijswijk, Netherlands.

Dr. Ivan L. Bennett, Director of the New York University Medical Center and Vice-President for Medical Affairs, New York University, New York.

Dr. S. Bhagavantam, Scientific Adviser to the Minister of Defense, New Delhi.

Dr. Jiri Franek, Director of the Military Institute for Hygiene, Epidemiology and Microbiology, Prague.

Dr. Yosio Kawakita, President of the University of Chiba, Professor of Bacteriology, Chiba City, Japan.

M. Victor Moulin, *Ingénieur en chef de l'armement, Chef du Bureau Défense chimique et biologique, Direction technique des armements terrestres,* Saint Cloud, France.

Dr. M. K. McPhail, Director of Chemical and Biological Defense, Defense Chemical, Biological and Radiation Laboratories, Defense Research Board, Ottawa.

Academician O. A. Reutov, Professor of Chemistry at the Moscow State University, Moscow.

Dr. Guillermo Soberon, Director, *Institute de Investigaciones Biomedicas, Universidad Nacional Autonoma de Mexico, Mexico City.*

Dr. Lars-Erik Tammelin, Chief of Department for Medicine and Chemistry, Research Institute for National Defense, Stockholm.

Dr. Berhane Teoume-Lessane, Medical Co-Director and Head of Department of Viruses and Rickettsiae, Imperial Central Laboratory and Research Institute, Addis Ababa.

Colonel Zbigniew Zoltowski, Professor of Medicine, Epidemiologist and Scientific Adviser to the Ministry of National Defense, Warsaw.

Sir Solly Zuckerman, Chief Scientific Adviser to the Government of the United Kingdom, Professor Emeritus, University of Birmingham.

The report was drafted during sessions held in Geneva between 20 and 24 January and between 16 and 29 April, and finalized at meetings held in New York between 2 and 14 June 1969.

The Group of Consultant Experts wish to acknowledge the assistance they received from the World Health Organization, the Food and Agriculture Organization, the International Committee of the Red Cross, the Pugwash Conference on Science and World Affairs (Pugwash) and the International Institute for Peace and Conflict Research (SIPRI), all of which submitted valuable information and material for the purposes of the study.

The Group of Consultant Experts also wish to express their gratitude for the valuable assistance they received from members of the United Nations Secretariat.

I have been requested by the Group of Consultant Experts, as their Chairman, to submit their unanimous report to you on their behalf.

Yours sincerely,

WILLIAM EPSTEIN,
Chairman, Group of Consultant Experts on Chemical and Bacteriological (Biological) Weapons.

QUESTION OF GENERAL AND COMPLETE DISARMAMENT

[Illustrations not printed in the RECORD]

(*Report of the Secretary-General on chemical and bacteriological (biological) weapons and the effects of their possible use*)

Pursuant to General Assembly resolution 2454 A (XXIII) of 20 December 1968, the Secretary-General has the honour to transmit herewith to the General Assembly the report on chemical and bacteriological (biological) weapons and the effects of their possible use, prepared with the assistance of qualified consultant experts.

In accordance with paragraph 4 of the resolution, the report is also being transmitted to the Security Council (S/9292) and the Conference of the Eighteen-Nation Committee on Disarmament[1] as well as to the Governments of Member States.

FOREWORD BY THE SECRETARY-GENERAL

During the past few years, I have become increasingly concerned by developments in the field of chemical and bacteriological (biological) weapons and have given expression to this concern on several occasions. A year ago, I stated publicly that "the international community was not sufficiently conscious of the dangers inherent in this new type of weapon of mass murder", and that "due attention had not been focused on this very serious problem". In the introduction to my annual report on the work of the Organization, in September 1966, I stated:

"While progress is being made in the field of nuclear disarmament, there is another aspect of the disarmament problem to which I feel too little attention has been devoted in recent years. The question of chemical and biological weapons has been overshadowed by the question of nuclear weapons, which have a destructive power several orders of magnitude greater than that of chemical and biological weapons. Nevertheless, these too are weapons of mass destruction regarded with universal horror. In some respects, they may be even more dangerous than nuclear weapons because they do not require the enormous expenditure of financial and scientific resources that are required for nuclear weapons. Almost all countries, including small ones and developing ones, may have access to these weapons, which can be manufactured quite cheaply, quickly and secretly in small laboratories or factories. This fact in itself makes the problem of control and inspection much more difficult. Moreover, since the adoption, on 17 June, 1925, of the Geneva Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases and of Bacteriological Methods of Warfare, there have been many scientific and technical developments and numerous improvements, if that is the right word, in chemical and biological weapons, which have created new situations and new problems. On the one hand, there has been a great increase in the capability of these weapons to inflict unimaginable suffering, disease and death to ever larger numbers of human beings; on the other hand, there has been a growing tendency to use some chemical agents for civilian riot control and a dangerous trend to accept their use in some form in conventional warfare.

"Two years ago, by resolution 2162 B (XXI), the General Assembly called for the strict observance by all States of the principles and objectives of the Geneva Protocol of 1925, condemned all actions contrary to those objectives and invited all States to accede to the Protocol. Once again, I would like to add my voice to those of others in urging the early and complete implementation of this resolution. However, in my opinion, much more is needed. . . ."

[1] By a letter dated 1 July 1969 from the Secretary-General to the Co-Chairmen of the Conference.

At its twenty-third session, by resolution 2454 A (XXIII), the General Assembly requested me to prepare, with the assistance of qualified consultant experts, a report on chemical and bacteriological (biological) weapons in accordance with the proposal contained in the introduction to my annual report on the work of the organization (A/7201/Add. 1), and in accordance with the recommendation contained in the report of the Conference of the Eighteen-Nation Committee on Disarmament of 4 September 1968 (A/7189).

In pursuance of this resolution, I appointed the following group of fourteen consultant experts to assist me in the preparation of the report: Dr. Tibor Bakacs, Professor of Hygiene, Director-General of the National Institute of Public Health, Budapest; Dr. Hotse C. Bartlema, Head of the Microbiological Department of the Medical-Biological Laboratory, National Defence Research Organization TNO, Rijswijk, Netherlands; Dr. Ivan L. Bennett, Director of the New York University Medical Center and Vice-President of Medical Affairs, New York University, New York; Dr. S. Bhagavantam, Scientific Adviser to the Minister of Defence, New Delhi; Dr. Jiri Franek, Director of the Military Institute for Hygiene, Epidemiology and Microbiology, Prague; Dr. Yoslo Kawakita, President of University of Chiba, Professor of Bacteriology, Chiba City, Japan; M. Victor Moulin, *Ingénieur en chef de l'armement, Chef du Bureau Défense chimique at biologique, Direction technique des armements terrestres,* Saint Cloud, France; Dr. M. K. McPhail, Director of Chemical and Biological Defence, Defence Chemical, Biological and Radiation Laboratories, Defence Research Board, Ottawa; Academician O. A. Reutov, Professor of Chemistry at the Moscow State University, Moscow; Dr. Guillermo Soberon, Director, *Instituto de Investigaciones Biomedicas, Universidad Nactional Autonoma de Mexico,* Mexico City; Dr. Lars-Erik Tammelin, Chief of Department for Medicine and Chemistry, Research Institute for National Defence, Stockholm; Dr. Berhane Teoume-Lessane, Medical Co-Director and Head of Department of Viruses and Rickettsiae, Imperial Central Laboratory and Research Institute, Addis Ababa; Colonel Zbigniew Zoltowski, Professor of Medicine, Epidemiologist and Scientific Adviser to the Ministry of National Defence, Warsaw; Sir Solly Zuckerman, Chief Scientific Adviser to the Government of the United Kingdom, Professor Emeritus, University of Birmingham.

Mr. William Epstein, Director of the Disarmament Affairs Division, Department of Political and Security Council Affairs, served as Chairman of the Group of Consultant Experts. Mr. Alessandro Corradini, Chief of the Committee and Conference Services Section, acted as Secretary of the Group. He was assisted by members of the Disarmament Affairs Division.

After giving due consideration to the terms of the resolution and to the views expressed and the suggestions made during the discussion of the question at the twenty-third session of the General Assembly, I reached the conclusion that the aim of the report should be to provide a scientifically sound appraisal of the effects of chemical and bacteriological (biological) weapons and should serve to inform Governments of the consequences of their possible use. Within this over-all framework, the report would furnish accurate information in a concise and readily understandable form on the following matters: the basic characteristics of chemical and basteriological (biological) means of warfare; the probable effects of chemical and bacteriological (biological) weapons on military and civil personnel, both protected and unprotected; the environmental factors affecting the employment of chemical and bacteriological (biological) means of warfare; the possible long-term effects on human health and ecology; and the economic and security implications of the development, acquisition and possible use of chemical and bacteriological (biological) weapons and of systems for their delivery.

The consultant experts to whom I conveyed these terms of reference accepted them as the basis for their study.

It was my intention that the Group of Consultant Experts should survey the entire subject from the technical and scientific points of view, so that the report could place these weapons in proper perspective. It was also my hope that an authoritative report could become the basis for political and legal action by the Members of the United Nations.

As the report was to be made available by 1 July 1969, very concentrated efforts by the consultant experts were required in order to cover this extensive field. The members of the Group, acting in their personal capacities, carried out this demanding task at three sessions between January and June 1969.

The Group had the benefit of valuable submissions from the World Health Organization, the Food and Agriculture Organization, the International Committee of the Red Cross, the Pugwash Conference on Science and World Affairs (Pugwash) and the International Institute for Peace and Conflict Research (SIPRI). I wish to express my grateful appreciation to all the consultant experts for their dedicated work and to the organizations and bodies who co-operated in the preparation of the study.

The Group has submitted me to a unanimous report embodying its findings and conclusions. I wish to avail myself of this opportunity to express my gratification for the very high level of competence with which the consultant experts have discharged their mandate. In a very short period of time, they have produced a study, which, in spite of the many complex aspects of the subject matter, is both concise and authoritative. It is a document which, I believe, provides valuable insights into the grave dangers that are posed by the production and possible use of these dreaded weapons.

I am particularly impressed by the conclusion of the consultant experts wherein they state:

"The general conclusion of the report can thus be summed up in a few lines. Were these weapons ever to be used on a large scale in war, no one could predict how enduring the effects would be, and how they would affect the structure of society and the environment in which we live. This overriding danger would apply as much to the country which initiated the use of these weapons as to the one which had been attacked, regardless of what protective measures it might have taken in parallel with its development of an offensive capability. A particular danger also derives from the fact that any country could develop or acquire, in one way or another, a capability in this type of warfare, despite the fact that this could prove costly. The danger of the proliferation of this class of weapons applies as much to the developing as it does to developed countries.

"The momentum of the arms race would clearly decrease if the production of these weapons were effectively and unconditionally banned. Their use, which could cause an enormous loss of human life, has already been condemned and prohibited by international agreements, in particular the Geneva Protocol of 1925, and, more recently, in resolutions of the General Assembly of the United Nations. The prospects for general and complete disarmament under effective international control, and hence for peace throughout the world, would brighten significantly if the development, production and stockpiling of chemcial and bacteriological (biological) agents intended for purposes of war were to end if they were eliminated from all military arsenals.

"If this were to happen, there would be a general lessening of international fear and tension. It is the hope of the authors that this report will contribute to public awareness of the profoundly dangerous results if these weapons were ever used, and that an aroused public will demand and receive assurances that Governments are working for the earliest effective elimination of chemical and bacteriological (biological) weapons."

I have given the study prepared by the consultant experts my earnest consideration and I have decided to accept their unanimous report in its entirety, and to transmit it to the General Assembly, the Security Council, the Eighteen-Nation Committee on Disarmament and to the Governments of Member States, as the report called for by resolution 2454 A (XXIII).

I also feel it incumbent upon me, in the hope that further action will be taken to deal with the threat posed by the existence of these weapons, to urge that the Members of the United Nations undertake the following measures in the interests of enhancing the security of the peoples of the world:

1. To renew the appeal to all States to accede to the Geneva Protocol of 1925;

2. To make a clear affirmation that the prohibition contained in the Geneva Protocol applies to the use in war of all chemical, bacteriological and biological agents (including tear gas and other harassing agents), which now exist or which may be developed in the future;

3. To call upon all countries to reach agreement to halt the development, production and stockpiling of all chemical ond bacteriological (biological) agents for purposes of war and to achieve their effective elimination from the arsenal of weapons.

INTRODUCTION

1. In accordance with the resolution of the General Assembly 2454 A (XXIII) the Secretary-General was asked to prepare, with the assistance of qualified consultant experts, a report on chemical and bacteriological (biological) weapons and on the effects of their possible use. Specifically the experts were asked to provide a scientific appraisal of the characteristics of the chemical and bacteriological (biological) weapons which could be used in warfare; of the effects they could have on military personnel and civilians; as well as of their long-term effects on health and our physical environment. They were also asked to provide a statement about the economic and security implications of the development, acquisition and possible use of such weapons and associated weapon systems. The report which follows is confined to these objectives.

2. No form of warfare has been more condemned than has the use of this category of weapons. The poisoning of wells has been regarded from time immemorial as a crime incompatible with the rules of war. "War is waged with weapons, not with poison" (*"Armis bella non venenis geri"*), declared the Roman jurists. As the destructive power of arms increased over the years, and with it the potential for the widespread use of chemicals, efforts were made to prohibit through international understandings and by legal means the use of chemical weapons. The Brussels Declaration of 1874 and the Hague Conventions of 1899 and 1907 prohibited the use of poisons and poisoned bullets and a separate declaration of the Hague Convention of 1899 condemned "the use of projectiles the sole object of which is the diffusion of asphyxiating or deleterious gases".

3. The fear today is that the scientific and technological advances of the past few decades have increased the potential of chemical and bacteriological (biological) weapons to such an extent that one can con-

ceive of their use causing casualties on a scale greater than one would associate with conventional warfare. At the moment most of our knowledge concerning the use of chemical weapons is based upon the experience of World War I. Gas was first used in 1914 and the first big attack in 1915 claimed 5,000 human lives. It is estimated that from then until the end of the war in 1918, at least 125,000 tons of toxic chemicals were used, and according to official reports gas casualties numbered about 1,300,000, of which about 100,000 were fatal. The agents which were used in this war were much less toxic than those, in particular nerve agents, which could be used today, and they were dispersed by means of relatively primitive equipment as compared with what is now available, and in accordance with battlefield concepts of a relatively unsophisticated kind.

4. It is true that a considerable effort has also been made to develop chemical agents which have as their purpose not to kill but to reduce a man's capacity to fight. Such agents are used by civil authorities of a number of countries in order to suppress disorders and to control riots, but when used in warfare they would inevitably be employed as an adjunct to other forms of attack, and their over-all effect might be lethal.

5. Since World War II, bacteriological (biological) weapons have also become an increasing possibility. But because there is no clear evidence that these agents have ever been used as modern military weapons, discussions of their characteristics and potential threat have to draw heavily upon experimental field and laboratory data, and on studies of naturally occurring outbreaks and epidemics of infectious disease, rather than on direct battlefield experience. Their potential importance in warfare can be sensed when one remembers that infectious disease even as late as World War II caused numerous casualties.

6. The greater threat posed by chemical weapons today derives from the discovery and manufacture of new, more toxic compounds. On the other hand, bacteriological (biological) agents already exist in nature and can be selected for use in warfare. Some of these agents, notably bacteria, have been known for several decades, but there is a vast number of other possible agents, especially viruses, which have been discovered only recently, and some of these also possess characteristics which make their use possible in war. Increases in potency of these various types of agent have been made possible by scientific and technological advances in microbial genetics, experimental pathology and aerobiology.

7. As is well known, the use of toxic gases in World War I generated so powerful a sense of outrage that countries were encouraged to adopt measures prohibiting both chemical and bacteriological (biological) weapons. The result was the Geneva Protocol of 17 June 1925, which prohibits the use in war of asphyxiating, poisonous or other gases and of all analogous liquids, materials or devices, as well as bacteriological methods of warfare. This established a custom and hence a standard of international law, and in practice most States have adhered to the principle that no one should resort to the use of such weapons. But despite the adhorrence in which they have always been held by civilized peoples, chemical weapons have none the less on occasion been used. For example, mustard gas was used in Ethiopia in 1935–36, causing numerous casualties amongst troops and a civilian population which was not only completely unprotected, but which lacked even the most elementary medical services. It should also be noted that the existence of the Geneva Protocol of 1925 may have helped as a deterrent to the use of chemical or bacteriological (biological) weapons in World War II, even though the belligerents in that conflict had developed, produced and stockpiled chemical agents for possible use. The International Tribunal at Nuremberg brought into the open the fact that amongst the new agents which had been produced and stockpiled during the course of the war were such highly lethal agents as Tabun and Sarin. Since then the validity and effectiveness of the Geneva Protocol have been reinforced by the approval, by the General Assembly of the United Nations, without a single dissenting voice, of resolutions 2162 B (XXI) of 5 December 1966 and 2454 A (XXIII) of 20 December 1968, calling for "strict observance by all States of the principles and objectives" of the Geneva Protocol, and inviting all States to accede to it.

8. It is simple to appreciate the resurgence of interest in the problems of chemical and bacteriological (biological) warfare. Advances in chemical and biological science, while contributing to the good of mankind, have also opened up the possibility of exploiting the idea of chemical and bacteriological (biological) warfare weapons, some of which could endanger man's future, and the situation will remain threatening so long as a number of States proceed with their development, perfection, production and stockpiling.

9. The report, as is noted in the General Assembly resolution, is designed to submit to peoples and governments, in a form easily understood by them, information on the effects of the possible use of chemical and bacteriological (biological) weapons, as well as to promote a further consideration of problems connected with chemical and bacteriological (biological) weapons. Information about the nature of chemical and bacteriological (biological) weapons, about their increase and diversification as technology has advanced, about their long-term effects on human beings, animals and vegetation, and about environmental factors which condition these effects, is provided in Chapters I to IV of the Report. In Chapter V, which deals with the economic and security implications of chemical and bacteriological (biological) warfare, the experts have interpreted the word "security" to mean both security in the narrow military sense, and security in terms of the adverse and long-term effects which these weapons, given they were ever used, could have on the framework of civilized existence.

10. As the present report shows, the outstanding characteristics of this class of weapons, and particularly of bacteriological (biological) weapons, is the variability, amounting under some circumstances to unpredictability, of their effects. Depending on environmental and meteorological conditions, and depending on the particular agent used, the effects might be devastating or negligible. They could be localized or widespread. They might bear not only on those attacked but also on the side which initiated their use, whether or not the attacked military forces retaliated in kind. Civilians would be even more vulnerable than the military. The development, acquisition and deployment of chemical and bacteriological (biological) weapons—quite apart from questions of protection—constitutes a real economic burden which varies in extent for different countries. Above all their acquisition could not possibly obviate the need for other weapons.

11. As chapters I and V of the report indicate, it would be enormously costly in resources, and administratively all but impossible, to organize adequate protection for a civilian population against the range of possible chemical agents. Even military personnel, if locally engaged in a particular operation in which chemical and/or bacteriological (biological) weapons were used and where they had the advantage of protective measures, would be unlikely to escape the wider-spread and longer-term effects on their country at large. These might arise, for example, from the impracticability of protecting soil, plants, animals and essential food crops against short and long-term effects.

12. To appreciate the risks which bacteriological (biological) warfare could entail, one has only to remember how a natural epidemic may persist unpredictably, and spread far beyond the initial area of incidence, even when the most up-to-date medical resources are used to suppress the outbreak. The difficulties would be considerably increased were deliberate efforts made, for military reasons, to propagate pathogenic organisms. Mass disease, following an attack, especially of civilian populations, could be expected not only because of the lack of timely warning of the danger, but also because effective measures of protection or treatment simply do not exist or cannot be provided on an adequate scale.

13. Once the door was opened to this kind of warfare, escalation would in all likelihood occur and no one could say where the process would end. Thus the report concludes that the existence of chemical and bacteriological (biological) weapons not only contributes to international tension, but that their further development spurs the arms race without contributing to the security of any nation.

14. The present report will, in accordance with resolution 2454 A (XXIII), be submitted to the Eighteen-Nation Committee on Disarmament to the Security Council and to the General Assembly at its twenty-fourth session. We hope that it will contribute to the implementation of measures which, in the final analysis, will eliminate chemical and bacteriological (biological) weapons from all military arsenals.

CHAPTER I. THE BASIC CHARACTERISTICS OF CHEMICAL AND BACTERIOLOGICAL (BIOLOGICAL) MEANS OF WARFARE

15. Since World War I, when chemical warfare was first resorted to on a large scale, the variety and potency of chemical and bacteriological (biological) weapons has grown steadily, and there has been a corresponding increase in the capacity to deliver them to a target area. The particular threat posed by chemical weapons today derives from the existence of new, and far more toxic, chemical compounds than were known fifty years ago. Since bacteriological (biological) agents exist naturally, their increased potency as weapons has resulted from a process of selection rather than from the production of entirely new agents. As is explained in later sections of this report, selection has been made possible by advances in our knowledge of the genetics of microbes, and through advances in experimental aerobiology.

16. The most significant result of these technical developments is the great variety of injurious effect which these agents can induce, and the consequent increase in the number and types of situation in which there might be a temptaton to use them for military purposes.

A. Characteristics of chemical and bacteriological (biological) weapons

17. For the purposes of this report, chemical agents of warfare are taken to be chemical substances, whether gaseous, liquid, or solid, which might be employed because of their direct toxic effects on man, animals and plants. Bacteriological (biological) agents of warfare are living organisms, whatever their nature, or infective material derived from them, which are intended to cause disease or death in man, animals or plants, and which depend for their effects on their ability to multiply in the person, animal or plant attacked.

18. Various living organisms (e.g. rickettsiae, viruses and fungi), as well as bacteria, can be used as weapons. In the context of warfare all these are generally recognized as "bacteriological weapons". But in order to eliminate any possible ambiguity,

the phrase "bacteriological (biological) weapons" has been used throughout to comprehend all forms of biological warfare.

19. All biological processes depend upon chemical or physico-chemical reactions, and what may be regarded today as a biological agent could, tomorrow, as knowledge advances, be treated as chemical. Because they themselves do not multiply, toxins, which are produced by living organisms, are treated in this report as chemical substances. We also recognize there is a dividing line between chemical agents of warfare in the sense we use the terms, and incendiary substances such as napalm and smoke, which exercise their effects through fire, temporary deprivation of air or reduced visibility. We regard the latter as weapons which are better classified with high explosives than with the substances with which we are concerned. They are therefore not dealt with further in this report.

20. Finally, we recognize that both chemical and bacteriological (biological) agents are designated either as lethal agents, that is to say, agents which are intended to kill, or as incapacitating agents, that is to say, agents which are intended to cause disability. These terms are not absolute, but imply statistical probabilities of response which are more uncertain with bacteriological (biological) than with chemical agents. Not all individuals will die from an attack with a given lethal agent, whereas some, for example infants and people weakened by malnutrition, disease or old age, as well as a high proportion of individuals in special circumstances, for example following irradiation, might succumb to an attack with incapacitating chemical or bacteriological (biological) agents. With a few chemical agents, notably some tear gases (lachrymators), there is a negligible probability of any fatal outcome, and these have been used by many Governments to quell riots and civil disorders. When used in this way they are called riot control agents. Lachrymators have also been widely used in warfare as harassing agents, in order to enhance the effectiveness of conventional weapons, or to facilitate the capture of enemy personnel.

1. Differences Between Chemical and Bacteriological (Biological) Warfare

21. Although there are some similarities between chemical and bacteriological (biological) agents regarded as weapons of war, they differ in certain important respects. These differences are related to (1) potential toxicity; (2) speed of action; (3) duration of effect; (4) specificity; (5) controllability; and (6) residual effects.

Potential toxicity

22. Although more toxic than most well-known industrial chemicals, chemical warfare agents are far less potent on a weight-for-weight basis than are bacteriological (biological) agents. The dose of a chemical agent required to produce untoward effects in man is measured in milligrams (1/1,000 of a gram), except for toxins which may be in the microgram (1/1,000 of a milligram) range. The corresponding dose for bacteriological (biological) agents is in the picogram (1/1,000,000 of a microgram) range.

23. This difference reflects the fact that bacteriological (biological) agents, being alive, can multiply, and its significance is that, weight-for-weight, bacteriological (biological) weapons could be expected to inflict casualties over very much more extensive areas than could chemical weapons.

24. Being living organisms, bacteriological (biological) agents are also very much more susceptible to sunlight, temperature, and other environmental factors than are chemical agents. A bacteriological (biological) agent disseminated into a given environment may retain its viability (ability to live and multiply) while losing its virulence (ability to produce disease and injury).

Speed of action

25. As a class, chemical agents produce their injurious effects in man, animals or plants more rapidly than do bacteriological (biological) agents. The time between exposure and significant effect may be minutes, or even seconds, for highly toxic gases or irritating vapours. Blister agents take a few hours to produce injury. Most chemicals used against crops elicit no noticeable effect until a few days have elapsed. On the other hand, a bacteriological (biological) agent must multiply in the body of the victim before disease (or injury) supervenes; this is the familiar "incubation period" of a disease, the time which elapses between exposure to infection and the appearance of symptoms of illness. This period is rarely as short as one or two days, and may be as long as a few weeks or even longer. For both chemical and bacteriological (biological) agents the speed of action is affected by the dose (i.e., the quantity absorbed) but this secondary factor does not obscure the basic difference between the two classes of agents in the time they take to manifest their effects.

Duration of effect

26. The effects of most chemical agents which do not kill quickly do not last long, except in the case of some agents such as phosgene and mustard, where they might continue for some weeks, months or longer. On the other hand, bacteriological (biological) agents which are not quickly lethal cause illness lasting days or even weeks and on occasion involve periods of prolonged convalescence. The effects of agents which act against plants and trees would last for weeks or months and, depending on the agent and the species of vegetation attacked, could result in death.

Specificity

27. While both classes of agents can be used to attack men, animals or plants, individual biological agents have in general a much greater degree of host specificity. Influenza, for example, is essentially a disease of man; foot-and-mouth disease mainly affects cloven-hoofed animals; and rice blast is a disease confined to rice only. On the other hand, some diseases (for example, brucellosis and anthrax) occur both in man and animals. However, chemical agents are much less specific: nerve agents can affect mammals, birds and invertebrates (e.g., insects).

Controllability

28. By controllability is meant the ability to predict the extent and nature of the damage which chemical and bacteriological (biological) agents can cause. This is a most important consideration in their use as weapons. The most likely means of delivering chemical and bacteriological (biological) agents is by discharge into the atmosphere, relying on turbulent diffusion and wind currents to dilute and spread the agent over the area being attacked. Control is thus possible only to the extent that the meteorological situation can be predicted.

29. Because they infect living organisms, some bacteriological (biological) agents can be carried by travellers, migratory birds, or animals, to localities far from the area originally attacked.

30. The possibility of this kind of spread does not apply to chemical agents. But control of contamination by persistent chemical agents could be very difficult. Should large quantities of chemical agents penetrate the soil and reach underground waters, or should they contaminate reservoirs, they might spread hundreds of kilometres from the area of attack, affecting people remote from the zone of military operations. Although we know of no comparable substance likely to be used as a chemical warfare agent, the spread of DDT over the globe illustrates, in an extreme form, how man-made chemicals can spread. This chemical insecticide is now found in the tissues of creatures in all parts of the world, even in places in which it has never been used. For example, as a result of its transfer through food chains, it is even found in the tissues of the penguins which live in Antarctica.

Residual effects

31. In circumstances which favour their persistence, herbicides, defoliants and perhaps some other chemical agents, might linger for months, stunting the growth of surviving or subsequent plant life, and even changing the floral pattern through selection. Following repeated use, certain chemical agents could even influence soil structure. The risk of residual effects with some bacteriological (biological) agents is potentially greater, mainly because they could lead to disease, which might become epidemic if man-to-man transmission occurred readily. Bacteriological (biological) agents might also find unintended hosts in the animals and plants of an area, or be transported by infected individuals over great distances to new environments.

2. Technology of Chemical and Bacteriological (Biological) Warfare

32. The technological problems associated with chemical and bacteriological (biological) warfare are of two kinds; (1) those associated with the production of the agents and the weapons needed for their dissemination and (2) those which concern the provision of the protective equipment and defenses necessary to protect military forces and civilian populations. Any nation whose chemical, pharmaceutical and fermentation industries are well advanced could produce chemical and bacteriological (biological) agents on a scale commensurate with its other military capabilities. The assurance of safety in the production of bacteriological (biological) agents, problems associated with the synthesis of complex chemical agents, and deciding on the best weapons to disseminate them, are examples of some of the relevant technological difficulties. A special problem associated with the development and maintenance of an offensive capability in bacteriological (biological) warfare relates to the fact that some agents are viable for only a short time (a few days) after manufacture. This period can be extended by refrigeration of the agent or by freeze-drying it before storage. The drying processes, however, are very complex and difficult where large quantities of highly pathogenic agents are involved. The problems which relate to defence are far more difficult, for as with most weapons, effective defence calls for much more stringent training, and demands far more manpower and monetary resources than does the offence. For example, alarm systems against chemical attack are very complex electromechanical devices whose production demands a highly technologically based industry. They cannot be maintained except by expert and highly trained personnel.

3. Chemical and Bacteriological (Biological) Weapons Systems

33. The use in warfare, and the possible military effectiveness, of chemical and bacteriological (biological) agents cannot be appreciated if they are thought of simply as poisons and plagues. They need to be considered in the context of the weapon systems of which they would be part.

34. A weapon system comprises all the equipment and personnel, as well as the organizational structure, required to maintain and operate a military device. By itself, for example, a cannon is not a weapon system. Only when it is integrated into an artillery battery, together with trained crew, ammunition, vehicles, supplies, spare parts, firing table, forward observer, communications and command organization does it constitute a weapon system. Correspondingly, artillery shells filled with mustard gas or nerve agents and guns to fire them, or an aircraft with a spray tank filled with a bacteriological (bio-

logical) agent, are not by themselves weapon systems.

35. Many complex technological problems have to be overcome in transforming a chemical or bacteriological (biological) "agent" into a "weapon system". A "weapon" is of little military value if it is not dependable and if it cannot be delivered to a target with certainty. This means that in the development of a chemical and bacteriological (biological) weapon system it is not only necessary to consider matters such as mass production, storage, transportation, and means of delivery, but also the limitations on use set by terrain and weather prediction.

36. In addition, considerations affecting defense need to be taken into account. Masks, protective clothing, detection alarms, special medical supplies, augmented logistic facilities and, above all, thoroughly trained military and civilian personnel are necessary parts of chemical and bacteriological (biological) weapon systems. The concept of a fully developed chemical or bacteriological (biological) weapon system is thus exceedingly complex, and implies as much technical capability and as high a degree of training as does the operation of any other advanced weapon systems. While chemical and bacteriological (biological) weapon systems are cheaper and more readily attained than nuclear weapons, and while they may in some circumstances be more effective militarily than conventional weapons, they are highly complex systems which for their development and operation call for sizeable resources and considerable expertise. But the possibility always exists that by choosing a single agent and a simple means of delivery, a nation could equip itself relatively cheaply to attack a limited area with a reasonable chance of success.

B. Concepts of the use of chemical and bacteriological (biological) weapons in war

1. Chemical Weapons

37. Chemical weapons could be used either within the zone of contact of opposing forces; or against military targets such as airfields, barracks, supply depots, and rail centres well behind the battle-area itself; or against targets which have no immediate connexion with military operations; for example, centres of population, farm land, and water supplies. The circumstances in which they could be used within a zone of contact are many and varied—for example, to achieve a rapid and surprise advantage against a poorly trained, ill-equipped military force which lacked chemical protective equipment; to overcome troops in dug-outs, foxholes, or fortifications where they would be otherwise protected against fragmenting weapons and high-explosive; to remove foliage, by means of chemical herbicides so as to improve visibility and to open up lines of fire, and to prevent ambush; to create barriers of contaminated land on or in the rear of the battlefield to impede or channel movement; or to slow an enemy advance by forcing them to use protective clothing and equipment. Such equipment undoubtedly restricts mobility and impedes normal activities. It is thus highly probable that onee one of two well-equipped sides had been attacked with chemical weapons, it would retaliate in kind, in order to force its opponent to suffer the same penalties of restriction. In all such operations civilians who had not fled from the battle-area might become casualties, as they also would if, while not in the battle-zone, vapours or aerosols drifted towards them with the wind, or if they strayed at a latter date into areas contaminated with a persistent agent. The risk of civilian casualties would obviously be greater if chemical attacks were made on military targets well in the rear of the zone of contact, and would be very serious in the case of attacks on centres of population.

2. Bacteriological (Biological) Weapons

38. There is no military experience of the use of bacteriological (biological) agents as weapons or war and the feasibility of using them as such has often been questioned. One issue which has frequently been raised concerns the validity of extrapolations made from laboratory experience to military situations in the field. Some recent investigations under field conditions throw light on this point.

39. In one field trial, zinc cadmium sulfide (a harmless powder) was disseminated in particles two microns (one micron is 1/1,000,000 of a metre in diameter, from a ship traveling 16 kilometres offshore. About 200 kilograms were disseminated while the ship travelled a distance of 260 kilometres parallel to the coastline. The resulting aerosol traveled at least 750 kilometres, and covered an area of over 75,000 square kilometres.

40. This observation provides an indication of the size of area which might be covered by a windborne aerosol, but it does not tell whether the bacteriological (biological) agents which might be spread in an aerosol would still retain the ability to produce disease. All bacteriological (biological) agents lose their virulence or die progressively while travelling in an aerosol and the distance of effective travel of the cloud would depend on the rate of decay of the particular agent in the particular atmospheric conditions prevailing.

41. Some idea of the relative size of areas which can be covered by bacteriological (biological) and chemical aerosols can be gained from this same experiment. Had the particles that were carried been a bacterial or viral agent, they would not have caused casualties over as large an area as the one covered, because of decay of the agent while in the aerosol state. However, depending on the organism and its degree of hardiness, areas of 5,000 to 20,000 km² could have been effectively attacked, infecting a high proportion of unprotected people in the area. If the same means are applied to a hypothetical chemical attack using the most toxic chemical nerve agent, then about 0.8 kg of agent would have been released per km. The downwind hazard from this, in which some casualties might be expected, would not have extended more than one kilometre, and probably less, unless meteorological conditions were extremely favourable (see chapter III). The area covered by such a chemical attack might thus have been 50 to 150 km², as compared with the 5,000 to 20,000 km² for the bacteriological (biological) attack.

42. For purposes of sabotage or covert (secret, as in sabotage actions behind enemy lines) operations, small aerosol generators for bacteriological (biological) agents could be built, for example, into fountain pens or cigarette lighters. It is also possible to conceive of the distribution of bacteriological (biological) agents by hand to poison either water supplies or ventilation systems, especially in a situation of breakdown of sanitary facilities due, say, to military mobilization, or to a nuclear attack. In addition to producing casualties, such an attack could produce severe panic. If half a kilo of a culture of Salmonella (a group of bacteria, many species of which produce severe intestinal infections, including gastro-enteritis, food ("ptomaine") poisoning, paratyphoid fever and typhoid fever) had been added to a reservoir containing 5 million litres of water, and complete mixing had occurred, severe illness or disability would be suffered by anyone drinking 1 decilitre (about 3 ounces) of untreated water.

43. The same degree of poisoning as would be produced by half a kilo of Salmonella culture could be achieved with 5 kilos of botulinum toxin (see chapter II), 7 kilos of staphylococcal enterotoxin (see chapter II), or 50 kilos of V-nerve agent, or in the case of common industrial chemicals, with five tons of sodium fluoroacetate (used as a rodenticide) or ten tons of potassium cyanide.

C. Chemical and bacteriological (biological) agents

Chemical Agents

44. Chemical agents are usually described in terms of their physiological effects and are characterized as follows:

Agents affecting man and animals

Nerve agents are colourless, odourless, tasteless chemicals, of the same family as organophosphorus insecticides. They poison the nervous system and disrupt vital body functions. They constitute the most modern war chemicals known; they kill quickly and are more potent than are any other chemical agents (except toxins).

Blister agents (vesicants) are oily liquids which, in the main, burn and blister the skin within hours after exposure. But they also have general toxic effects. Mustard gas is a good example. Blister agents caused more casualties than any other chemical agent used in World War I.

Choking agents are highly volatile liquids which, when breathed as gases, irritate and severely injure the lungs, causing death from choking. They were introduced in World War I and are of much lower potency than the nerve agents.

Blood agents are also intended to enter the body through the respiratory tract. They produce death by interfering with the utilization of oxygen by the tissues. They, too, are much less toxic than nerve agents.

Toxins are biologically produced chemical substances which are very highly toxic and may act by ingestion or inhalation.

Tear and harassing gases are sensory irritants which cause a temporary flow of tears, irritation of the skin and respiratory tract, and occasionally nausea and vomiting. They have been widely used as riot control agents, and also in war.

Psycho-chemicals are drug-like chemicals intended to cause temporary mental disturbances.

Agents affecting plants

Herbicides (defoliants) are agricultural chemicals which poison or dessicate the leaves of plants, causing them to lose their leaves or die. The effectiveness of different chemical warfare agents against man, animals and plants is shown in table I. The various specific chemical agents are listed and described in chapter 2.

Methods of delivery

45. Chemical munitions are designed to fulfill three objectives: (1) to provide a container for the agent so that the agent/munition combination can be delivered to its target; (2) to attain an effective distribution of agent over the target area; and (3) to release the agent in active form. In the case of incapacitating and riot control agents, it is necessary that the munition itself should not cause injury or death, and that it should not start fires. This is particularly important for devices used in the control of riots.

46. The munitions to be used would depend on the method of delivery, the shape and size of the target area, and other variables. Ground-to-ground munitions include grenades, shells, rockets; and missile warheads; air-to-ground munitions include large bombs, dispensers, spray tanks, and rockets; emplaced munitions include generators and mines.

47. *Ground-to-ground munitions.* Small ground-to-ground munitions (grenades, shells and small rockets) function much like their conventional counterparts. Upon impact in the target area, they would either explode or burn, and so expel the agent to form a cloud which would diffuse and drift downwind, resulting in an elongated elliptical area within which casualties would occur. This represents a point source of dissemination (chapter II).

TABLE 1.—CATEGORIES OF CHEMICAL WARFARE AGENTS AND THEIR CHARACTERISTICS

	Physical state at 20° C.	Persistency	Main state of aggregation in target	Effective route of entry	Effective against
Nerve agents	Liquid	Low to high	Vapour, aerosol, liquid	Lungs, eyes, skin	Man, animals.
Blister agents	Liquid, solid	High	do	do	Do.
Choking agents	Liquid	Low	Vapour	do	Do.
Blood agents	Liquid, vapors	do	do	Lungs	Do.
Toxins	Solid	do	Aerosol, liquid	Lungs, intestinal tract	Do.
Tear and harassing gases	Liquid, solid	do	Vapor, aerosol	Lungs, eyes	Do.
Incapacitants	do	do	Aerosol, liquid	Lung , skin	Do.
Herbicides (defoliants)	do	Low to high	do	Foliage and roots	Plants.[1]

[1] Some herbicides, particularly those containing organic arsenic are also toxic for man and animals.

48. Small rockets would frequently be fired in "ripples", and artillery shells in salvos, resulting in a group of impacts over the target area. This would constitute an area source of dissemination (chapter II).

49. Large ground-to-ground (as well as aerial munitions and missile warheads) might carry a number of small submunitions as well as agent in bulk. The parent munition, upon functioning, would disperse the submunitions over the target area. These would then disseminate the agent over a wide area rather than a single point of impact, as in the case of bulk munitions.

50. Another military concept is to use large warheads filled with several hundred kilos of an agent of low vapour pressure. Such a warhead, burst at a suitable altitude would produce a shower of droplets, effectively contaminating everything on which it fell. A number of such weapons could be used to assure that the target was covered.

51. *Air-to-ground munitions.* Bombs dropped from aircraft are larger than most shells, and consequently would result in a higher concentration of the chemical near the point of ground impact. Bombs bursting close to the ground could be used to achieve a wider dissemination of the agent, especially with chemical agents.

52. A dispenser is a container for submunitions, which, after opening, could remain attached to the aircraft. The submunitions could be released simultaneously or in succession.

53. Small rockets or missiles could also be used to deliver chemical agents from aircraft. The pattern of dispersal would be much the same as that produced by ground-to-ground rockets or missiles.

54. *Ground-emplaced munitions.* Ground-emplaced munitions comprise generators and mines. The generator is a tank containing a chemical agent, a source of pressure, and a nozzle through which the agent is forced. Generators would be placed upwind of the target, and then activated by a suitable device.

55. Chemical mines would be placed in areas of anticipated enemy activity, and would be activated by pressure or trip wires.

2. Bacteriological (Biological) Agents

56. Like chemical agents, bacteriological (biological) agents may also be classified in terms of their intended use, whether designed to incapacitate or to kill human beings, to incapacitate or kill food and draft animals, or to destroy food plants and industrial crops.

57. Bacteria, viruses, fungi, and a group of microbes known as rickettsiae are by far the most potent agents which could be incorporated into weapon systems. There is no assurance, however, that other living organisms may not in the future become more important as potential agents for warfare.

The selection of agents for use in warfare

58. The number of bacteriological (biological) agents which could potentially be used in warfare is far fewer than those which cause naturally-occurring disease. To be effective for this purpose they should:

(a) be able to be produced in quantity;

(b) be capable of ready dissemination in the face of adverse environmental factors;

(c) be effective regardless of medical counter-measure;

(d) be able to cause a large number of casualties (this would imply that any agent chosen would be highly infectious, but whether the agent chosen would also be easily transmissible from man-to-man, would depend upon an intent to initiate an epidemic spread).

Agents affecting man

59. All the diseases under consideration occur naturally, and the causative organisms with few exceptions, are known to scientists throughout the world. Incapacitating agents are those which, in natural outbreaks, cause illness but rarely death. If the natural disease has an applicable mortality, the agent is regarded as a lethal one. However, these agents when used as aerosol weapons might cause more severe disease than occurs naturally.

60. Different populations have varying degrees of resistance to the diseases produced by bacteriological (biological) agents. An infectious disease which might be only mildly incapacitating in one population might prove disastrous to another. For example, when measles was first introduced into the Hawaiian Islands, it caused far more deaths than in the relatively resistant populations of Europe. A bacteriological (biological) weapon which might be intended only to incapacitate could be highly lethal against a population where resistance had been lowered as a result of malnutrition. Conversely, a weapon which was intended to spread a lethal disease might only cause occasional mild illness in people who had been given a protective vaccine or who had become immune as a result of natural infection. The history of epidemiology is rich with surprises.

61. *Viruses* are the smallest forms of life. Most of them can be seen only with the electron microscope, and must be grown on living tissue (tissue cultures, fertile eggs, etc.) Genetic manipulation of the whole virus or chemical manipulation of its nucleic acid, might be used to acquire strains of higher virulence or greater stability to environmental stresses.

62. *Rickettsiae* are intermediate between the viruses and bacteria. Like the viruses, they grow only in living tissue. Judging by the scientific literature, research into the genetics of rickettsiae has been less intense than into that of viruses and bacteria.

63. *Bacteria* are larger than viruses, ranging in size from 0.3 micron to several microns. They can be easily grown on a large scale employing equipment and processes similar to those used in the fermentation industry, but special skills and experience would be needed to grow them in quantity in the particular state in which they readily cause disease. Although many pathogenic (disease-producing) bacteria are susceptible to antibiotic drugs, antibiotic-resistant strains occur naturally, and can be selected or obtained through the use of suitable methods of genetic manipulation. Similarly, it is possible to select strains with increased resistance to inactivation by sunlight and drying.

64. *Fungi* also produce a number of diseases in man, but very few species appear to have any potential in bacteriological (biological) warfare.

65. *Protozoa* are one-celled microscopic organisms which cause several important human diseases, including malaria. Because of their complex life cycles, they too appear to have little significance in the present context.

66. Parastic *worms* such as hook-worm, and the filarial worms have very complicated life cycles. They cause illness and disability only after long exposure and repeated infection, and would be extremely difficult to produce in quantity, to store, to transport, or disseminate in a weapon. Insects are also difficult to conceive of as weapons. Some, such as the mosquito and the tick are transmitters of disease, and as "vectors", have to be looked upon as having potential military significance. Higher forms of life, such as rodents and reptiles can be dismissed in the context of the present discussion.

Agents affecting animals

67. Bacteriological (biological) anti-animal agents, such as foot-and-mouth disease and anthrax would be used primarily to destroy domestic animals, thereby indirectly affecting man by reducing his food supply.

68. Outbreaks of contagious disease in animal populations, knows as epizootics, may spread much more readily than do epidemics among human beings. Viral infections are probably more serious for animals than those caused by other classes of micro-organisms.

69. Most of the bacterial diseases of animals which could probably be used in warfare are also transmissible to man. Human beings would be expected to get the disease if they were affected by the attacking aerosol cloud, and occasional individuals might contract the disease from infected animals.

Agents affecting plants

70. The natural occurrence of devastating plant diseases such as the blight of potatoes in Ireland in 1845, the coffee rust of the 1870s in Ceylon, the chestnut blight of 1904 in the United States of America, and the widespread outbreaks today of cereal (especially wheat) rusts has suggested that plant pathogens might be used for military purposes. There are four major requirements for the deliberate development of a plant disease into epidemic (epiphytotic), proportions: large amounts of the host plant must be present in the region; the agent should be capable of attacking the particular varieties of host plant that are grown; adequate quantities of the agent must be present; and the environmental conditions within the region should be favorable for the spread of the disease. An epiphytotic cannot develop if any one of the above requirements is not satisfied.

Methods of delivery

71. Bacteriological (biological) agents can, in principle, be loaded into the same type of munitions as can chemical agents. Other than for covert or "special-purpose missions", bacteriological (biological) weapons, if developed for military purposes, would in all probability be delivered by aircraft or by large ballistic missiles. Aircraft (including cruise missiles and drones) could drop a large number of bomblets from high altitude, or

spray from a low altitude. Because a small amount of agent will cover relatively large areas, bombs would probably be small (1 kilo or less) and dispersed over as wide an area as possible. They could be released from clusters or from dispensers in the manner of chemical weapons, but probably from a higher altitude.

72. An aircraft could establish a line of agent which, as it traveled downwind, would reach the ground as a vast elongated infective cloud (see chapter II). The effectiveness of such a procedure would be highly dependent on weather conditions, but the larger the area, the larger the weather front involved, the greater the chances that the predicted results would be achieved. A small relative error might, however, involve a country not in the conflict.

73. It is conceivable that bacteriological (biological) weapons, probably bomblets, could be packaged in a ballistic missile. The bomblets could be released at a predetermined altitude to burst at ground level. The effect would be the same as bomblet delivery by aircraft except that it would be more costly.

74. Unless transmitted by insects, bacteriological (biological) agents have little power to penetrate the intact skin. Infections through the respiratory tract by means of aerosols is by far the most likely route which could be used in warfare.

75. Many naturally-occurring diseases (e.g. influenza, tuberculosis) are spread by the aerosol route, and some of them, notably influenza, can generate into large epidemics. When an infected person sneezes, coughs, or even speaks, an aerosol is formed which contains particles ranging widely in size. The larger particles are usually of little importance because they fall to the ground. But small particles (3 microns or less in diameter) dry out rapidly in the air, and are the most infectious. They may remain suspended in the atmosphere for a long time. Animal experiments have shown that a great many infectious agents (including many which are transmitted otherwise in nature) can be transmitted to animals by aerosols of small particle size. Laboratory accidents and experiments on volunteers have confirmed the effectiveness of the aerosol route of infection for man.

76. If bacteriological (biological) warfare ever occurred, the aerosol technique would thus be the one most likely to be used, simply because the respiratory tract is normally susceptible to infection by many microorganisms; because of the wide target area which could be covered in a single attack; and because ordinary hygienic measures are ineffective in preventing the airborne route of attack. Since the particle size of an aerosol is crucial to its ability to penetrate into the lung (see chapter III for detailed discussion), the method for aerosolizing a bacteriological (biological) agent would have to be controllable so as to assure the dissemination of a large proportion of particles less than 5 microns in diameter.

77. Aerosols of bacteriological (biological) agents could be formed by three general methods. Agents could be disseminated by explosive means in much the same way as chemical agents. However, the size of the resulting particle is hard to control by this method, and much of the agent may be destroyed by the heat and shock of the exploding munition. Particles could also be formed by using pressure to force a suspension of the organisms through a nozzle. Particle size is determined by the amount of pressure, the size of the discharge orifices, the physical characteristics of the agent, and atmospheric conditions. Size control of solid particles (dry form of agent) can be achieved by "pre-sizing" before dissemination. Aerosol particles could also be produced by a spray by releasing the agent in liquid suspension into a high velocity air stream. This principle can be applied to spray devices for use on high performance aircraft.

D. Defence of man against chemical and bacteriological (biological) agents

78. A comprehensive defensive system against attacks by chemical or bacteriological (biological) agents would have to provide for detection and warning, rapid identification of agents, protection of the respiratory tract and skin, decontamination, and medical prophylaxis and treatment. Some aspects of such a system could be dealt with by fairly simple equipment. Others would necessitate highly sophisticated apparatus. But the whole complex would necessitate a very effective organization manned by well-trained personnel. While military units and small groups of people could be equipped and trained to protect themselves to a significant extent, it would be impracticable for most (if not all) countries to provide comprehensive protection for their entire civil population.

1. Medical Protection

Chemical attacks

79. No general prophylactic treatment exists which could protect against chemical attacks. Antidotes (atropine and oximes) to nerve agents of value if administered within half an hour before or within a very short time after exposure. Atropine is itself toxic, however, and might incapacitate unexposed individuals given large doses. Skin can be protected from the vapours of blister agents by various ointments, but they are not effective against liquid contamination.

Bacteriological (biological) attacks

80. Vaccination is one of the most useful means of protecting people from natural infective disease, and the only useful means available for prophylaxis against bacteriological (biological) attacks. The protective value of vaccines against small-pox, yellow fever, diphtheria, and other diseases is fully established, although the protection they afford can be overcome if an immunized individual is exposed to a large dose of the infectious agent concerned. It is probable, however, that even those existing vaccines which are effective in preventing natural infectious diseases might afford only limited protection against respiratory infection by an agent disseminated into the air in large amounts by a bacteriological (biological) weapon. Moreover, whole populations could not be vaccinated against all possible diseases. The development, production, and administration of so many vaccines would be enormously expensive, and some vaccines might produce undesirable or dangerous reactions in the recipients.

81. This picture is not significantly altered by certain new developments in the field of vaccination: e.g. the use of living bacterial vaccines against tularemia, brucellosis and plague; or aerosol vaccination, which is particularly relevant to vaccination of large numbers of people. There have been recent advances in the control of virus diseases, but at present none of these is practicable for the protection of large populations against bacteriological (biological) warfare.

82. Prophylaxis against some diseases can also be provided by the administration of specific anti-sera from the blood of people or animals previously innoculated with micro-organisms, or products derived from them, to increase the anti-body levels (immunity) in their blood. Tetanus anti-toxin is used in this manner, and until more effective methods replaced them, such anti-sera were used for many diseases. It would, however, be impossible to prepare specific anti-sera against all possible bacteriological (biological) agents and to make them available for large populations.

83. Other possibilities, for example the use of therapeutic materials before symptoms appear, are equally remote from practical realization. They include immune serum, gammaglobulin, or drugs such as antibiotics or sulfonamide drugs. The use of gammaglobulin to prevent, or mitigate the severity of, disease may be useful for individuals known to have been exposed. But since gammaglobulin is made by separation from human blood, stocks could never be available except for isolated cases. In theory, chemoprophylaxis (the use of drugs and antibiotics to prevent infection) might also be useful in the short term for small groups operating at especially high risk. But it would only be prudent to assume that the bacteriological (biological) agents which an enemy might use would be those which were resistant to such drugs.

2. Detection and Warning

84. The requirement is to detect a cloud of a chemical or a bacteriological (biological) agent in the air sufficiently quickly for masks and protective clothing to be donned before the attack can be effective. Usually the objective would be to try and detect the cloud upward of the target so that all those downwind could be warned. There are also requirements for the detection of ground contaimanation with chemical agents and for detection equipment to enable those under attack to decide when it would be safe to remove their protective equipment.

Chemical attacks

85. In World War I it was possible to rely upon odour and colour as the primary means of alerting personnel that a chemical attack had been launched. The newer more toxic chemical agents cannot be detected in this way. On the other hand, presumptive evidence that such weapons had been used would none the less still be of value as warning. Once an enemy had used chemical weapons, each subsequent attack would necessarily have to be presumed to be a possible chemical attack, and protective measures would have to be instituted immediately. Individuals would have to mask not only in the air attack in which spray was used, or when there was smoke or mist from an unknown source, or a suspicious smell, or when they suffered unexpected symptoms such as a runny nose, choking and tightness in the chest, or disturbed vision, but whenever any bombardment occurred. But because of the uncertainty, it would be clearly desirable to devise and provide a system of instruments which can detect the presence of toxic chemicals at concentrations below those having psysiological effects, and which would give timely and accurate warning of a chemical attack. It would also be advantageous to have test devices, collectors and analytical laboratory facilities in order to determine whether the environment was safe, as well as to identify accurately the specific chemical agent used in an attack.

86. The first and essential component of a defensive system would be an instrument which could detect low concentrations of a chemical agent. However low the concentration, a person could inhale a toxic amount in a short time because he breathes 10–20 litres of air per minute. Since the human body can eliminate or detoxify very small amounts of many toxic materials, there is no need to consider very long periods of exposure—the concern is with the exposures of only a few hours. This is often referred to technically as the Ct (concentration time) factor. Essential requirements of a method of detection suitable for use by military or civil defence personnel are that it be simple, specific, sensitive and reliable. Typical detector kits contain sampling tubes and/or reagent buttons, papers, etc. After being exposed to particular chemical agents, these detectors change colour or exhibit some other changes easily obeervable without special insturments. Chemical detection kits could also be used to decide when it is safe to remove protective masks or other items of protective cloth-

ing. Obviously, laboratories, whether mobile or fixed, can perform more elaborate chemical analyses than can detection kits.

87. Warning devices which have been devised incorporate sensitive detectors that actuate an automatic alarm which alerts individuals to take protective action before a harmful dose of agent is received. They are of two trends: point sampling devices, which sample the air at one location by means of an air pump, and area scanning devices, which probe a specific area for chemical agents. The disadvantage of point source alarms is that they must be placed upwind of the area that has to be protected, and a rather large number may be needed. If the wind shifts, they have to be repositioned. Successful area scanning alarms have not yet been developed.

88. It must be recognized that in spite of instrumental warning systems, personnel near the point of dissemination of a chemical agent might still not have sufficient time to take protective action.

Bacteriological (biological) attacks

89. Unlike chemical weapons, bacteriological (biological) weapons cannot readily be distinguished from the biological "background" of the environment by specific chemical or physical reactions, and much lower aerosol concentrations of bacteriological (biological) agents are dangerous than of chemical agents. The problem of early detection and warning is thus even more difficult than for chemical weapons. A partial solution to the problem has been achieved with certain non-specific but very sensitive physical devices such as particle-counters and protein detectors (protein is a typical constituent of micro-organisms). Presumptive evidence of a bacteriological (biological) attack might be obtained if there is an unusual deviation from the normal pattern of material in the air recorded by the instruments. The elevation of such a deviation, however, would necessitate intensive and prolonged study of the normal pattern in a given location. This subject is discussed further in annex A.

3. Physical Protection

90. The primary objective is to establish a physical barrier between the body and the chemical and bacteriological (biological) agents, and especially to protect the skin and the respiratory tract. Without this no warning system, however effective, has the slightest value. Protection could be achieved by using various types of individual protective equipment or by means of communal shelters.

Individual protection

91. Protective masks are the first line of defense against all chemical and bacteriological (biological) agents. Although protective masks differ in appearance and design, they have certain features in common: a fitted facepiece, made of an impermeable material soft enough to achieve an effective seal against the face, and some means of holding it in place, such as a head strap, and a filter and absorption system, in canister or other form, which will remove particulate (aerosol) agents by mechanical filtration. The canister also contains activated charcoal, sometimes impregnated to react with agents in the vapour state, but which in any case will absorb toxic vapours. Some masks are made so as to permit the drinking of water while the individual is masked, or attempts at resuscitation measures on casualties without unmasking them. Civil defense masks are often less elaborate versions of the military mask. Gas proof protectors can be provided for infants.

92. A protective mask, properly fitted and in good working condition, will provide complete respiratory protection against all known chemical and bacteriological (biological) agents. However, a certain percentage of masked personnel can be expected to become casualties because of lack of training, failure to keep the mask in good condition, growth of beard, or because facial injuries prevent a good fit, etc. The amount of leakage that can be tolerated with bacteriological (biological) agents is much less because of their greater potency.

93. Since mustard gases and the nerve agents of low or intermediate volatility can penetrate the unbroken skin, even through normal clothing, the whole body surface must be protected by some form of special clothing, of which there are two kinds, one which is impermeable to liquid agents, and the other which, though permeable to air and moisture, has been treated so as to prevent chemical agents from getting through. Rubber coated fabrics, made into protective suits, constitute the first, while normal clothing, treated with chlorimides or absorbents, is an example of the second. In addition, some form of impermeable cover, ground sheet or cape, can be used to protect against gross liquid contamination. Feet and hands are usually protected by special gloves, and either by boot covers or treated boots.

94. Together with a mask, protective clothing, properly worn and in good condition, will afford excellent protection against known chemical and bacteriological (biological) agents. The greatest degree of protection is provided by the impermeable type but when worn continuously it becomes very burdensome because of heat stress, particularly in warm environments. Permeable clothing allows somewhat greater activity, but even so, physical activity is impaired.

Collective or communal protection

95. Collective protection takes the form of fixed or mobile shelters capable of accommodating groups of people, and has been devised not only for civilians but also for special groups of military personnel (e.g. command posts, field hospitals). Collective protection is the most effective physical means of protection against all forms of attack. Sealing or insulating the shelter will provide protection only for a limited time, because of lack of ventilation. Sealing plus a supply of oxygen and a means of eliminating carbon dioxide is better, but once again the time of occupancy is limited. The shelter could be none the less safe even though surrounded by fire or high concentrations of carbon monoxide. The best kind of shelter provides ventilation with filtered air to maintain a positive pressure relative to that outside. This positive internal pressure prevents the penetration of airborne agents, and permits entry or exit of personnel and equipment without contamination of the interior of the shelter. Extended periods of occupancy are possible.

96. These principles of collective protection as applicable to all enclosures arranged for human or animal occupancy. They have been used to provide protection by: hastily constructed or improvised field shelters, mobile vans and armoured vehicles, and permanent or fixed shelters designated for housing civilian or military personnel.

97. Once a bacteriological (biological) attack had been suspected or detected, it would be necessary to identify the specific agents involved so that proper protective measures could be taken and chemo-prophylaxis and treatment planned. Identification would also help to predict the incubation period and hence the time available for remedial measures to be taken. At present the only means of identifying specific micro-organisms is by normal laboratory procedures. Many routine laboratory methods of identification require as long as two to five days, but some recent developments have reduced this time appreciably. It is possible to collect the particles from large volumes of air and concentrate them in a small amount of fluid. Bacteria can then be trapped on special filters and transferred to nutrient media, where sufficient growth may take place to permit identification of some kinds of bacteria within fifteen hours. Another method, the fluorescent antibody technique, can be highly specific, and is applicable to bacteria and some viruses. In some cases, it allows of specific identification within a few hours. But despite all these recent developments, laboratory identification of biological agents is still a complicated and unsatisfactory process.

4. Decontamination

Chemical agents

98. Prolonged exposure to weather and sunlight reduces or eliminates the danger of most chemical agents, which are slowly decomposed by humidity and rain. But one could not rely on natural degradation to eliminate the risk and, in general, it would be essential to resort to decontamination. This would reduce the hazard but it is a time-consuming process and would greatly hamper military operations.

99. A wide range of chemicals could be used as decontaminants, the choice depending on the particular agent which has to be neutralized, the type of surface that needs to be treated, the extent of contamination, and the amount of time available. Decontaminants range from soap and detergent in water, to caustic soda, hypochlorite and various organic solvents, and their successful use calls for large numbers of people, a copious supply of water, and appropriate equipment.

100. Decontaminating solutions, powders, applicators and techniques have been developed for decontaminating skin, clothing, personal equipment and water. These would need to be used immediately after an attack.

101. Unless food has been stored in metal cans or other containers which were impermeable to chemical agents, it would have to be destroyed. Decontamination of complex equipment and vehicles is a difficult and time-consuming procedure. Special pressurized sprayers to disseminate powdered and liquid decontaminants have been developed for this purpose, as have paints or coatings to provide a smooth impermeable surface to preclude the penetration of chemical agents.

102. Decontamination might even need to be extended to roads and selected areas. This would involve the removal of contaminated soil by bulldozing, or covering it with earth, using explosives to spread a powdered decontaminant over a wide area.

Bacteriological (biological) agents

103. Decontamination procedures for biological agents are similar to those used for toxic chemical agents. Aeration and exposure to strong sunlight will destroy most micro-organisms, as will also exposure to high temperatures. Thoroughly cooking exposed food, and boiling water for at least fifteen minutes will kill almost all relevant micro-organisms. Calcium hyprochlorite and chlorine can also be used to purify water. Certain chemical compounds, such as formaldehyde, ethylene oxide, calcium and sodium hypochlorites, sodium hydroxide and betapropiolactone, can be used to decontaminate materials and work areas. A hot, soapy shower is the best way to decomtaminate human beings.

E. Protection of domestic animals and plants against chemical and bacteriological (biological) attacks

1. Chemical Attacks

104. The widespread protection of domestic animals and plants from chemical attack would be impracticable. Once a crop had been attacked with herbicides there is no effective remedial action. The damage could be made good only by a second planting of either the same or another crop, depending on the season.

2. Bacteriological Biological) Attacks

Animals

105. Animals or flocks could be protected by collective shelters, although the cost would be great and, in the absence of automatic warning devices, it would be impossible to assure that the creatures would be sheltered at the time of attack.

106. The ideal means of protection for animals would be vaccination. Vaccines have been developed, and many are routinely produced, for foot-and-mouth disease, rinderpest, anthrax, Rift Valley fever, hog cholera, Newcastle disease and others. Vaccination of animal herds by aerosols is a promising area of investigation.

Plants

107. The only hopeful approach would be to breed disease resistant plants. This is a regular part of most national agricultural programmes, and has as its object the increase of crop yields. But unless the exact identity of the bacteriological (biological) agent which might be used were known well in advance (possibly years), it would not be feasible to apply this principle to provide protection to crops against this kind of attack.

108. Efforts devoted to spraying fungicides and similar preparations to reduce loss after attack do not appear to be economically effective. In most cases the best procedure is to utilize available manpower and machines in planting second crops.

ANNEX A: EARLY WARNING SYSTEMS FOR AIRBORNE BACTERIOLOGICAL (BIOLOGICAL) AGENTS

An ideal automatic system for early warning against an attack with bacteriological (biological) agents would comprise the following components:

(1) a device to collect large volumes of air and concentrate the particulate matter obtained, in a small volume of fluid or on a small surface;

(2) a device to quantify and identify the collected material;

(3) a mechanism to assess the results and to initiate an alarm if necessary.

To collect and identify bacteriological (biological) agents and to initiate an alarm so that protective measures can be taken in sufficient time to be useful is extremely difficult. This is so because, firstly, identification of agents is generally time-consuming and, secondly, large and fluctuating quantities of bacterial and other organic materials exist in the atmosphere at all times. Thus if pathogens from a cloud released by an aggressor were collected, the device would need, not only to determine whether the quantity collected was significantly above the normal amounts that might occur, but also what the agent was, or at least that, in the amount collected, it was highly dangerous to man.

At present, warning devices are available which are sensitive but non-specific and these, unfortunately, would give an unacceptably high proportion of false alarms. Others are being developed which attempt to incorporate both rapid response with high specificity, but none to date is in the production stage. Research on this important problem is being continued and some of the approaches and techniques that are being used in this study are listed below.

Classification of automated biodetection approaches *

General category: Physical particle detection.

Suggested approach: magnification, light scattering, volume displacement.

General category: key biochemical components.

Suggested approach: antigen detection by fluorescent labelling, dyes and staining, bioluminescence and fluorescences, optical activity, pyrolysis products detection, ATP detection, proteins, nucleic acids, or others.

General category: Biological activity.

Suggested approach: Growth (increase in cell mass or numbers), CO_2 evolution, phosphatase activity, substrate change (pH, Eh, O_2 interchange), Pathogenic effects.

* Adapted from Greene, V.W. "Biodetecting and Monitoring Instruments Open New Doors for Environmental Understanding", *Environmental Science Technology*, February 1968, pp. 104–112.

CHAPTER II. THE PROBABLE EFFECTS OF CHEMICAL AND BACTERIOLOGICAL (BIOLOGICAL) WEAPONS ON MILITARY AND CIVILIAN PERSONNEL, BOTH PROTECTED AND UNPROTECTED

A. The effects of chemical agents on individuals and populations

109. The effects of chemical warfare agents on humans, animals and plants depend on the toxic properties of the agent, the dose absorbed, the rate of absorption and the route by which the agent enters the organism. Toxic agents may enter the body through the skin, the eyes, the lungs, or through the gastro-intestinal tract (as a result of eating contaminated food or drinking contaminated liquids).

110. For a given agent absorbed under the same conditions, the effect will be proportional to the dose absorbed. This is why it is possible to define for each agent certain characteristic doses, such as the dose which, under given conditions, will on average cause death in 50 per cent of the individuals exposed (the 50 per cent lethal dose, or "LD 50"), or the dose which will cause 50 per cent non-fatal casualties, or the dose which will have no appreciable military effect. These are expressed in milligrams of agent, with reference to a healthy adult of average weight. They may also be given in terms of milligrams per kilogram of body weight.

111. For purposes of evaluation it is convenient to express the same idea somewhat differently in the case of gases, vapours and aerosols absorbed through the respiratory passages. Here the absorbed dose depends on the concentration of the agent in the air, on the respiration rate of the subject, and on the duration of the exposure. If, for the sake of illustration, it is assumed that the average respiration rate for groups of individuals engaged in various activities remains relatively constant, it follows that the dose, and therefore the effect produced, will be directly proportional to the product of the concentration of the agent in the air (C in milligrams/cubic metre) and the exposure time (t in minutes). This is called the dosage (or Ct factor), certain characteristic values of which (for example the LD 50) are used in particular situations for quantitative estimates of the effects produced.

112. For toxic agents acting on or through the skin, the dose absorbed by contact will often be related to the "contamination rate," expressed in grams/square metre, which indicates to what extent surfaces are contaminatde by the liquid.

113. The consequences of an attack on a population are a combination of the effects on the individuals in it, with both the concentration of agent and the susceptibility of individuals varying over the whole area exposed to risk. Different individuals would respond differently to an attack, and might have different degrees of protection. Possible long-term contamination of personnel from chemical warfare agents persisting on the ground and vegetation may add to the immediate, direct effects.

114. Protective masks, protective clothing and shelters and, to a certain extent, decontamination when applicable, give substantial protection against all chemical warfare agents. But, as already emphasized, the mere possession of a means of protection by no means constitutes an absolute safeguard against contamination by poisons. Alarm and detection equipment is important, sometimes vital, because without it timely warning, which is essential to the proper use of protective equipment, would be lacking. Since protective measures are most effective when performed by trained personnel working effectively in units, military personnel are more likely to be provided with adequate protection than a civilian population. In any event, the civilian population in most countries is simply not provided with protection against chemical warfare.

115. Several chemical warfare agents which were known during World War I, and others developed since, have been reported on in the scientific literature. However, the effects of the more lethal modern chemical weapons have not been studied under conditions of actual warfare. Furthermore, no complete and systematic field studies of the use of defoliants, herbicides and riot control agents are available. The following descriptions of the probable effects of chemical weapons, based both upon evidence and on technical judgment, must therefore be regarded as somewhat conjectural.

1. Effects of Lethal Chemical Agents on Individuals

116. Table 1 provides a classification of the most important lethal chemical agents, and notes some of their characteristics in terms of the effects they produce. More details are given in annex A.

TABLE 1.—GENERAL CHARACTERISTICS OF LETHAL CHEMICAL AGENTS

Type	Mechanism	Time for onset of effects	Examples
Nerve agent G	Interferes with transmission of nerve impulses.	Very rapid by inhalation (a few seconds).	Tabun, Sarin, Soman.
Nerve agent V	Interferes with transmission of nerve impulses.	Very rapid by inhalation (a few seconds); Relatively rapid through skin (a few minutes to a few hours).	VX.
Blister agent	Cell poison	Blistering delayed hours to days; eye effects more rapid.	Sulfur mustard. Nitrogen mustard.
Choking agent	Damages lungs	Immediate to more than three hours	Phosgene.
Blood agent	Interferes with all respiration	Rapid (a few seconds or minutes)	Hydrogen cyanide.
Toxin	Neuromuscular paralysis	Variable (hours or days)	Botulinum toxin.

117. Lethal chemical agents kill in relatively small doses, and as a rule the amount that causes death is only slightly greater than that which causes incapacitation. Death may occasionally be caused by high doses of presumed incapacitating agents and, conversely, minor effects could be caused by low doses of lethal agents. Blister agents are considered with the lethal agents, since a small but significant fraction of the personnel attacked with such agents may die or suffer serious injury.

Nerve agents

118. These lethal compounds are readily absorbed through the lungs, eyes, skin and intestinal tract without producing local irritation, and they interfere with the action of an enzyme (cholinesterase) essential to the functioning of the nervous system. The nerve-agent casualty who has been exposed to a lethal dose will die of asphyxiation within a few minutes if he is not treated swiftly by means of artificial respiration and drugs such as atropine or oximes. Otherwise

recovery is generally rapid and complete. Occasionally, it may take several weeks, but will be complete unless anoxia or convulsions at the time of exposure were so prolonged as to cause irreversible brain damage.

119. The route of entry of the agent into the body has some influence on the appearance of symptoms. These develop more slowly when the agent is absorbed through the skin than when it is inhaled. Low dosages cause a running nose, contraction of the pupil of the eye and difficulty in visual accommodation. Constriction of the bronchi causes a feeling of pressure in the chest. At higher dosages, the skeletal muscles are affected—weakness, fibrillation, and eventually paralysis of the respiratory muscles occurring. Death is usually caused by respiratory failure, but heart failure may occur. It is estimated that the most toxic nerve gases may cause death at a dosage of about ten mg min/m³.* Less toxic ones are lethal at dosages of up to 400 mg min/m³.

Blister agents or vesicants

120. Mustard is a typical blister agent which, like other members of this class, also has general toxic effects. Exposure to concentrations of a few mg/m³ in the air for several hours results at least in irritation and reddening of the skin, and especially irritation of the eyes, but may even lead to temporary blindness. Exposure to higher concentrations in the air causes blisters and swollen eyes. Severe effects of this kind also occur when liquid falls on the skin or into the eyes. Blistering with mustard is comparable to second degree burns. More severe lesions, comparable to third degree burns, may last for a couple of months. Blindness may be caused, especially if liquid agent has entered the eyes. Inhalation of vapour or aerosol causes irritation and pain in the upper respiratory tract, and pneumonia may supervene. High doses of blister agents cause a general intoxication, similar to radiation sickness, which may prove lethal.

121. The first step in treating a person who has been exposed to a vesicant or blister agent, is to wash it out of the eyes and decontaminate the skin. Mild lesions of the eyes require little treatment. The blisters are treated in the same way as any kind of second-degree burn.

Other lethal agents

122. *Phosgene* and compounds with similar physiological effects were used in World War I. Death results from damage to the lungs. The only treatment is inhalation of oxygen and rest. Sedation is used sparingly.

123. *Hydrogen cyanide* in lethal doses causes almost immediate death by inhibiting cell respiration. Lower doses have little or no effect.

124. Most of the so-called blood agents contain cyanide, and all act rapidly. The casualty would either die before therapy could begin, or recover soon after breathing fresh air.

125. *Botulinum toxin* is one of the most powerful natural poisons known, and could be used as a chemical warfare agent. There are at least six distinct types, of which four are known to be toxic to man. Formed by the bacterium *Clostridium botulinum*, the toxin is on occasion accidently transmitted by contaminated food. The bacteria do not grow or reproduce in the body, and poisoning is due entirely to the toxin ingested. It is possible that it could be introduced into the body by inhalation.

126. Botulism is a highly fatal poisoning characterized by general weakness, headache, dizziness, double vision, dilation of the pupils, paralysis of the muscles concerned in swallowing, and difficulty of speech. Respiratory paralysis is the usual cause of death.

After consumption of contaminated food, symptoms usually appear within twelve to seventy-two hours. All persons are susceptible to botulinum poisoning. The few who recover from the disease develop an active immunity of uncertain duration and degree. Active immunization with botulinum toxoid has been shown to have some protective value, but antitoxin therapy is of limited value, particularly where large doses of the toxin have been consumed. Treatment is mainly supportive.

2. Effects of Lethal Agents on Populations

127. As already indicated, the possible effects of an attack on populations with lethal chemical warfare agents would depend upon the agent used, upon the intensity of the attack, whether the population was mainly under cover or in the open, on the availability of protective facilities, on the physiological state of the individuals affected, and upon the meteorological conditions, which might differ from what had been predicted, and alter during the course of an attack.

128. The importance of meteorological conditions on the spread of agent from its point or area of release is illustratsd by Figures 1(a), 1(b) and 1(c) which show in an idealized diagramatic form the type of dosage contours to be expected from a point source, from multiple sources and from a linear aerial source respectively when exposed to the effects of wind.

129. Figure 1 (a) shows the shape of the zone travelled by the chemical cloud produced by a point source (for example, one isolated munition), at the far left of the innermost cigar-shaped figure under conditions of a strong wind (say, 5-30 km/h) in the direction indicated.

130. The number on each line indicates the dosage (Ct = concentration times time) on the line. The dosage at any point inside the area delimited by the curve is greater than the number indicated. On the basis of these data, it is possible to estimate the casualties when the characteristic dosages of the agent used are known. For example, if the LD 50 value of the agent were 30 milligram-minutes/cubic metre, there would be more than 50 per cent fatalities in the area inside the contour marked 30.

131. This figure applies to a volatile agent such as Sarin, which is usually released in the form of a vapour or an aerosol cloud. In the case of a non-volatile liquid released in the form of droplets which fall onto the ground and contaminate it, a corresponding map could be drawn for the level of contamination of the soil (expressed in milligrams/square metre).

132. Figure 1 (b) shows the same phenomenon in relation to an area source such as would result, for example, from attack by a missile warhead filled with small bombs or by an artillery salvo.

133. In the case of a volatile agent released in the form of a vapour or aerosol, the resulting cloud, carried downwind, covers a zone whose general shape is the same as in the case of a point source (Figure 1 (a)), but its dimensions are obviously much larger and the dosage values are also larger.

134. If a non-volatile agent were released in the form of droplets, the hazard would be very great in the impact area because all surfaces (skin, clothing, vehicles, equipment, vegetation, etc.) would be contaminated. The downwind hazard caused by the drift of the most minute particles would extend over a much smaller area than in the previous case because only a relatively small number of minute particles would be carried by the wind.

135. Figure 1(c) shows the zone covered by a linear aerial source, as in the case of dissemination of a non-volatile agent from an aircraft.

136. The emitted cloud is carried by the wind and does not touch the ground until it has travelled some distance away from the line of flight of the disseminating aircraft; this depends on the altitude of the aircraft and on the wind velocity. Since the cloud has already been subjected to the influence of turbulent diffusion before *reaching* the ground, the dosage values or contamination rates will be highest some distance away from the zone boundary nearer the source.

137. Because of meteorological and other variables, it is impossbile to make general statements about the quantitative effects of chemical weapons on populations. The following hypothetical examples, therefore, are intended merely to illustrate what might happen and the degree to which protective measures could reduce casualties. To provide representative illustrations, the examples chosen include the different hazards created by nerve agents used in a battle zone, on military targets in the rear and on civilians in a town.

Effects of nerve gas on protected troops in combat

138. A heavy attack with air-burst munitions dispersing non-volatile liquid nerve agent would create concentrations on the ground that could rage from one-tenth of a gram to ten grams of liquid per square metre, giving a mean value of about five grams. This would be extremely hazardous. At the same time, aerosol concentrations would be created over almost the entire impact area (dosages about twenty mg. min/m³). This would produce casualties even if there were no liquid hazard.

139. To counter this type of attack, protective measures of a very high order of efficiency, including protective masks, light protective clothing, means for decontamination, detection systems, antidotes and medical care, would have to be available. Protective clothing and rapid utilization of gas masks would give a certain measure of protection. But in this case, subsequent decontamination and medical care would be necessary to avoid heavy lethal losses.

Effects of nerve gas on a military target in the rear

140. An attack from the air with a volatile nerve agent against a military installation in a rear area would cause an intense liquid and vapor hazard in the installation itself, and a vapour hazard downwind in the surrounding area. As suggested in figure 1(b), the impact area would be very heavily contaminated; gas dosages inside and close to the impact area would be very high. Further downwind the gas concentration would decrease gradually, and finally become innocuous. A general picture of the way casualties would occur in a downwind area is indicated in figure 1(a).

141. After an attack in which tons of Sarin were used against an area of one square kilometre, the impact area and the area immediately downwind from it would be highly lethal to all unprotected personnel. Lethal casualties would occur at dosages above eighty mg. min/m³ and severe casualties down to thirty mg. min/m³. Some very light casualties would result at dosages around five mg. min/m³. The distance between the impact area and the area of lowest effective dosage would depend on the local topography and on weather conditions, but would rarely exceed a few tens of kilometres.

142. Personnel provided only with gas masks, but not wearing them at the moment of the attack, would suffer substantial losses in and close to the impact area, both because of the effects of the liquid and because of the high gas concentration inhaled before they could don their masks. Further downwind, masks would give essentially complete protection if warning were provided reasonably quickly.

Effects of a nerve gas attack on a town

143. The population density in a modern city may be 5,000 people per square kilometre.

*A dosage of one mg min/m³ consists of an exposure of one minute to gas at a concentration of one milligram per cubic metre.

A heavy surprise attack with non-volatile nerve gas by bombs exploding on impact in a wholely unprepared town would, especially at rush hours, cause heavy losses. Half of the population might become casualties, half of them fatal, if about one ton of agent were disseminated per square kilometre.

144. If such a city were prepared for attack, and if the preparations included a civil defence organization with adequately equipped shelters and protective masks for the population, the losses might be reduced to one half of those which would be anticipated in conditions of total surprise.

145. Although it would be very difficult to achieve, if there were a high level of preparedness, comprising adequate warning and effective civil defence procedures, it is conceivable that most of the population would be sheltered at the time of the attack, and that very few would be in the streets.

146. Given a town with a total population of 80,000, a surprise attack with nerve gas could thus cause 40,000 casualties, half of them fatal, whereas under ideal circumstances for the defence, fatalities might number no more than 2,000. It is inconceivable, however, that the ideal would ever be attained.

3. Effects of Incapacitating Chemical Agents

147. Incapacitating chemicals, like tear gases and certain psychochemicals, produce in normal health people a temporary, reversible disability with few if any permanent effects. In your children, old people and those with impaired health, the effects may sometimes be aggravated. They are called incapacitating because the ratio between the lethal and incapacitating doses is very high. The types which could have a possible military use are limited by requirements of safety, controlled military effectiveness and economic availability.

Tear and harassing gases

148. Many chemical compounds fall into this category, of which ω-chloracetophenone (CN), ortho-chlorobenzylidenemalononitrile (CS), and adamsite (DM) are probably the most important. They are solids when pure, and are disseminated as aerosols.

149. Either as vapour or in areosol, tear and harassing gases rapidly produce irritation, smarting and tears. These symptoms disappear quickly after exposure ceases. The entire respiratory tract may also be irritated, resulting in a running nose and pain in the nose and throat. More severe exposures can produce a burning sensation in the trachea. As a result, exposed persons experience difficulty in breathing, attacks of coughing and occasionally, nausea and headaches.

150. Extremely high dosages of tear and harassing gases can give rise to pulmonary edema (fluid in the lungs). Deaths have been reported in three cases after extraordinary exposure to ω-chloracetophenone (CN) in a confined space.

151. The effects of adamsite (DM) are more persistent. Nausea is more severe and vomiting may occur.

152. Results of experiments on various species of animals (see annex B) and some observations of human responses lead to the following tentative conclusions First, CS is the most irritating of these gases followed by adamsite (DM) and ω-chloracetophenone (CN). Second, the tolerance limits (highest concentration which a test subject can tolerate for one minute) of DM and CS are about the same. Third, the least toxic of the tear gases is CS, followed by DM and then CN. Fourth, human beings vary in their sensitivity to, and tolerance of, tear and harassing gases. And finally, the toxicity of these gases varies in different animal species and in different environmental conditions.

153. The symptoms caused by tear gases disappear, as tears wash the agent from the eyes, and if the victim gets out of the tear gas atmosphere. Some, however, cause reddening or rarely even blistering of the skin when the weather is hot and wet.

Toxins

154. Staphylococcus toxin occurs naturally in outbreaks of food poisoning—which is the only medical experience with this toxin. The symptoms have a sudden, sometimes violent, onset, with severe nausea, vomiting and diarrhea. The time from ingestion of the toxin to the onset of symptoms is usually two to four hours, although it may be as short as a half hour. Most people recover in 24–48 hours and death is rare. Treatment is supportive and immunity, following an attack, is short-lived. The toxin is resistant to freezing, to boiling for thirty minutes, and to concentrations of chlorine used in the treatment of water. Staphylococcus toxin could be considered as an incapacitating chemical warfare agent. Symptoms can be produced in animals by intravenous injection, and the toxin may also be active by the respiratory route.

Psychochemicals

155. These substances have been suggested for use in war as agents which could cause temporary disability by disrupting normal patterns of behavior. The idea cannot be accepted in its simple form, since these substances may lead to more permanent changes, particularly in individuals who are mentally unbalanced or who are in the early stages of a nervous and mental disease. Moreover, very high doses, which would be difficult to exclude during use in war, can cause irreversible damage to the central nervous system or even death. Psychochemicals could also have particularly severe effects on children.

156. Compounds such as LSD, mescaline, psilocybin, and a series of benzilates which cause mental disturbance—either stimulation, depression or hallucination—could be used as incapacitating agents. Mental disturbance is, of course, a very complex phenomenon, and the phychological state of the person exposed to a psychochemical, as well as the properties of the agent, would profoundly influence its manifestations. But, despite the variation in responses between individuals, all those affected could neither be expected to act rationally, nor to take the initiative, nor make logical decisions.

157. Psychochemicals do more than cause mental disturbance. For example, the general symptoms from the benzilates are interference with ordinary activity; dry, flushed skin; irregular heartbeat; urinary retention; constipation; slowing of mental and psychical activity; headache, giddiness; disorientation; hallucinations; drowsiness; occasional maniacal behaviour; and increase in body temperature. While these effects have not been fully studied, there would be a significant risk of affected individuals, particularly military personnel, becoming secondary casualties due to unco-ordinated behaviour. A single dose of 0.1 to 0.2 mg LSD25 will produce profound mental disturbance within half an hour, the condition persisting for about ten hours. This dose is about a thousandth of the lethal dose.

158. Treatment of the symptoms of psychochemicals is mainly supportive. Permanent psychotic effects may occur in a very small proportion of individuals exposed to LSD.

159. It is extremely difficult to predict the effects which an attack with psychochemical agents would produce in a large population. Apart from the complication of the varying reaction of exposed individuals, there could be strange interactions within groups. A few affected individuals might stimulate their fellows to behave irrationally, in the same way as unaffected persons might to some extent offset the reactions of those affected. Since the probability of fatal casualties resulting directly from exposure is low, some normal group activity might be sustained. Protective masks would probably provide complete protection since practically all potential psychochemical agents, if used as offensive weapons, would be dessiminated as aerosols.

4. Other Effects of Chemical Agents

Effects on animals

160. The effects of lethal chemical agents on higher animals are, in general, similar to those on man. The nerve agents also kill insects.

Effects on plants

161. A variety of chemicals kill plants, but as already indicated, little is known about their long-term effects. The effective dose ranges of defoliants vary according to the particular species of plant attacked, its age, the meteorological conditions and the desired effect: e.g., plant death or defoliation. The duration of effect usually lasts weeks or months. Some chemicals kill all plants indiscriminately, while others are selective. Most defoliants produce their effects within a few weeks, although a few species of plant are so sensitive that defoliation would occur in a period of days.

162. An application of defoliating herbicide* of approximately 3 gallons (32 pounds) per acre (roughly 36 kg per hectare) can produce 65 per cent defoliation for six to nine months in very densely forested areas, but in some circumstances some species of trees will die. Significantly lower doses suffice for most agricultural and industrial uses throughout the world. Defoliation is, of course, a natural process—more common in trees in temperate zones than in the tropics. Essentially what defoliants do is trigger defoliation prematurely.

163. Desiccation (the drying out) of leaves results in some defoliation, although usually the leaf-drop is delayed, and the plant would not be killed without repeated application of the chemical. Chemical desiccants cause a rapid change in colour, usually within a few hours.

B. The effects of bacteriological (biological) agents on individuals and populations

164. Mankind has been spared any experience of modern bacteriological (biological) warfare, so that any discussion of its possible nature has to be based on extrapolation from epidemiological knowledge and laboratory experiment. The number of agents which potentially could be used in warfare is limited by the constraints detailed in chapter I. On the other hand, the variability which characterizes all living matter makes it conceivable that the application of modern knowledge of genetic processes and of selection could remove some of these limitations. Some species of micro-organisms consist of a number of strains characterized by different degrees of virulence, antigenic constitution, susceptibility to chemotherapeutic agents, and so on. For example, strains of tularaemia bacilli isolated in the United States are generally much more virulent in human beings than those found in Europe or Japan. Foot-and-mouth disease virus is another well-known example of an organism with various degrees of virulence. The situation with bacteriological (biological) weapons is thus quite different from that of chemical weapons, where the characteristics of a given compound are more specific.

1. Effects on Individuals

165. Bacteriological (biological) agents could be used with the intention of killing people or of incapacitating them either for a short or a long period. The agents, however, cannot be rigidly defined as either lethal or incapacitating, since their effects are de-

*For example, the commonly used "2,4–D" and "2,4,5–T" which are the butyl esters of (2,4-dichlorophenoxy) acetic acid and (2,4,5-trichlorophenoxy) acetic acid.

pendent upon many factors relating not only to themselves but also to the individuals they attack. Any disease-producing agent intended to incapacitate may, under certain conditions, bring about a fatal disease. Similarly, attacks which might be intended to provoke lethal effects might fail to do so. Examples of naturally occurring lethal disease are shown in table 2 and representative incapacitating diseases in table 3. A detailed list of possible agents, with a brief description of their salient characteristics is given in annex C.

166. A number of natural diseases of man and domestic animals are caused by mixed infections (e.g., swine influenza, hog cholera). The possible use of two or more different organisms in combination in bacteriological (biological) warfare needs to be treated seriously because the resulting diseases might be aggravated or prolonged. In some instances, however, two agents might interfere with one another and reduce the severity of the illness they might cause separately.

167. The effects of some forms of bacteriological (biological) warfare can be mitigated by chemotherapeutic, chemoprophylactic and immunization measures (for protection see chapter I and annex C of this chapter). Specific chemotherapeutic measures are effective against certain diseases, but not against those caused by viruses. But it may not always be possible to apply such measures, and they might not always be successful. For example, with some diseases early therapy with antibiotics is usually successful, but relapses may occur. Moreover, resistance against antibiotics may develop in almost all groups of micro-organisms, and resistant strains may retain full virulence for man as well as for animals.

TABLE 2.—EXAMPLES OF AGENTS THAT MIGHT BE USED TO CAUSE DEATH

Agents	Diseases	Incubation period (days)	Effect of specific therapy	Likelihood of spread from man to man
Viruses	Eastern equine encephalitis	5 to 15	Nil	Nil.[1]
	Tick-borne encephalitis	7 to 14	do	Do.
	Yellow fever	3 to 6	do	Do.
Rickettsiae	Rocky Mountain spotted fever	3 to 10	Good	Do.
	Epidemic typhus	6 to 15	do	Do.
Bacteria	Anthrax	1 to 5	Moderate	Low.
	Cholera	do	Good	High.
	Plague, pneumonic	2 to 5	Moderate	Do.
	Tularaemia	1 to 10	Good	Low.
	Typhoid	7 to 21	do	High.

[1] Unless vector present.

TABLE 3.—EXAMPLES OF AGENTS THAT MIGHT BE USED TO CAUSE INCAPACITATION

Agents	Diseases	Incubation period (days)	Effect of specific therapy	Likelihood of spread from man to man
Viruses	Chikungunya fever	2 to 6	Nil	Nil.[1]
	Dengue fever	5 to 8	do	Do.
	Venezuelan equine encephalitis.	2 to 5	do	Do.
Rickettsiae	Q-fever	10 to 21	Good	Low.
Bacteria	Brucellosis	7 to 21	Moderate	Nil.
Fungi	Coccidioidomycosis	7 to 21	Poor	Do.

[1] Unless mosquito vector present.

Possible bacteriological (biological) agents

168. Victims of an attack by bacteriological (biological) weapons would, in effect, have contracted an infectious disease. The diseases would probably be known, but their symptoms might be clinically modified. For example, apart from the deliberate genetic modification of the organism, the portals of infection might be different from the natural routes, and the disease might be foreign to the geographical area in which it was deliberately spread. Possible bacteriological (biological) agents representing diseases caused by the main groups of relevant micro-organisms are:

169. *Anthrax:* Under natural conditions, anthrax is a disease of animals, the main source of infection for man being cattle and sheep. Its vernacular synonym "wool sorter's disease" indicates one way men used to contract the disease. Depending on the mechanism of transmission, a cutaneous (skin) form (contact infection), an intestinal form (alimentary infection), or pulmonary form (airborne infection) may develop. The lung or respiratory form is most severe, and unless early treatment with antibiotics is resorted to, death ensues within two-three days in nearly every case.

170. Antibiotic propbylaxis is possible, but would have to be prolonged for weeks, since it has been shown that monkeys exposed to anthrax aerosol die if antibiotic treatment is discontinued after ten days. In certain countries, several types of vaccines are employed, but their value has not been fully evaluated.

171. The anthrax bacillus forms very resistant spores, which live for many years in contaminated areas, and which constitute the most dangerous risk the disease presents. From epidemiological observations, the inhalation, infectious dose for man is estimated at 20,000 spores. Experiments on animals show that anthrax can be combined with influenza infection or with some noxious chemical agent, and that the susceptibility of the animal to airborne anthrax infection is then markedly enhanced.

172. With suitable expertise and equipment large masses of anthrax bacilli can be easily grown, and heavy concentrations of resistant anthrax spore aerosols can be made. Such aerosols could result in a high proportion of deaths in a heavily exposed population. Immunization could not be expected to protect against a heavy aerosol attack. The soil would remain contaminated for a very long time, and so threaten live-stock farming.

173. *Coccidioidomycosis:* This disease, which is also called desert fever, is caused by a fungus found in the soil of deserts in the United States, South America and the USSR. The spores of the fungus are very stable, and can easily be disseminated as an aerosol. If they are inhaled, pneumonia with fever, cough, ague and night-sweatinig, and muscle pains follow after an incubation period of one-three weeks. In most cases, recovery from the disease occurs after some weeks of illness. An allergic rash sometimes breaks out during the first or second week of the illness, and can be significant for proper diagnosis. Treatment presents great difficulties.

174. *Plague:* Under natural conditions, small rodents, from which the disease is transmitted by fleas, are the main source of human infection with plague. This is how "bubonic" plague develops. If the plague microbes are inhaled, pneumonic plague develops after a three-to-five-day incubation period. The patient suffers from severe general symptoms and if untreated, normally dies within two to three days. A patient with pneumonic plague is extremely contagious to contacts.

175. Preventive vaccination is moderately effective against bubonic, but not pneumonic, plague. If administered early, streptomycin treatment may be successful.

176. In a study of experimental pulmonary plague in monkeys, it was found that an average dose of only 100 bacteria caused fatal disease in half the animals tested. Animal experiments have also show that particles of 1 micrometre diameter (1.25,000 of an inch), containing single microbial cells, can cause primary pneumonia, with a rapid and fatal outcome. If the aerosol is formed by larger particles (5–10 micrometres diameter) microbial cells are deposited in the nose and other regions of the upper respiratory tract, and primary foci of the disease develop in the corresponding lymphatic nodes. A fatal generalized infection may then follow.

177. A large mass of plague bacteria could be grown, and probably lyophilized (freeze-dried) and kept in storage. The agent is highly infectious by the aerosol route and most populations are completely susceptible. An effective vaccine against this type of disease is not known. Infection might also be transmitted to urban and/or field rodents and natural foci of plague may be treated.

178. *Q-fever:* Under natural conditions, Q-fever is a disease of animals, the main sources of infection to man being sheep, goats and cattle. The infection is transmitted most frequently by the air route.

179. An incubation period of two to three weeks follows the inhalation of the infectious material. A severe attack of influenza-like illness follows, with high fever, malaise, joint and muscle pains, which may be followed in five to six days by pneumonia. In untreated cases, the illness lasts two to three weeks; the patient feels exhausted and is unable to do normal work for everal weeks. But the disease can be successfully treated with broad spectrum antibiotics (tetracyclines). Prophylactic vaccines have been prepared in some countries, but have not yet been proved suitable for large-scale use.

180. The agent causing the disease is a rickettsia, and is extremely infectious for man. An epidemic of Q-fever once occurred due to contaminated dust which was carried by the wind from a rendering plant some ten kilometers away. Q-fever is also a common and significant laboratory hazard, even though it is only rarely transmitted from man to man. The high susceptibility of humans to this agent has been demonstrated in volunteers.

181. Q-fever rickettsiae are extraordinarily resistant to environmental factors such as temperature and humidity. Very large amounts can be produced in embryonated chicken eggs (20,000 million mirco-organisms par millilitre) and can be stored for a long period of time. A Q-fever aerosol could produce an incapacitating effect in a large proportion of the population of an attacked area. The infective agent could persist in the environment for months and infect animals, possibly creating atural foci of infection.

182. *Tularaemia:* Under natural conditions, tularaemia is a disease of wild animals, the source of human infection being rodents, especially rabbits and hares. When it occurs naturally in human beings, who are very susceptible to the disease, skin lesions with swelling of the lymph nodes are its usual

manifestation (infection by contact with sick and dead animals, or by way of ticks and other vectors). Infection can also occur through the eye and the gastro-intestinal tract. The pulmonary form (airborne infection) is the more serious. Pulmonary tularaemia is associated with general pain, irritant cough, general malaise, etc., but in Europe and Japan mortality due to this form of the disease was never higher than 1 percent even before antibiotics became available. American tularaemia strains in the other epidemics have been associated with a mortality rate as high as 20 percent despite antibiotic treatment. Usually treatment with streptomycin or tetracycline is highly effective. A tularaemia vaccine developed in the Soviet Union is also highly effective.

183. The agent causing the disease is a microbe which is very sensitive to common disinfectants, but which is able to survive for as long as a few weeks in contaminated dust, water, etc.

184. Aerosols of tularaemia have been tested on volunteers. The inhalation infectious dose for man is about ten to twenty-five microbes, and the incubation period five days. By increasing the inhaled dose a hundred times, the incubation period shortens to two to three days. Owing to its easy aerosol transmission, tularaemia has often infected laboratory workers.

185. The microbiological characteristics are similar to those of the plague bacillis (although antibiotic treatment and vaccination prophylaxis are effective). Both lethal and incapacitating effects are to be expected. The disease is not transferred from man to man, but long-lasting natural foci might be created.

186. *Venezuelan equine encephalitis virus (VEE)*: In nature, VEE is an infection of animals (equines, rodents, birds) transmitted to man through mosquitos which have fed on infected animals.

187. The disease has sudden onset, with headache, chills and fever, nausea and vomiting, muscle and bone pains, with encephalitis occurring in a very small proportion of cases. The mortality rate is very low and recovery is usually rapid after a week, with residual weakness often persisting for three weeks. No specific therapy is available. The vaccine is still in the experimental stage.

188. Numerous laboratory infections in humans have been reported, most of them airborne. In laboratory experiments, monkeys were infected with aerosolized virus at relatively low concentrations (about 1,000 guinea pig infectious doses).

189. Since the virus can be produced in large amounts in tissue culture or embryonated eggs, and since airborne infection readily occurs in laboratory workers, concentrated aerosols could be expected to incapacitate a very high percentage of the population exposed. In some areas, persistent endemic infection in wild animals would be established.

190. *Yellow fever:* In nature, yellow fever is primarily a virus disease of monkeys, transmitted to man by a variety of mosquitos (*Aedes aegypti, Aedes simpsoni, Hamagogus* species, etc.). After an incubation period of three-six days, influenza-like symptoms appear with high fever, restlessness and nausea. Later the liver and the kidneys may be seriously affected, with jaundice and diminished urinary excretion supervening. The very severe forms end in black vomitus and death. In a non-immune population, mortality rates for yellow fever may be as high as 30–40 per cent. There is no specific treatment, but prophylactic vaccination, being highly effective is widely used in yellow fever endemic areas.

2. Effects on Populations

191. Other than for sabotage, the use of aerosol clouds of an agent is the most likely form of attack in bacteriological (biological) warfare. For example, material can be produced containing infective micro-organisms at a concentration of 10,000 million per gram. Let us suppose that an aircraft were to spray such material so as to produce an aeronsol line source 100 kilometres in length across a 10 kilometre per hour wind. Then, assuming that 10 per cent of organisms survived aerosolization, and that subsequent environmental stresses caused them to die at a rate of 5 per cent per minute, about 5,000 square kilometres would be covered at a concentration such that 50 per cent of the unprotected people in the area would have inhaled a dose sufficient to infect them, assuming that the infective dose is about 100 micro-organisms per person. This particular calculation is valid for agents such as those which cause tularaemia, plague, as well as for some viruses. The decay rate of the causative agents of Q-fever, anthrax and some other infections is much lower and the expected effect would be still greater.

192. The effects of bacteriological (biological) attacks would obviously vary according to circumstances. Military personnel equipped with adequate protective measures, well trained in their use and provided with good medical services could, if warned of an attack, be able to protect themselves to a considerable degree. But effective early warning and detection systems do not yet exist. On the other hand, attacks on civil populations are likely to be covert and by surprise and, at present no civilian populations are protected. Unprotected military or civilian personnel would be at complete risk, and panic and irrational behaviour would complicate the effects of the attack. The heavy burden which would be imposed on the medical services of the attacked region would compound disorganization, and there would be a major risk of the total disruption of all administrative services.

193. In view of the extensive anti-personnel effects associated with agents of the kind with which this report is concerned, it is useful to view them against the area of effect of a one-megaton nuclear explosion, which as is well recognized, would be sufficient to destroy utterly a town with a population of a million. It should of course be emphasized that direct comparisons of the effects of different classes of weapons are, at best, hypothetical exercises. From the military point of view, effectiveness of a weapon cannot be measured just in terms of areas of devastation or numbers of casualties. The final criterion will always be whether a specific military objective can be achieved better with one than another set of weapons. The basic hypotheses chosen for the comparison are rather artificial; and in particular, environmental factors are ignored. But despite this limitation, table 4 gives data that help to place chemical, bacteriological (biological) and nuclear weapons in some perspective as to size of target area, numbers of casualties inflicted, and cost estimates for development and production of each type of weapon. The figures speak for themselves.

TABLE 4.—COMPARATIVE ESTIMATES OF DISABLING EFFECTS OF HYPOTHETICAL ATTACKS ON TOTALLY UNPROTECTED POPULATIONS USING A NUCLEAR, CHEMICAL, OR BACTERIOLOGICAL (BIOLOGICAL) WEAPON THAT COULD BE CARRIED BY A SINGLE STRATEGIC BOMBER

Criterion for estimate	Type of weapon		
	Nuclear (1 megaton)	Chemical (15 tons of nerve agent)	Bacteriological (biological) (10 tons [1])
Area affected	Up to 300 km^2	UP to 60 km^2	UP to 100,000 km^2.
Time delay before onset of effect.	Seconds	Minutes	Days.
Damage to structures	Destruction over an area of 100 $km.^2$	None	None.
Other effects	Radioactive contamination in an area of 2,500 $km.^2$ for 3–6 months.	Contamination by persistence of agent from a few days to weeks.	Possible epidemic or establishment of new endemic foci of disease.
Possibility of later normal use of affected area after attack.	3–6 months after attack	Limited during period of contamination.	After end of incubation period or subsidence of epidemic.
Maximum effect on man	90 percent deaths	50 percent deaths	50 percent morbidity; 25 percent deaths if no medical intervention.
Multiyear investment in substantial research and development production capability.[2]	$5,000–10,000 million	$1,000–5,000 million	$1,000–5,000 million.

[1] It is assumed that mortality from the disease caused by the agent would be 50 percent if no medical treatment were available.

[2] It is assumed that indicated cumulative investments in research and development and production plants have been made to achieve a substantial independent capability. Individual weapons could be fabricated without making this total investment.

3. Effects on Animals

194. The way bacteriological (biological) weapons might be used against stocks of domestic animals would probably be the same as that used in attacks against man. Representative diseases and their characteristics are shown in table 5.

195. Viral infections probably cause the most important diseases of domestic animals and could have more devastating effects than diseases produced by other types of pathogens. Since many of the organisms which cause infectious diseases in domestic animals are also pathogenic for man, and since some of them may also be readily transmitted from animals to man, either directly or by vectors, such attacks might also affect the human population directly. Attacks upon livestock would not only result in the immediate death of animals, but also might call for compulsory slaughter as a means of preventing the spread of infection.

196. Covert bacteriological (biological) attack during peacetime directed against domestic animals could give rise to serious political and economic repercussions if large numbers of stock were affected. For example, African swine fever occurs endemically on the African continent as a subclinical disease of warthogs. In 1957 it was accidentally brought from Angola to Portugal, and then in 1960 to Spain. Despite strict and extensive veterinary measures that were enforced, losses in pig breeds were estimated to amount within a single year to more than $9,000,000.

197. Isolated attacks against stocks of domestic animals during wartime would have only a nuisance value. However, if a highly infectious agent (e.g., foot-and-mouth disease) were used, even a local attack could have very widespread effects because of spread by the normal commercial movement of animals, particularly in highly developed countries. Extensive attacks with travelling clouds could, however, lead to a disastrous state of affairs. The history of myxamatosis (a rabbit disease) in Europe provides a parallel. Not only did it drastically reduce the rabbit population in France, into which it was first introduced; it immediately spread to other countries of Europe, including the United Kingdom. The risk of the uncontrolled spread of infection to a number of countries is an important consideration in

the use of some bacteriological (biological) weapons.

198. The possibilities of protecting domestic animal stocks against bacteriological (biological) attacks are so remote that they are not worth discussing.

TABLE 5.—EXAMPLES OF DISEASES THAT MIGHT BE USED TO ATTACK DOMESTIC ANIMALS

DISEASE	ANIMALS ATTACKED
Viruses:	
African swine fever	Hogs.
Equine encephalitis	Horses.
Foot-and-mouth disease	Cattle sheep, hogs.
Fowl plague	Chickens, turkeys.
Hog cholera	Hogs.
Newcastle disease	Chickens, turkeys.
Rift Valley fever	Cattle, goats, sheep.
Rinderpest	Cattle, sheep, oxen, goats, water buffaloes.
Vesicular stomatitis	Cattle, horses, mules, hogs.
Ricksettsiae:	
Veldt disease	Cattle, sheep, goats.
Q-fever	Do.
Bacteria:	
Anthrax	Cattle, sheep, horses, mules.
Brucellosis	Cattle sheep, goats, hogs, horses.
Glanders	Horses, mules.
Fungi:	
Lumpy jaw	Cattle, horses, hogs.
Aspergillosis	Poultry, cattle.

4. Effects on Plants

199. Living micro-organisms could also be used to generate diseases in crops which are economically important either as food or as raw material (e.g., cotton and rubber). Significant food crops in this respect include potatoes, sugar-beet, garden vegetables, soya beans, sorghum, rice, corn, wheat and other cereals and fruits. Obviously the selection of the target for a biological attack would be determined by the relative importance of the crop in the national diet and economy. Deliberately induced epiphytotics (plants disease epidemics) could in theory have serious national and international consequences.

200. The fungal, bacterial, or viral agents which could be used against plants are shown in table 6.

201. With a few minor exceptions, the plant viruses could be cultured only in living plant systems, the causal agent being found only in the plant tissues and juices. Virus diseases are transmitted principally by insect vectors and to some extent by mechanical means.

202. Bacterial agents which attack plants can persist for months on or in the plants. All of them can be cultured on artificial media. Normally, plant bacteria are not disseminated to any great extent by winds; the principal methods for spread in nature are insects, animals (including man) and water. Rain can spread bacteria locally, while insects and animals are responsible for their more extensive spread. It is conceivable that bacterial plant pathogens could be adapted for deliberate aerial dissemination.

203. Plant fungi, which cause some of the most devastating diseases of important agricultural crops, are disseminated mainly by winds, but also by insects, animals, water and man. Many fungal pathogens produce and liberate into the air countless numbers of small, hardy spores which are able to withstand adverse climatic conditions. The epidemic potential of a number of fungal pathogens is considerable.

204. In theory there are measures which could protect crops against bacteriological (biological) attacks; but at present their potential cost rules them out in practice. There is no essential difference between the counter-measures which would have to be introduced to counter bacteriological (biological) weapons and those employed normally to control plant diseases in peacetime. But the use of bacteriological (biological) weapons to destroy crops on a large scale would imply that the attacker would choose agents capable of overcoming any known, economical method of protection. Advanced countries might, as a precautionary measure exchange susceptible plants by more resistant strains. This would be difficult for countries whose agricultural standards were not high, and which would be the most vulnerable to bacteriological (biological) attacks on their crops.

TABLE 6.—EXAMPLES OF DISEASES THAT MIGHT BE USED TO ATTACK PLANTS

	Diseases	Liklihood of spread
Viruses	Corn stunt	High.
	Hoja blanca (rice)	Do.
	Fiji disease (sugar cane)	Do.
	Sugar beet curly top	Do.
	Potato yellow dwarf	Do.
Bacteria	Leaf blight (rice)	Do.
	Blight of corn	Do.
	Gummosis of sugarcane	Low.
Fungi	Late blight (potato)	Very high.
	Cereal rusts	Do.
	Rice blast	Do.
	Corn rust	High.
	Coffee rust	Very high.

5. Factors Influencing the Effects of Bacteriological (Biological) Attacks

Exotic diseases

205. Any country which resorted to bacteriological (biological) warfare would presumably try to infect, with a single blow, a large proportion of an enemy population with an exotic agent to which they had not become immune through previous exposure. Such exotic agents would lead to the appearance of diseases which normally had not occurred before in a given geographical area, either because of the absence of the organism involved (e.g., foot-and mouth disease in North America or Japan), and/or of natural vectors (e.g., Japanese or Venezuelan encephalitis in Europe, Rocky Mountain spotted fever in many countries). In addition, a disease which had been controlled or eradicated from an area (e.g., urban or classical yellow fever from many tropical and sub-tropical countries, epidemic typhus from developed countries) might be reintroduced as a result of bacteriological (biological) warfare.

Altered or new diseases

206. Deliberate genetic steps might also be taken to change the properties of infectious agents, especially in antigenic composition and drug resistance. Apart from genetic changes that could be induced in known organisms, it is to be expected that new infectious diseases will appear naturally from time to time and that their causative agents might be used in war. However, it could not therefore be assumed that every outbreak of an exotic or new disease could necessarily be a consequence of a bacteriological (biological) attack. The Marburg disease, which broke out suddenly in 1967 in Marburg, Frankfurt and Belgrade, was a good example. It was acquired by laboratory workers who had handled blood or other tissues of vervet monkeys which had been recently caught in the wild, and by others who came into contact with them. Because the outbreak occurred in medical laboratories it was very skillfully handled. In other circumstances, it might have spread widely before it was controlled.

Epidemic spread

207. As already emphasized, a wide variety of agents can infect by the inhalation route, so that in a bacteriological (biological) attack a large number of persons could be infected within a short time. From the epidemiological point of view, the consequences would differ depending on whether the resultant disease was or was not transmissible from man to man. In the latter case the result would be a once-for-all disaster, varying in scale and lethality according to the nature of the organism used and the numbers of people affected. The attack would undoubtedly have a strong demoralizing effect on the unaffected as well as the affected population, and it would be in the nature of things that were would be a breakdown of medical services.

208. If the induced disease were easily transmissible from man to man, and if it was one against which the population had not been effectively immunized, it is possible to imagine what could happen by recalling say, the periodical appearance of new varieties of influenza virus, e.g. the 1957 influenza pandemic. In Czechoslovakia (population about 14 million), 1,500,000 influenza patients were actually reported; the probable total number was 2,500,000. About 50 per cent of the sick were people in employment and their average period away from work was six days. Complications necessitating further treatment developed in 5–6 per thousand of the cases, and about 0.2 per thousand died. Those who are old enough to remember the 1918 influenza pandemic, which swept over most of the world, will judge the 1957 outbreak as a mild affair.

Susceptibility of population

209. A very important factor in the effectiveness of an aerosol attack is the state of immunity of the target population. Where the population is completely lacking in specific immunity to the agent which is disseminated, the incidence and severity of disease are likely to be exceptionally high. Naturally occurring examples of very severe epidemics in virgin populations are well known (e.g. measles in Fiji, poliomyelitis and influenza in the Arctic). A similar result follows the introduction of a suspectible population (often a military force) into an already infected area. Thus there was a high prevalence of dengue fever in military forces operating in the Pacific in World War II—sometimes affecting as many as 25 per cent of the operational strength of a unit. The local population suffered relatively little from the disease because they had usually been infected early in life, and were subsequently immune.

Populations of increased vulnerability

210. *Malnutrition:* Recent statistical studies reveal a clear association between malnutrition and the incidence of infectious diseases. FAO, WHO and UNICEF have pointed out that in developing countries, a shortage of nutritious food is a major factor in the high mortality rate due to infectious diseases, particularly in children.

211. *Housing and clothing:* Primitive housing and inadequate clothing would lead to an increased vulnerability to bacteriological (biological) and more particularly chemical weapons. Millions of people live in houses which are permeable to any sort of airborne infection or poison, and millions are inadequately clothed and walk farefooted.

212. Other conditions which characterize poor populations have a definite influence on the spread of infections. Large families increase the opportunities for contagious contact. Inadequate housing, lack of potable water and, in general, bad sanitation, a low educational level, numerous vectors of infectious disease (e.g. insects), and, of course, lack of medical services are factors which also favour the spread of disease. The agents used might also persist in the soil, on crops, grasses, etc., so that delayed action might need to be taken into account.

Social effects and public health measures

213. A basic factor which influences the risk of epidemic situation during every war is a rapid impairment of standards of hygiene. Widespread destruction of housing and of sanitary facilities (water works, water piping, waste disposal, etc.), the inevitable decline in personal hygiene, and other difficulties, create exceptionally favourable conditions for the spread of intestinal infections, or louse-transmitted disease, etc.

214. The importance of adequate public health services is well illustrated by an explosive *water-borne* epidemic of infectious hepatitis in Delhi in 1955–1956, which affected some 30,000 persons, and which occurred because routine water treatment was ineffective. This epidemic was caused by the penetration into the water supply of waste waters heavily contaminated with hepatitis virus. However, there was no concurrent increase in the incidence of bacillary dysentery and typhoid fever, showing that the routine treatment of the water had been adequate to prevent bacterial but not viral infections.

215. Air streams, migrating animals and running water may transport agents from one country to the other. Refugees with contagious diseases pose legal and epidemiological problems. In areas with multinational economies, losses in livestock and crops may occur in neighbouring countries by the spread of the disease through regional commerce.

216. The experiences from fairly recent smallpox epidemics can also be used to illustrate the social effects of an accidentally introduced, highly dangerous airborne infection. In New York (1947) one patient started an epidemic, in which twelve persons became ill and two died. Within a month more than 5 million persons were revaccinated. Similarly in Moscow, in January 1960, a smallpox epidemic of forty-six cases (of whom three died) developed, caused by a single patient. At that time 5,500 vaccination teams were set up and vaccinated 6,372,376 persons within a week. Several hundreds of other health workers searched a large area of the country for contacts (9,000 persons were kept under medical supervision, of these 662 had to be hospitalized as smallpox suspects).

ANNEX A.—CHEMICAL PROPERTIES, FORMULATIONS AND TOXICITIES OF LETHAL CHEMICAL AGENTS (EXCERPT FROM MATERIAL SUPPLIED BY WORLD HEALTH ORGANIZATION)

[Key to table: (1) Trivial name; (2) military classification; (3) approximate solubility in water at 20° C.; (4) volatility at 20° C; (5) physical state (a) at −10° C., (b) at 20° C.; (6) approximate duration of hazard (contact, or airborne following evaporation) to be expected from ground contamination (a) 10° C., rainy, moderate wind, (b) 15° C., sunny, light breeze, (c) −10° C., sunny, no wind, settled snow; (7) casualty producing dosages (lethal or significant incapacitating effects); (8) estimated human respiratory LCt_{50} (mild activity: breathing rate ca. 15 liters /min.); (9) estimated human percutaneous toxicity.]

(1)	Sarin	VX	Hydrogen cyanide	Cyanogen chloride	Phosgene	Mustard gas	Botulinal toxin A
(2)	Lethal agent (nerve gas)	Lethal agent (nerve gas)	Lethal agent (blood gas)	Lethal agent (blood gas)	Lethal agent (lung irritant).	Lethal agent (vesicant)	Lethal agent.
(3)	100 percent	1 to 5 percent	100 percent	6 to 7 percent	Hydrolysed	0.05 percent	Soluble.
(4)	12,100 mg/m³	3 to 18 mg/m³	873,000 mg/m³	3,300,000 mg/m³	6,370,000 mg/m³	630 mg/m³	Negligible.
(5) (a)	Liquid	Liquid	Liquid	Solid	Liquid	Solid	Solid.
(b)	do	do	do	Vapour	Vapour	Liquid	Do.
(6) (a)	¼ to 1 hour	1 to 12 hours	Few minutes	Few minutes	Few minutes	12 to 48 hours	
(b)	¼ to 4 hours	3 to 21 days	do	do	do	2 to 7 days	
(c)	1 to 2 days	1 to 16 weeks	1 to 4 hours	¼ to 4 hours	¼ to 1 hour	2 to 8 weeks	
(7)	>5 mg.-min./m.³	>0.5 mg.-min./m.³	>2,000 mg.-min./m.³	>7,000 mg.-min./m.³	>1,600 mg.-min./m.³	>100 mg.-min./m.³	0.001 mg. (oral).
(8)	100 mg.-min./m.³	10 mg.-min./m.³	5,000 mg.-min./m.³	11,000 mg.-min./m.³	3,200 mg.-min./m.³	1,500 mg.-min./m.³	0.02 mg.-min./m.³
(9)	1,500 mg./man	6 mg./man				4,500 mg./man [1]	

[1] A drop of mustard weighing a few milligrams can produce a serious blister which will be incapacitating if it interferes with the normal activities of an individual.

ANNEX B—TEAR AND HARASSING GASES

Three parameters will be used to qualify the effects of tear gases. These are defined as follows:

Threshold of irritation is the atmospheric concentration of the substance (in mg per m³), which, in one minute of exposure, causes irritation.

Tolerance limit is the highest atmospheric concentration (in mg per m³) which a test subject can tolerate during one minute of exposure.

Lethal index is a dosage, and thus the product of the concentration in the air (in mg per m³) and the time of exposure (in minutes), which causes mortality. Data for various tear gases are given in the following table.

The data given under "Lethal index" are from animal experiments with various species.

Tear gas	Treshold of irritation (mg/m³)	Tolerance limit (mg/m³)	Lethal index (mg.min/m³)
Adamside (DM)	0.1	2–5	15,000–30,000
Ethyl bromacetate	5	5–50	25,000
Bromacetone	1.5	10	30,000
Omega-chloracetophenone (CN)	0.3–1.5	5–15	8,500–25,000
O-chlorbenzylidene malononitrile (CS)	.05–.1	1–5	40,000–75,000

ANNEX C.—SOME BIOLOGICAL AGENTS THAT MAY BE USED TO ATTACK MAN

Disease	Infectivity [1]	Transmissibility [2]	Incubation period [3]	Duration of illness [3]	Mortality [3]	Antibiotic therapy	Vaccination [4]
Viral:							
Chikungunyna fever	Probably high	None	R to 6 days	2 weeks to a few months.	Very low (less than 1 percent)	None	None.
Dengue fever	High	do	5 to 8 days	A few days to weeks	do	do	Do.
Eastern equine encephalitis	do	do	5 to 15 days	1 to 3 weeks	High (greater than 60 percent).	do	Under developmenL
Tick-borne encephalitis	do	do	1 to 2 weeks	1 week to a few months	Variable up to 30 percent	do	Do.
Venezuelan equine encephalitis	do	do	2 to 5 days	3 to 10 days	Low (less than 1 percent)	do	Do.
Influenza	do	do	1 to 3 days	3 to 10 days	Usually low, except for complicated cases.	do	Available.
Yellow fever	do	do	3 to 6 days	1 to weeks	High (up to 40 percent)	do	Do.
Smallpox	do	High	7 to 16 days	12 to 24 days	Variable but usually high (up to 30 percent).	do	Do.
Ricksettsial:							
Q-fever	do	None or negligible.	10 to 21 days (sometimes shorter).	1 to 3 weeks	Low (usually less than 1 percent.)	Effective	Under development.
Psittacosis	do	Moderately high	4 to 15 days	1 to several weeks	Moderately high	do	None.
Rocky Mountain spotted fever	do	None	3 to 10 days	2 weeks to several months.	Usually high (up to 80 percent.)	do	Under development.
Epidemic typhus	do	do	6 to 15 days	A few weeks to months	Variable but usually high (up to 70 percent).	do	Available.
Bacterial:							
Anthrax (pulmonary)	Moderately high.	Negligible	1 to 5 days	3 to 5 days	Almost invariably fatal	Effective if given very early.	Do.
Brucellosis	High	None	1 to 3 weeks	Several weeks to months	Low (less than 5 percent)	Moderately effective	Under development.
Cholera	Low	High	1 to 5 days	1 to several weeks	Usually high (up to 80 percent)	do	Available.
Glanders	High	None	2 to 14 days	4 to 6 weeks	Almost invariably fatal	Little effective.	None.
Melioidosis	do	do	1 to 5 days	4 to 20 days	Almost 100 percent fatal	Moderately effective	Do.
Plague (pneumonic)	do	High	2 to 5 days	1 to 2 days	do	Moderately effective if given early.	Available.
Tularemia	do	Negligible	1 to 10 days	2 to several weeks	Uusually low sometimes high (up to 60 percent).	Effective	Do.
Typhoid fever	Moderately high.	Moderately high.	1 to 3 weeks	A few to several weeks	Moderately high up to (10 percent).	Moderately effective	Do.
Dysentery	High	High	1 to 3 days	A few days to weeks	Low to moderately high depending on strain.	Effective	None.
Fungal: Coccidioido mycosis	do	None	1 to 3 weeks	A few weeks to months	Low	None	Do.

[1] Infectivity: indicates the potency of the parasite to penetrate and multiply in the host's organism, regardless of the clinical manifestation of illness. In fact, there are several agents by which the great majorityof the exposed population will be infected without developing clinica. symptoms.

[2] Transmissibility: This refers to direct transmission from man to man without the intervention of any arthropod vector.

[3] The figures listed under incubation period, duration of disease, and mortality are based on epidemiological data. They vary, according to variations in virulence and dose of the infecting agent, resistance of the host and many other factors. It also should be noted that if the agents concerned would be deliberately spread in massive concentrations as agents of warfare, the incubation periods might be shorter and the resulting symptoms more serious. As to mortality, this refers to the ratio between the number of fatalities to the number of diseased (not to that of infected) individuals, if no treatment is given.

[4] The availability of vaccines is no indication of their degree of effectiveness.

CHAPTER III. ENVIRONMENTAL FACTORS AFFECTING THE USE OF CHEMICAL AND BACTERIOLOGICAL (BIOLOGICAL) CONSIDERATIONS

A. General considerations

217. Extraneous factors influence the behaviour of chemical and bacteriological (biological) weapons to a far greater extent than they do any other kind of armament. Some, such as wind and rain, relate to the state of the physical environment, and to a certain extent can be evaluated quantitatively. Others, which reflect the general ecological situation, and the living conditions and physiological state of the populations exposed to the effects of the weapons, are more difficult to define; their influence—though they could be considerable—cannot be quantified.

218. This limitation applies particularly to bacteriological (biological) weapons. The natural course of infectious diseases—for example in influenza epidemics—shows that they are governed by so many uncontrollable factors that the way they develop cannot as a rule be foreseen. This would also be probably true of pathogenic agents which were deliberately dispersed. On the other hand, the knowledge gained through the study of epidemiology, and in the study of artificial dispersions of bacteriological (biological) agents, both in the laboratory and the field, has shed some light on some of the factors concerned.

219. The ecological problem is the main theme of chapter IV. The factors which concern the variability of the human target, e.g. physiological and living conditions, and levels of protection, have already been described in chapters I and II. This chapter is concerned with physical environment (climate, terrain).

1. Phenomena Associated With the Dispersal of Chemical and Bacteriological (Biological) Agents

220. It has already been pointed out that chemical substances and living organisms capable of being used as weapons are extremely varied in their nature and in their effects. On the other hand, regarded solely from the standpoint of their physical state after dispersion in the atmosphere, they can clearly be placed in one or the other of the following categories:

Liquid drops and droplets of varying size; (diameters greater than about 10 Microns).

More or less finely divided liquid and solid aerosols; (diameters less than about 10 Microns).

Vapours.

221. Almost always, moreover, especially in the case of liquid chemical agents, the result of dispersion is a mixture of these different phases; thus, a liquid dispersed by an explosive charge gives rise to a mixture of aerosol and vapour, while aerial spraying may produce a mixture of droplets and aerosols. Solid chemical substances will be in aerosol form, and this will also be true, as has already been pointed out, of bacteriological (biological) agents.

222. Thus, chemical attacks would usually take effect simultaneously in two forms:

Contamination of the ground at, and in the immediate vicinity of, the target by direct deposition of the agent at the time of dispersion, and by subsequent settling of large particles;

Formation of a toxic cloud consisting of fine particles or droplets, of aerosol, and possibly of vapour.

223. Most bacteriological (biological) attacks would be designed primarily to create an infectious aerosol as an inhalation hazard. Some ground contamination might, however, also result when infectious particles settled on the ground.

224. Both ground contamination and toxic or infectious clouds would be immediately subject to the physical action of the atmosphere.

225. If the soil contaminants are liquid chemical agents, they would either evaporate, producing a sustained secondary cloud, or be absorbed by the ground, or diluted or destroyed by atmospherical precipitation. If they were solid agents, whether chemical or biological, they might be returned to a state of suspension by air currents, and perhaps carried out of the initially contaminated zone.

226. As it becomes formed, the toxic or infectious cloud is immediately exposed to atmospheric factors, and is straightaway carried along by air currents. At the same time, the particles within it are deposited at different rates according to their mass, and reach the ground at varying distances from the point of emission, depending on wind velocity (up to several kilometres in the case of particles less than a few tens of microns in diameter). The mechanically stable fraction of the aerosol (particles under 5 microns in diameter) remains in suspension, and may be carried along for considerable distances.

B. The influence of atmospheric factors on clouds of aerosols or vapours

227. The movement of a toxic or infectious cloud after its formation depends chiefly on the combined effects of wind and atmospheric conditions. The cloud is carried a longer or shorter distance by the wind; at the same time it is dispersed and diluted at a faster or slower rate by turbulence of the atmosphere and by local disturbances of mechanical origin resulting from the roughness of the ground.

228. The cloud may rise rapidly in the atmosphere or remain in the immediate vicinity of the ground, thus retaining its destructive power for a greater or lesser time depending on whether the air layer in which it is released is in a stable or unstable state.

1. State of the Atmosphere

229. The state of the atmosphere plays such an important role in the behaviour of aerosol clouds that one might almost say that it is the predominant factor in determining the outcome of an attack, the effect of which could be considerably reduced, or almost nullified, were the atmosphere very unstable, or very serious if it was in a state of pronounced and prolonged stability. For this reason the mechanisms governing the turbulent movements of air, caused by differences in temperatures between superimposed air layers require some explanation (see fig. 2).

230. Disregarding the frictional layer of air close to the ground, where mechanical turbulence resulting from friction between the air and the rough ground over which it moves creates special conditions, air temperature in the troposphere decreases on average at the rate of 0.64° C for every 100 metres of altitude. Very frequently, however, as a result of thermal exchange between the air and the ground, a cooler air layer may be formed beneath a mass of hot light air; in such conditions, the lower air layer, with its greater density, does not tend to rise and the atmosphere is said to be in "stable equilibrium".

231. The situation, in which the vertical temperature gradient becomes inverted, is known as "temperature inversion", while the air layer affected by the phenomenon is termed as "inversion layer". When present it is eminently favourable to the persistence of toxic clouds.

232. After a day of sunshine, the surface of the ground cools rapidly, with the result that the layer of air close to the ground cools more rapidly than those above it. Both the intensity of the inversion and the thickness of the air layer involved increase to a maximum towards 4 a.m., and then decrease again, finally disappearing shortly after sunrise. This variation is very marked when the sky is clear, and in favourable conditions the inversion may last from fourteen to eighteen hours a day, depending on the season.

233. Very often, however, especially in winter or in overcast weather, when the rays of the sun are not sufficiently intense to heat the surface of the ground, the temperature inversion may last for several days. This condition has characterized all the disasters caused by industrial pollution; for example, the smog which claimed 4,000 victims in London in 1952 took its toll during a period of atmospheric stability which lasted for seven days.

234. Figure 2 shows the evolution of a toxic cloud depending on the state of the atmosphere. (Fig. 2 not printed.)

235. Apart from this kind of low-altitude inversion, which is most important in the context of this report since it governs the behaviour of toxic clouds released close to the ground, similar process may take place on a large scale at higher altitudes (hundreds of thousands of metres) whenever a cool air layer is formed beneath a hot air mass. This may take place over large, cold expanses (i.e. large expanses of land or sea, cloud or fog masses, etc.). Because of the high altitude at which they form, these inversion layers have little effect on toxic clouds released at ground level; but in the case of the long-distance transfer of spores they may act as a screen or reflector.

236. The configuration of the surface of the earth in a particular area, which alters the thermal exchange pattern, may also be conducive to the formation of an inversion. For example, inversions are a customary phenomenon in winter in deep valleys surrounded by high peaks, and occur more frequently in the neighbourhood of slopes facing the north than on southern slopes. This also occurs whenever hills of any size enclose a plain or basin, interrupting the general flow of air and preventing mixing from taking place. It is interesting to note that apart from the periodic appearance of smog in London, all the other major accidents resulting from air pollution have occurred in regions where the land configuration fits this description. For example, the small town of Donora, in the United States, lies in a relatively narrow plain bordered by high hills. In 1948 air pollution in the course of an inversion lasting five days led to twenty deaths and 6,000 cases of illness among the town's 14,000 inhabitants.

2. Urban Areas

237. The case of urban built-up areas is more complex, and it may even be said that each one possesses its own micro-climate, depending on its geographical situation, its topography and the layout and nature of its buildings.

238. Because the materials from which they are constructed are better conductors, and because their surfaces face in very varied directions, buildings usually capture and reflect solar radiation better than does the natural ground. Urban complexes therefore heat up more quickly than does the surrounding countryside, and the higher temperature is still further augmented by domestic and industrial heating plants. The results in a flow of cool air from the neighbouring countryside towards the hot centre of the town, beginning shortly after sunrise, decreasing at the beginning of the afternoon and then rising again to a maximum shortly before sunset. This general flow, which is of low velocity, is disturbed and fragmented at ground level by the buildings, forming local currents flowing in all directions.

239. This constant mechanical turbulence, to which is added the thermal turbulence caused by numerous heat-generating sources, should prevent the establishment in towns of a temperature inversion at low altitude. In fact, however, inversions do occur, when conditions are otherwise favourable, but the inversion layer is situated at a higher

altitude than over the surrounding countryside (30 to 150 metres).

240. At night, local inversions may be generated at low altitude as a result of rapid radiation from the roofs of houses; thus in a narrow street lined with buildings of equal height, an inversion layer may be created at roof-top level which will persist until dawn.

241. Fog is more frequent over towns than over open country (+30 per cent in summer and +100 per cent in winter). The process of fog formation is accelerated by the particles, dust and smoke which form a dome over the town. At night these particles act as nuclei around which the fog condenses, the fog contributing in its turn to the retention of the particles in the dome. Fog will obviously have the same concentrating effect on particles originating in toxic clouds.

242. One final point which should be noted is that toxic aerosols and vapours may take some time to penetrate enclosed spaces. Once they have done so, they may continue as a hazard for very long unless adequate ventilation is provided.

3. Effect of Wind and Topography

243. The wind carries and spreads the toxic or infectious cloud, which is simultaneously diluted by turbulence. The distance which the cloud travels before its concentration has fallen to a level below which it is no longer harmful depends on the velocity of the wind and the state of the atmosphere. Since topography also produces changes in the normal wind pattern, it too plays an important part in determining the direction of travel of toxic clouds, sometimes focusing their effects in individual areas. Local winds may also be established as a result of differences in the heat absorbed by, and radiated from, different ground surfaces.

244. These local, surface winds, which affect the air layer nearest the ground up to 300 metres, are frequent and widespread in mountain ranges and near sea coasts. There are slope breezes, valley breezes, sea breezes and land breezes; and they could shift a toxic cloud in directions which cannot be predicted from a study of the general meteorology of the area. The breezes develop according to a regular cycle. During the day, under the influence of solar radiation, the air moves up the valleys and slopes, and moves from the sea towards the land; at night these currents are reversed. In temperate climates land and sea breezes are predominant during the summer; but they are masked by the general wind pattern during the other seasons of the year. They are predominant in subtropical and tropical regions throughout the year.

4. Example of Combined Effects of Wind and the State of the Atmosphere on a Cloud

245. There is some similarity between the evolution of toxic clouds which could be produced by chemical and bacteriological (biological) attacks and that of clouds containing industrial pollutants, so much so that the mathematical models developed for forecasting atmospheric pollution can be applied, with a few modifications, to toxic clouds. But the initial characteristics of the two are as a rule different. Characteristic features of chemical or bacteriological (biological) attacks are the multiplicity and high yield of the sources of emission and their very short emission time, all of which are factors making for a greater initial concentration in the cloud than the concentration of pollutants in industrial clouds.

246. Figure 4 indicates the order of magnitude of these phenomena, and demonstrates the schematic form, and for different atmospheric conditions, the size of area which would be covered by toxic clouds originating from a chemical attack using Sarin, with an intensity arbitrarily chosen at 500 kg/km. It shows that the theoretical distance of travel by the cloud, determined for bare and unobstructed ground, may exceed 100 km. In practice the atmosphere must remain stable for more than ten hours in order to enable the cloud to travel such distances, a condition which, although certainly not exceptional, is fairly uncommon. (Figure 4 not printed.)

247. This figure illustrates the effect of atmospheric conditions on the distance a toxic cloud can be carried by the wind.

248. The example chosen is that of a medium-intensity (500 kg) attack with Sarin on a circular objective 1 km in diameter. The wind velocity is 7 km/h.

249. Each of the lines represents a contour of the hazard zone, i.e. the zone in which any unprotected person would be exposed to the effects of the agent.

250. Under highly unstable conditions (for example, on a very sunny day), this hazard zone is no greater than the area of objective aimed at (the circle at the left end of the figure). On the other hand, in any other situation—(1) slightly unstable, (2) neutral, (3) slightly stable, (4) moderately stable or (5) highly stable—the distance traveled will be greater, and it may extend almost 100 km if conditions remain highly stable for a sufficiently long time. It must be noted, however, that the distance of 100 km could be reached only if a very marked inversion persisted for about fourteen hours (100÷7); such a situation is quite rare.

251. Corresponding evaluations cannot be made for an urban area, since the parameters involved are too numerous and too little understood. But it may be presumed that most of the characteristics of the urban micro-climate would tend to increase the persistence of chemical clouds. This is serious cause for concern, when it is remembered that in highly industrialized countries 50 to 90 per cent of the population live in urban areas

252. To sum up, a stable or neutral atmosphere in equilibrium might cause a toxic cloud produced by a chemical or bacteriological (biological) attack to persist for hours after it had exercised its military effect, which could generally be expected to materialize in the first few minutes following the attack. These conditions could obtain not only at night, but also during long winter periods over vast continental expanses. If a neutral atmosphere in equilibrium were associated with a light wind irregular in direction, then the area affected could be relatively large, and, assuming an adequately heavy initial attack, the concentrations would be high.

5. Special Features of Bacteriological (Biological) Aerosols

253. So far as physical phenomena are concerned (horizontal and vertical movements, sedimentation, dilution, etc.), bacteriological (biological) aerosols would be generally affected in the same way as chemical clouds of aerosol and vapour, but not necessarily to the same extent. But since the effective minimum does for bacteriological (biological) agents are considerably smaller than for chemical agents, bacteriological (biological) aerosols would be expected to remain effective even in a very dilute state and, consequently, that they could contaminate much larger areas than could chemical clouds. An example is given in chapter II.

254. There would be no limit to the horizontal transport of micro-organisms, if there were none to the capacity of the organisms to survive in the atmosphere. Thus if the microbial aerosol particles were so small that their speed of fall remained close to the speed of the vertical air movements in the frictional layer (under average conditions this is on the order of 10 cm/s), the agents, whether alive or dead, would remain suspended and travel very considerable distances. Even if bacteriological (biological) clouds were to move only in the air layer nearest the ground, they could cover very large areas. For example, in one experiment 600 litres of *Bacillus globigii* (a harmless spore-forming bacterium which is highly resistant to aerosolization and environmental stresses) were released off shore; bacteria were found more than 30 km inland. Organisms were found over 250 km² which was the entire area within which there were monitoring stations during the trial. The actual area covered was much more extensive.

255. On the other hand, most pathogenic agents are highly vulnerable when outside the organism in which they normally reproduce, and are liable to biological inactivation, which is sometimes rapid, in the aerosol state. This inactivation process is governed by several factors (such as temperature, humidity, solar radiation, etc.) which are now the subject of aerobiological research.

256. The size of the infective particles in a bacteriological (biological) aerosol is highly significant to their ability to initiate disease as a result of inhalation. It has been established that the terminal parts of the respiratory tract are the most susceptible sites for infection by inhalation. As with chemical agents, the penetration and retention of inhaled bacteriological (biological) particles in the lungs is very dependent on particle size, which is primarily determined by the composition of the basic material and the procedure of aerosolization, as pointed out in chapter I.

257. The influence of particle size of aerosol infectivity is illustrated in table 1, which shows that there is a direct relationship between the LD_{50} and particle diameter of an aerosol of *Franciscella tularensis*.

TABLE 1.—NUMBERS OF BACTERIA OF *FRANCISCELLA TULARENSIS* REQUIRED TO KILL 50 PERCENT OF EXPOSED ANIMALS

Diameter of particles (microns)	Numbers of bacterial cells LD_{50}	
	Guinea pigs	Rhesus monkeys
1	3	17
7	6,500	240
12	20,000	540
22	170,000	3,000

C. Influence of atmospheric factors on chemical agents

1. Influence of Temperature

258. An attack with a liquid chemical agent, as already pointed out, would be as a rule result in the formation of a cloud of small droplets, aerosol and vapour in varying proportions, as well as in ground contamination, all of which would be affected by air temperature.

259. *Influence on droplet and aerosol clouds:* Only particles having dimensions within certain limits penetrate and are retained by the lungs. The larger ones are trapped in the upper part of the respiratory tract (e.g. nose and trachea), whereas the smaller ones are exhaled. Penetration and retention have maximum values in the size range of 0.5 to 3 microns.

260. Liquid chemical agents exercise their effects both by penetrating the skin and by inhalation. The material absorbed by the lungs acts immediately, whereas there is a delay before the effects become manifest from an agent absorbed through the skin or the mucous membrane of the upper air passages.

261. A high temperature favours the evaporation of particles which will decrease in size and thus reach the lungs, contributing to the immediate effect; an additional quantity of vapour is produced which contributes to the same effect.

262. *Effect on ground contamination:* The temperature of the air, and even more that

of the ground, have a marked effect on the way ground contamination develops and persists. The temperature of the ground, which depends on the thermal characteristics of its constituent materials and on the degree of its exposure to the sun, either increases or reduces evaporation, and consequently decreases or increases the duration of contamination. The surface temperature is extremely variable from point to point, depending on the type and colour of the soil; a temperature difference of 20° has been noted between the asphalt surface of a road and the surrounding fields. The temperature gradient also varies during the course of the day; in clear weather the differences may range from 15 to 30° C. in a temperate climate, and up to 50° C. in a desert climate. High temperatures of both air and ground favour the rate of evaporation, thus reducing the persistence of surface contamination; wind, because of the mechanical and thermal turbulence it creates, has a similar effect.

263. To illustrate the effect of these variable factors, it is worth noting that the contamination of bare ground by unpurified mustard, at a mean rate of 30 g/m², will persist for several days or even weeks at temperatures below 10° C at medium wind velocities, whereas it lasts for only a day and a half at 25° C. Furthermore, because of accelerated evaporation at high temperatures, the cloud produced is more concentrated, and the danger of vapour inhalation in, and downwind of, the contaminated area becomes greater.

2. Influence of Humidity

264. In contrast to high temperature, high relative humidity may lead to the enlargement of aerosol particles owing to the condensation of water vapour around the nuclei which they constitute. The quantity of inhalable aerosol would thus diminish, with a consequent reduction in the immediate effects of the attack.

265. On the other hand, a combination of high temperature and high relative humidity causes the human body to perspire profusely. This intensifies the action of mustard-type vesicants, and also accelerates the transfer through the skin of percutaneous nerve agents.

3. Influence of Atmospheric Precipitation

266. Light rain disperses and spreads the chemical agent which thus presents a larger surface for evaporation, and its rate of evaporation rises. Conversely a heavy rain dilutes and displaces the contaminating product, facilitates its penetration into the ground, and may also accelerate the destruction of certain water-sensitive compounds (e.g. lewisite, a powerful blistering agent).

267. Snow increases the persistence of contamination by slowing down the evaporation of liquid contaminants. In the particular case of mustard gas, the compound is converted into a pasty mass which may persist until the snow melts.

268. Soil humidity, atmospheric precipitation and temperature also exercise a powerful influence on the activity of herbicides, which are much more effective at higher humidities and temperatures, than in dry weather and at low temperatures. This applies equally to preparations applied to plants and to those introduced into the soil.

4. Influence of Wind

269. As vapors emanating from ground contaminated by liquid chemical agents begin to rise, the wind comes into play. The distance the vapor will be carried depends on the wind velocity and the evaporation rate of the chemical, which will itself change with variations in ground and air temperatures. The distance is maximal (several kilometres) when there is a combination of the conditions promoting evaporation (high soil temperature) persistence of the cloud (stable atmosphere) and dispersal of the cloud (gentle winds). These conditions exist in combination at the end of a sunny day, at the time when a temperature inversion exists.

5. Influence of Soil—Dependent Factors

270. *Nature of the soil.* The soil itself, through its texture and the porosity of its constituent materials, plays an important role in the persistence of liquid chemical contaminants, which may penetrate to a greater or lesser extent, or remain on the surface. In the former case the risk of contamination by contact is reduced in the short term, but persistence will be increased to the extent that factors favourable to evaporation (temperature, wind) are prevented from acting. In the latter case, when the contaminant remains on the surface, the danger of contact contamination remains considerable, but persistence is reduced. Thus persistence in sandy soils may be three times as long as in clay.

271. *Vegetation.* Vegetation prevents a liquid contaminant from reaching the soil and also breaks it up, thus encouraging evaporation. But at the same time the short-term danger is enhanced because of the widespread dispersion of the contaminant on foliage, and the consequently increased risk of contact contamination.

272. The canopy of foliage in dense forests (e.g., conifers, tropical jungle), traps and holds a considerable portion of a dispersed chemical agent, but the fraction which none the less reaches the soil remains there for a long time, since the atmospheric factors involved in the process of evaporation (temperature, wind, over the soil, turbulence) are hardly significant in such an environment as compared with open spaces.

273. Too little is known about the absorption and retention of toxic substances by plants to make it possible to assess the resulting danger to the living creatures whose food supply they may constitute. Like certain organic pesticides, it is probable that other toxic chemicals may penetrate into plant systems via the leaves and roots. Cases could then arise where all trace of contaminant had disappeared from the soil but with the toxic substance presisting in vegetation.

274. *Urban areas.* It can also be assumed that, in spite of a surface temperature which is on the average higher, contaminants might persist longer in built-up areas than over open ground. There are two reasons for this. Structural, finishing and other building materials are frequently porous, and by absorbing and retaining liquid chemical agents more readily, they increase the duration of contamination. Equally the factors which, in open country, tend to reduce persistence (sunshine, wind over ground) play a less important part in a built-up city.

275. Climate, in general, may exercise an indirect influence on the effect of percutaneous chemical agents, simply because of the fact that in hot climates the lightly clad inhabitants are very vulnerable to attacks through the skin.

276. The predominating influence of climatic factors and terrain on the persistence of contamination indicates that the *a priori* classification of chemical agents as persistent or non-persistent, solely on the basis of different degrees of volatility, is somewhat arbitrary since, depending on circumstances, the same material might persist for periods ranging from a few hours to several weeks, or even months.

D. Influence of atmospheric factors on bacteriological (biological) agents

277. Infectious agents, when used to infect by way of food and water, or by means of animal vectors are, of course, hardly subject to the influence of climatic factors. But any large-scale attack by bacteriological (biological) agents would probably be carried out by aerosols, in which the agents would be more susceptible to environmental influences than chemical agents.

278. Physico-chemical atmospheric factors have a destructive effect on aerosol-borne micro-organisms. Their viability decreases gradually over a period of hours or days at a progressively diminishing rate. Some decay very rapidly: for example, certain bio-aerosols used for pest control in temperate climates, and dispersed under average conditions in the cold and transitional seasons, show a rate of decay of 5 per cent per minute.

279. This apparent vulnerability of micro-organism in aerosols might cast some doubt on the possible effectiveness of bacteriological (biological) attacks. However there are various means by which the rate of decay in the aerosol can be considerably reduced. For example: the use of very high concentrations of agent; the use of suitably "modeled" pathogenic strains; or the protection of aerosol particles by encapsulating them in certain organic compounds.

280. These procedures, which prolong the survival of micro-organisms in air, could presumably also be applied to potential agents of bacteriological (biological) warfare. Means are also available for prolonging the survival of micro-organisms in water, soil, etc.

1. Influence of Temperature

281. The effect of temperature on the survival of micro-organisms in bacteriological (biological) aerosols is not highly significant in the temperature ranges generally encountered. As a general rule, aerosol-borne biological agents will be destroyed more rapidly the more the temperature rises. On the other hand, in some circumstances high temperatures may act on bacteriological (biological) aerosols in the same way as on chemical aerosols, that is to say, particle size will be diminished by evaporation, and thus their rate of entry into the lungs will be enhanced.

2. Influence of Humidity

282. Relative humidity is the most important of the atmospheric conditions which affect the rate of decrease of viability of micro-organisms in the air. The extent of its effect varies with different micro-organisms, with the nature of the suspending fluid from which the aerosol is disseminated, with the manner of its dissemination (as a spray or as a dry powder). As a general rule, the rate of inactivation is greater at lower relative humidity although with some organisms maximum inactivation occurs in the middle range of relative humidity (30–70 per cent). The rate of inactivation will, however, tend to decrease with time, and may become extremely low when a state of equilibrium (stabilization) between the particles and their environment has been established. This implies that irrespective of relative humidity values, the final infective concentration of a stabilized aerosol may still be above the threshold minimum dose for infection by inhalation. Even so, microbial survival in a stabilized aerosol may be further reduced by sudden variations in atmospheric humidity.

283. The effectiveness of aerosol-borne bacteriological (biological) agents depends not only on their capacity to survive in the air. Also important is their low rate of sedimentation, combined with the capacity of the micro-organisms to spread and penetrate into buildings, so contaminating surfaces and materials indoors as well as outdoors. The possibility that some infective agents can survive for a long time in such conditions, and the fact that environmental dust particles may exercise a protective influence on organisms have been demonstrated on many occasions. Studies made in hospitals have shown that surviving micro-organisms can be dispersed from sites which have come to be called "secondary reservoirs", and that they may become sources of new infections, carried either through the air or by contact.

3. Influence of Solar Radiation

284. The ultra-violet part of the solar spectrum has a powerful germicidal effect. Bacterial spores are much less sensitive to this radiation than are either viruses or vegetative bacteria, and fungal spores are even less sensitive than bacterial spores. The destructive effect of solar radiation on micro-organisms is reduced when relative humidity is high (over 70 per cent). Air pollution, including a high proportion of atmospheric dust, also provides some protection.

285. Ultra-violet light exercises its destructive effects on micro-organisms through the structural degradation of the nucleic acids which carry the genetic information. Most research on this subject has been carried out on microbes in liquid suspensions, but the results of studies of aerosol-borne microbes seem to lead to similar conclusions.

286. The germicidal effect of ultra-violet radiation has been known for a long time and used in combating airborne infections in schools, military buildings and hospitals. The problem of proper radiation dosage, and proper techniques, however, still remain to be solved.

287. The lethal effect of sunlight on micro-organisms is less marked, although still apparent, in diffuse light. This is why a bacteriological (biological) attack, if one ever materialized, would be more probably undertaken in darkness.

4. Influence of Atmospheric Precipitation

288. Rain and snow have relatively little effect on bacteriological (biological) aerosols.

5. Influence of the Chemical Composition of the Atmosphere

289. Little is known about the influence on the viability of mirco-organisms of the chemical compounds present in the atmosphere. Oxygen promotes the inactivation of aerosol-borne agents, particularly in conditions of low humidity, and recent studies have also demonstrated that an unstable bactericidal factor (formed by combination between ozone and gaseous combustion products of petroleum) is present in the air, particularly downwind of heavily populated areas.

6. General Effects of Climate

290. Climate may also have a general and considerable influence on the development of epidemics and epizootics, in so far as the proliferation of vectors which spread disease may be encouraged, given the right conditions. This is indicated by the way myxomatosis developed in Australia. Although several attempts in 1927, and then from 1936 to 1943, to impart the disease to Australian rabbits failed, the epizootic spread rapidly from 1950 onwards, apparently for the sole reason that the summer, which was particularly rainy that year, was associated with an exceptional proliferation in the flooded Murray River valley of the mosquitoes which carry the disease.

291. Atmospheric humidity and temperature also have a strong influence on micro-organisms acting upon vegetation.

CHAPTER IV. POSSIBLE LONG-TERM EFFECTS OF CHEMICAL AND BACTERIOLOGICAL (BIOLOGICAL) WARFARE ON HUMAN HEALTH AND ECOLOGY

A. Introduction

292. So far this report has dealt essentially with the potential short-term effects of chemical and bacteriological (biological) warfare. The possible long-term effects of the agents concerned need to be considered against the background of the trends whereby man's environment is being constantly modified, as it becomes transformed to meet his ever-increasing needs. Some of the changes that have occurred have been unwittingly adverse. The destruction of forests has created deserts, while grasslands have been destroyed by over-grazing. The air we breathe and our rivers become polluted, and chemical pesticides, despite the good they do, also threaten with undesirable secondary effects. The long-term impact of possible chemical and bacteriological (biological) warfare clearly needs to be considered within an adequate ecological framework.

293. *Ecology* may be defined as the study of the interrelationships of organisms on the one hand and of their interactions with the physical environment in which they are found on the other. The whole complex of plants and animals within a specific type of environment—a forest, a marsh, a savannah—forms a community comprising all the plant life and all the living creatures—from the microorganisms and worms in the soil, to the insects, birds and mammals above the ground—within that environment, and the understanding of their interrelationships also necessitates a knowledge of the physical characteristics of the environment which bear on the living complex. Ecological communities are normally in dynamic equilibrium, which is regulated by the interaction of population density, available food, natural epidemics, seasonal changes and the competition of species for food and space.

294. Man has his special ecological problems. His numbers are multiplying fast, and increasing population requires commensurate increases in food production. The production and distribution of adequate food for the population which is predicted for the latter part of this century, and which will go on increasing through the next, will allow no relaxation in the effort which has already proved so successful. Food production has increased phenomenally in the past fifty years, primarily because of (1) improved agricultural practices, and particularly because of a marked increase in the use of chemical fertilizers and pesticides; (2) the development of genetically improved plants, herbs and flocks; and (3) increased industrialization of food-producing processes. There is hope that steps such as these will continue to bear fruit.

295. But while the use of fertilizers, herbicides and pesticides has brought about a massive increase in food production, it has aslo added to the pollution of soil and water, and as a result has altered our ecological environment in an enduring way. So too have other features of our industrial civilization. The motor car has been a very potent factor in increasing air pollution in towns and cities. The increasing population of the world creates unprecedented wastes, and the methods used to dispose of it—burying it, burning it, or discharging it into streams or lakes—have further polluted the environment. The remarkable development of synthetic and plastic materials in recent years has also added a new factor to the short- and long-term biological effects on man. Every new advance on our technological civization helps to transform the ecological framework within which we evolved. From this point of view the existence and possible use of chemicals and bactriological (biological) agent in warfare have to be regarded as an additional threat, and as a threat which might have enduring consequences, to our already changing environment.

B. Consequences to man of upsetting the ecological equilibrium

296. The chemical industry doubled its output between 1953 and 1960 and it is still growing fast but the useful results of its continued development are none the less of the utmost importance to man's future. The good effects on food production of the use of artificial fertilizers alone far outweigh any secondary deleterious consequences of their use. The facts are too well known to need spelling out. It is enough to point out, as one example, that maize production in the United States increased between 1923 and 1953, a thirty-year period, by barely four quintals per hectare, but that in the ten years between 1953 and 1964, when the use of fertilizers and more productive hybrid seeds came widespread, the increase was eleven quintals. This is characteristic of what has happened everywhere where fertilizers have been used on a large scale.

297. The beneficial effect of the use of modern chemical pesticides also does not need spelling out. It is estimated that the present annual world loss in production due to weeds and parasites is still approximately 460 million quintals of wheat and 360 million quintals of maize, and that to eliminate this waste will mean the use of even more pesticides than are now being consumed.

298. What has to be realized about modern agricultural practices is that without them the increases in the output of food which the world needs could never be achieved. Unless production mounts everywhere, those who have not yet cast off the burdens of living in a primitive agricultural world will never reach the level of civilization to which all aspire.

299. But, as already indicated, the great increase in the use of fertilizers, pesticides and herbicides does have deleterious side effects. For example, in Switzerland, surface waters and springs have been contaminated in times of high rainfall by excessive amounts of fertilizers corresponding to 0.3–0.5 kg of phosphorous and 45 kg of nitrogen per hectare per year. This kind of thing occurs elsewhere as well, and it cannot but help transform—for all we know adversely—the environment in which living matter including fish otherwise thrive.

300. The dangers of the side effects of modern pesticides are also beginning to be appreciated, and are already beginning to be guarded against in advanced countries. Except in high dosage, these substances act only on lower organisms, although some organophosphorous compounds are toxic to man and other vertebrates. Less selective agents may be toxic to soil bacteria, plankton, snails and fish. Chlorinated hydrocarbons, such as DDT, are toxic only in unusually high dosages, but accumulate in fat, and deposit in the liver and the central nervous system. Following surface application, pesticides enter the soil and seep into underground waters; or become washed by rain into rivers, lakes and reservoirs. It is theoretically possible that in some situations, in which non-selective chemical pesticides are used, disruption of the ecological equilibrium could lead to the long-term suppression of useful animals and plants. These are dangers which only constant vigilance will avert.

301. Detergents are another modern chemical development whose use has had to be regulated, since they have a direct short-term effect on certain types of natural food such as daphniae and the algae which are eaten by fish. The first detergents which came on the market led to enormous quantities of foam on river, and this in turn reduced the supply of oxygen for organisms living in the water. They also damage the earth by affecting soil bacteria. Such detergents, which resist destruction even by the most modern water treatment methods, have all but disappeared from use and have been replaced by others, which can be almost completely destroyed by waste water treatment.

302. In the context of the possible long-term effects of chemical and bacteriological (biological) weapons, we have finally to note that towns and cities are growing all over the world, and that in the developed countries, conurbations (fusion of cities with loss of suburbs) have reached population levels approaching 50 million. Such great concentrations of people require very complicated arrangements for supply of food, water and other materials, transport and general administration. The use of chemical or bacteriological (biological) weapons against cities would undoubtedly have an ex-

ceptionally severe disorganizing effect, and the full re-establishment of the services necessary for health, efficient government, and the smooth operation of industry might take a very long time.

C. Possible long-term effects of chemical and bacteriological (biological) means of warfare on man and his environment

303. Chemical weapons, in addition to their highly toxic short-term effects, may also have a long-term effect on the environment in which they are disseminated. If used in very high concentration they might cause damage by polluting the air, by poluting the water supplies and by poisoning the soil.

304. Bacteriological (biological) weapons could be directed against man's sources of food through the spread of persistent plant diseases or of infectious animal diseases. There is also the possibility that new epidemic diseases could be introduced, or old ones reintroduced, which could result in deaths on the scale which characterized the medieval plagues.

1. Chemical Weapons

305. There is no evidence that the chemical agents used in World War I—chlorine, mustard, phosgene, and tear-gas—had any untoward ecological consequences. As already observed, over 120,000 tons of these agents were used during that war, and in some areas which were attacked, concentrations must have added up to hundreds of kilograms per hectare. These regions have long since returned to normal and fully productive use.

306. The organophosphorous, or nerve, agents have never been used in war, and no corresponding experience is available to help form a judgment about their possible long-term effects. But since these agents are toxic to all forms of animal life, it is to be expected that if high concentrations were disseminated over large areas, and if certain species were virtually exterminated, the dynamic ecological equilibrium of the region might be changed.

307. On the other hand there is no evidence to suggest that nerve agents affect food chains in the way DDT and other pesticides of the chlorinated hydrocarbon type do. They hydrolyze in water, some of them slowly, so there could be no long-term contamination of natural or artificial bodies of water.

308. The use of herbicides during the course of the Viet-Nam conflict has been reported extensively in news media, and to a lesser extent in technical publications. The materials which have been used are 2,4-dichlorophenoxyacetic acid, 2,4,5-trichlorophenoxyacetic acid, cacodylic acid and picloram.

309. Between 1963 and 1968 these herbicides were used to clear forested areas for military purposes over some 9,100 km². This may be divided by forest type as shown in the following table.

TABLE 1.—TYPE OF FOREST AND EXTENT AND AREA TREATED WITH HERBICIDES IN SOUTH VIETNAM, 1963–68

Type of forest	Extent kilometers²	Area treated kilometers²
Open forest (semideciduous)	50,150	8,140
Mangrove and other aquatic	4,800	960
Coniferous	1,250	0
Total	56,200	9,100

310. South Viet-Nam is about 172,000 km² in area, of which about one-third is forested. The area treated with herbicides up to the end of 1968 thus amounts to about 16 per cent of the forested area, or a little over 5 per cent of the total.

311. There is as yet no scientific evaluation of the extent of the long-term ecological changes resulting from these attacks. One estimate is that some mangrove forests may need twenty years to regenerate, and fears have been expressed about the future of the animal population they contain. Certain species of bird are known to have migrated from areas that have been attacked. On the other hand, there has been no decline in fish catches, and as fish are well up in the food chain, no serious damage would seem to have been done to the aquatic environment.

312. When a forest in a state of ecological equilibrium is destroyed by cutting, secondary forest regenerates, which contains fewer species of plants and animals than were there originally, but larger numbers of those species which survive. If secondary forest is replaced by grassland, these changes are even more mraked. If one or more of the animal species which increases in number is the host of an infection dangerous to man (a zoonosis), then the risk of human infection is greatly increased. This is exemplified by the history of scrub typhus in South-East Asia, where the species of rat which maintains the infection and the vector mite are much more numerous in secondary forest, and even more so in grassland, so increasing the risk of the disease being transmitted to people as forest is cleared.

313. In high rainfall areas, deforestation may also lead to serious erosion, and so to considerable agricultural losses. Deserts have been created in this way.

2. Bacteriological (Biological) Weapons

Against man

314. New natural foci, in which infection may persist for many years, may be established after an arosol or other type of bacteriological (biological) attack. This possible danger can be appreciated when one recalls the epidemiological consequences of the accident introduction of rabies and other veterinary infections (blue-tongue, African swine fever) into a number of countries. The spred of rabies in Europe following World II, as a consequence of the disorganization caused by the war, shows how an epidemiologically complicated and medically dangerous situation can emerge even with an infection which had long been successfully controlled. In 1945 there were only three major foci of infection in Czchoslovakia. In the following years, foxes multiplied excessively because farms were left unworked, because of the increased number of many kinds of wild creatures, and also because of the discontinuation of systematic control. Foxes also came in from across frontiers, and the epizootic gradually worsened. In the period 1952/1966 a total of 888 foci were reported, 197 new ones in 1965 alone. Bringing the situation under control demand extraordinary and prolonged efforts by the health service: in 1966 alone, 775,000 domestic animals were vaccinated in affected areas of the country. Non the less, the disease has not yet been stamped out. Natural foci cannot be eliminated without organized and long-term international co-operation.

315. Arthropods (insects, ticks) also play an important part, along with other creatures, in the maintenance of pathogenic agents in natural foci. A man exposed to a natural focus risks infection, particularly from arthropods, which feed on more than one species of host. A bacteriological (biological) attack might lead to the creation of multiple and densely distributed foci of infection from which, if ecological conditions were favourable, natural foci might develop in regions where they had previously never existed, or in areas from which they had been eliminated by effective public health measures.

316. On the other hand, the large-scale use of bacterological (biological) weapons might reduce populations of susceptible wild species below the level at which they could continue to exist. The elimination of a species or group of species from an area would create in the ecological community an empty niche which might seriously disturb its equilibrium, or which might be filled by another species more dangerous to man because it carried a zoonosis infection acquired either naturally or as a result of the attack. This would result in the establishment of a new natural focus of disease.

317. The gravity of these risks would depend on the extent to which the community of species in the country attacked contained animals which were not only susceptible to the infection, but were living in so close a relationship to each other that the infection could become established. For example, not all mosquito species can be infected with yellow fever virus, and if the disease is to become established, those which can become vectors must feed frequently on mammals, such as monkeys, which are also sufficiently susceptible to the infection. A natural focus of yellow fever is therefore very unlikely to become established in any area lacking an adequate population of suitable mosquitos and monkeys.

318. Endemics or enzootics of diseases (i.e. infections spreading at a low rate, but indefinitely, in a human or animal population) could conceivably follow a large-scale attack, or might be started by a small-scale sabotage attack, for which purpose the range of possible agents would be much wider, and might even include such chronic infections as malaria.

319. *Malaria* is a serious epidemic disease in a susceptible population, but it is difficult to envisage its possible employment as a bacteriological (biological) weapon, because of the complex life cycle of the parasite. Drug-resistant strains of malaria exist in, for example, areas of Asia and South America, and their possible extension to areas where mosquitos capable of transmitting the disease already exist, would greatly complicate public health measures, and cause a more serious disease problem because of the difficulties of treatment.

320. *Yellow fever* is still enzootic in the tropical regions of Africa and America. Monkeys and other forest-dwelling primates, together with mosquitos which transmit the virus, constitute natural foci and ensure survival of the virus between epidemics.

321. Importation of this disease is possible wherever a suitable environment and susceptible animal and mosquito hosts exist. This occurred naturally in 1960 when a previously uninfested area of Ethiopia was invaded by yellow fever and an epidemic resulted in about 15,000 deaths. Because of the inaccessibility of the area, some 8,000–9,000 people had died before the epidemic was recognized. The epidemic was extinguished but it is likely that a permanent focus of yellow fever infection has been established in this area, previosuly free of the disease. It might be extremely serious if the virus were introduced into Asia or the Pacific islands where the disease appears never to have occurred, but where local species of mosquito are crown to be able to transmit it. Serious problems could also arise if the virus were introduced into the area of the United States where vector mosquitos still exist, and where millions of people live in an area of a few square kilometers.

322. Another consideration is the possible introduction of a new species of animal to an area to cause either long-term disease or economic problems. For example, mongooses were introduced many years ago to some Caribbean islands, and in one at least they have become a serious economic pest of the sugar crop, and an important cause of rabies. The very large economic effect on the introduction of rabbits to Australia is well known. Certain mosquito species (a yellow fever mosquto, *Aedes aegypti*, and a malaria mosquito, *Anopheles gambiae*) have naturally spread to many areas of the world from their original home in Africa, and have been responsible for serious disease problems in the areas that have been invaded. It is con-

ceivable that in the war the introduction of such insects on a small scale might be tried for offensive purposes.

323. In addition to the development of new natural foci, another long-term hazard, but one which is very much more speculative than some of the possibilities mentioned above, is that of the establishment of new strains of organisms of altered immunological characteristics or increased virulence. This might occur if large numbers of people or other susceptible animal species became infected in an area through a bacteriological (biological) attack, thus providing opportunities for new organisms to arise naturally. The appearance from time to time of immunologically different forms of influenza shows the type of thing which might happen. Such altered forms of agents might cause more severe and perhaps more widespread epidemics than the original attack.

Against domestic animals

324. *Foot-and-mouth disease* is a highly infectious but largely non-fatal disease of cattle, swine and other cloven-footed animals It is rarely transmitted from a diseased animal to man, and when it is, the order is a trivial one.

325. The milk yield of diseased cows decreases sharply and does not reach its normal yield even after complete recovery. Losses range from 9 to 30 per cent of milk yield. In swine, loss from foot-and-mouth are estimated at 60–80 per cent among suckling pigs. Foot-and-mouth is endemic in many countries and breaks out from time to time even in countries which are normally free of the disease. Some countries let it run its course without taking any steps to control it; others try to control it by the use of vaccines; and some pursue a slaughter policy in which all affected animals and contacts are killed.

326. It is obvious that a large epizootic could constitute a very serious economic burden, for example, by bringing about a serious reduction in the supply of milk. It is in this context that foot-and-mouth disease could conceivably serve as a bacteriological (biological) weapon, especially since war conditions would greatly promote its spread. Efficient prevention is possible through active immunization, but the immunity is rather short-lived and annual vaccination is required.

327. *Brucellosis* is an example of chronic disease which could possibly result from bacteriological (biological) weapon attacks. There are three forms known, which attack cattle, swine and goats respectively. Any of these may be transmitted to man, in whom it causes a debilitating but rarely fatal disease lasting for four to six months or even longer. It is enzootic in most countries of the world, and an increased incidence of the disease resulting from its use as a weapon could be dealt with, after the initial blow, in the same way as is the natural disease. But the cost of eliminating disease such as brucellosis from domestic animals is very high.

328. *Anthrax* was described in chapter II and what concerns us here is that if large quantities of anthrax spores were disseminated in bacteriological (biological) weapons, thus contaminating the soil of large regions, danger to domestic animals and man might persist for a very long time. There is no known way by which areas could be rendered safe. The use of large quantities of anthrax as a weapon might therefore cause long-term environmental hazards.

Against crops

329. The *rust* fungus, as already noted, is one of the most damaging of natural pathogens which affects wheat crops. Each rust pustule produces 20,000 uredospores a day for two weeks, and there may be more than 100 pustules on a single infected leaf. The ripe uredospores are easily detached from the plant even by very weak air currents. The spores are then carried by the wind over distances of many hundreds of kilometres. It is estimated that the annual total world loss of wheat from rust is equivalent to about $500 million.

330. Weather plays a decisive role in the epiphytotic spreading of rust. Temperature influences the incubation period and the rate of uredospore germination. Germination and infection occur only when there is a water-saturated atmosphere for three to four hours. Thus, epiphytotic spread occurs when there are heavy dews and when the temperature is between 10° and 30° C. The principal means of prevention is to destroy the pathogen and to breed resistant species. Recently, ionizing radiation has been employed to develop resistant strains.

331. The cereal rusts die out during winter unless some other susceptible plant host, such as barberry, is present, and therefore their effect on crops would be limited to a single season. As they are capable of reducing man's food reserves considerably, rust spores could be extremely dangerous and efficient bacteriological (biological) weapons, especially if deployed selectively with due regard to climatic conditions. Artificial spreading of an epiphytotic would be difficult to recognize and delivery of the pathogen to the target would be relatively simple.

332. Rust epiphytotics might have a very serious effect in densely populated developing countries, where the food supply might be reduced to such an extent that a human population already suffering from malnutrition might be driven to starvation, which, depending on the particular circumstances, might last a long time.

333. Another conceivable biological weapon, although neither a practical nor a bacteriological one, is the *potato beetle*. To use it for this purpose, the beetle would have to be produced in large numbers, and introduced, presumably clandestinely, into potato growing regions at the correct time during maturation of the crop. In the course of spread the beetle first lives in small foci, which grow and increase until it becomes established over large territories. The beetle is capable of astonishing propagation: the progeny of a single beetle may amount to about 8,000 million in one-and-a-half years.

334. Since beetles prefer to feed and lay their eggs in plants suffering from some viral disease, they and their larvae may help transmit the virus thereby increasing the damage they cause. The economic damage caused by the beetle varies with the season and the country affected, but it can destroy up to 80 per cent of the crop. Protection is difficult because it has not been possible to breed resistant potato species and the only means available at present is chemical protection.

335. Were the beetle ever to be used successfully for offensive purposes, it could clearly help bring about long-term damage because of the difficulty of control.

3. Genetic and Carcinogenic Changes

336. The possibility also exists that chemical and bacteriological (biological) weapons might cause genetic changes. Some chemicals are known to do this. LSD, for example, is known to cause genetic changes in human cells. Such genetic changes, whether induced by chemicals or viruses, might conceivably have a bearing on the development of cancer. A significantly increased incidence of cancer in the respiratory tract (mainly lung) has been reported recently among workers employed in the manufacture of mustard gas during World War II. No increased prevalence of cancer has been reported among mustard gas casualties of World War I although it is doubtful if available records would reveal it. However, most of these casualties were exposed for only short periods to the gas whereas the workers were continuously exposed to small doses for months or years.

CHAPTER V. ECONOMIC AND SECURITY IMPLICATIONS OF THE DEVELOPMENT, ACQUISITION AND POSSIBLE USE OF CHEMICAL AND BACTERIOLOGICAL (BIOLOGICAL) WEAPONS AND SYSTEMS OF THEIR DELIVERY

A. Introduction

337. Previous chapters have revealed the extent to which developments in chemical and biological science have magnified the potential risks associated with the concept of chemical or bacteriological (biological) warfare. These risks derive not only from the variety of possible agents which might be used, but also from the variety of their effects. The doubt that a chemical or bacteriological (biological) attack could be restricted to a given area means that casualties could occur well outside the target zone. Were these weapons used to blanket large areas and cities, they would cause massive loss of human life, affecting non-combatants in the same way as combatants, and in this respect, they must clearly be classified as weapons of mass destruction. The report has also emphasized the great problems and cost which would be entailed in the provision of protection against chemical and bacteriological (biological) warfare. It is the purpose of this final chapter to explore in greater depth the economic and security implications of matters such as these.

B. Production

1. Chemical Weapons

338. It has been estimated that during the course of the First World War, at a time when the chemical industry was in a relatively early stage of development, about 180,000 tons of chemical agents were produced, of which more than 120,000 tons were used in battle. With the rapid development of the industry since then, there has been an enormous growth in the potential capacity to produce chemical agents.

339. The scale, nature, and cost of any progamme for producing chemical weapons, and the time needed to implement it, would clearly be largely dependent on the scientific, technical and industrial potential of the country concerned. It would depend not only on the nature of the chemical industry itself, and on the availability of suitably trained egnineers and chemists, but also on the level of development of the chemical engineering industry and of the means of automating chemical processes, especially where the production of highly toxic chemical compounds is involved. Whatever the cost of developing a chemical or bacteriological (biological) capability, it needs to be realized that it would be a cost additional to, and not a substitute for, that of acquiring an armoury of conventional weapons. An army could be equipped with the latter without having any chemical or bacteriological (biological) weapons. But it could never rely on chemical or bacteriological (biological) weapons alone.

340. Today a large number of industrialized countries have the potential to produce a variety of chemical agents. Many of the intermediates required in their manufacture, and in some cases even the agents themselves, are widely used in peace time. Such substances include, for example, phosgene, which some highly developed countries produce at the rate of more than 100,000 tons a year and which is commonly used as an intermediate in the manufacture of synthetic plastics, herbicides, insecticides, paints and pharmaceuticals. Another chemical agent, hydrocyanic acid, is a valuable intermediate in the manufacture of a variety of synthetic organic products and is produced in even greater quantities. Ethylene-oxide, which is used in the manufacture of mustard gases, is also produced on a large scale in various countries. It is a valuable starting material in the production of a large number of important substances, such as detergents, disinfectants and wetting agents. The world

production of ethylene-oxide and propylene-oxide is now well in excess of 2 million tons per year. Mustard gas and nitrogen mustard gases can be produced from ethylene-oxide by a relatively simple process. Two hundred and fifty thousand tons of ethylene-oxide would yield about 500,000 tons of mustard gas.

341. The production of highly toxic nerve agents, including organophosphorus compounds, presents problems which, because they are relatively difficult, could be very costly to overcome. To a certain extent this is because of the specialized safety precautions which would be needed to protect workers against these very poisonous substances, a need which, of course, applies to all chemical agents, especially to mustard gas. However, many intermediates used in the manufacture of nerve agents have a peacetime application: for example, dimethylphosphite, necessary for the production of Sarin, is used in the production of certain pesticides. But even leaving operating expenses aside, the approximate cost of acquiring one plant complex to produce munitions containing up to 10,000 tons of Sarin a year would be about $150 million. The cost would, of course, be considerably less if existing munitions could be charged with chemical agents.

342. A country which possesses a well-developed chemical industry could clearly adapt it to produce chemical agents. But were it to embark on such a step, it would be only the beginning. The establishment of a comprehensive chemical warfare capability would also involve special research centres, experimental test grounds, bases, storage depots and arsenals. The development of sophisticated and comprehensive weapons systems for chemical or bacteriological (biological) warfare would be a very costly part of the whole process. None the less, the possibility that a peacetime chemical industry could be converted to work for military purposes, and of chemical products being used as weapons, increases the responsibility of Governments which are concerned to prevent chemical warfare from ever breaking out.

2. Bacteriological (Biological) Weapons

343. The microbiological expertise necessary to grow agents of bacteriological (biological) warfare exists to a large extent in many countries, since the requirements are similar to those of a vaccine industry and, to a lesser extent, a fermentation industry. Apart from the combination of the highly developed technologies of these two industries, there remains only a need for some specialized knowledge, expertise and equipment to permit the safe handling of large quantities of bacteriological (biological) agents. Consequently, existing facilities in the fermentation, pharmaceutical and vaccine industries could be adapted for the production of bacteriological (biological) agents. But the technological complexities of producing bacteriological (biological) agents in dry powder form are very much greater than for wet spray systems. Moreover, it would be desirable to provide an effective vaccine with which to protect production staff. The technical difficulties would increase with the scale and complexity of the weapons systems that were being developed. But the fact remains that any industrially advanced country could acquire whatever capability it set out to achieve in this field.

344. The difficulty and cost of providing for the transport and storage of bacteriological (biological) weapons are considerable, since special storage conditions, e.g., refrigeration, and stringent safety and security precautions are essential. In addition, testing to determine the potential effectiveness of the material produced would require considerable and costly testing facilities both in the laboratory and in the field.

345. Despite the fact that the development and acquisition of a sophisticated armoury of chemical and bacteriological (biological) weapons systems would prove very costly in resources, and would be dependent on a sound industrial base and a body of well-trained scientists, any developing country could in fact acquire, in one way or another, a limited capability in this type of warfare—either a rudimentary capability which it developed itself, or a more sophisticated one which it acquired from another country. Hence, the danger of the proliferation of this class of weapons applies as much to developing as it does to developed countries.

C. Delivery systems

346. Practically all types of explosive munitions (artillery shells, mines, guided and unguided rockets, serial bombs, landmines, grenades, etc.) can be adapted for the delivery of chemical agents. A modern bomber, for example, can carry about fifteen tons of toxic chemical agents, and it is estimated that only 250 tons of V-gas, an amount which could be delivered by no more than fifteen or sixteen aircraft, is enough to contaminate a great city with an area of 1,000 square kilometres and a population of 7 to 10 million. Were such a population mainly in the open and unprotected, fatal casualties might reach the level of 50 per cent.

347. Existing armaments which (with some modification) could be used to deliver agents in order to generate local outbreaks of disease, could also contaminate large areas with pathogens. For example, a single aircraft could cover with a bacteriological (biological) agent an area of up to 100,000 square kilometres, although the area of effective dosage might be much smaller due to loss of the infectivity of the airborne agent.

348. While the development and production costs of chemical and bacteriological (biological) agents might well be high, the cost of the complete weapons system (see chapter I) would be even greater. The cost of developing, procuring and operating a squadron of modern bombers far outweighs the cost of the bombs it could carry. However, for some purposes, an existing weapon system or a far less sophisticated means of disseminating might be used.

D. Protection

349. The measures which would be required to protect a population, its livestock and plants against chemical or bacteriological (biological) attack are immensely costly and complex (chapter I). At present, warning systems for the detection of aerosol clouds are fairly rudimentary. Systems for the detection of specific chemical and bacteriological (biological) agents might be devised, but again they are likely to prove very expensive, if indeed they are feasible.

350. With certain agents, contamination of the environment, for example of buildings and soil, could persist for several days or weeks. Throughout this period people would be exposed to the risk of contamination by contact and by inhalation. Protective clothing, even if adequately prefabricated and distributed or improvised, would make it difficult to carry on with normal work. The prolonged wearing of respirators causes physiological difficulties, and it would prove necessary to provide communal shelters with air filtration and ventilations systems for civil populations. Shelters would be extremely costly to build and operate, and a programme for their construction would constitute a heavy burden on the economy.

351. Even if protective measures were provided against known agents, it is conceivable that new ones might be developed whose physical or chemical properties would dictate a need for new individual and communal protective equipment. This could constitute an even greater economic burden.

352. Defensive measures, especially against chemical agents, would also have to include the extremely laborious and expensive task of decontaminating large numbers of people, as well as equipment, weapons and other materials. This would mean setting up decontamination centres and training of people in their use. Stocks of decontaminating agents and replacement clothing would also be required.

353. A very important part of a defence system against chemical or bacteriological (biological) weapons would be the means of very rapidly detecting an attack and identifying the specific agent used in an attack. Methods for doing this rapidly and accurately are still inadequate. Specific protection against bacteriological (biological) agents would necessitate the use of vaccines and perhaps antibiotics (see annex C of chapter II). Vaccines vary in their effectiveness, even against naturally-occurring infections, and even those which are highly effective in natural circumstances may not protect against bacteriological (biological) agents deliberately disseminated into the air and inhaled into the lungs. Antibiotics used propbylactically are a possible means of protection against bacteria and rickettsiae but not against viruses. But the large and complex problems of their use in large populations would be all but insuperable.

354. It would be extremely difficult to arrange for the medical treatment of a civilian population which had been attacked with chemical or bacteriological (biological) weapons. Mobile groups of specialists in infectious disease, of microbiologists, and of well-trained epidemologists, would have to be organized to provide for early diagnosis and treatment, while a network of reserve hospitals and a massive supply of drugs would have to be prepared in advance. The maintenance of a stockpile of medical supplies is extremely costly. Many drugs, especially antibiotics, deteriorate in storage. Huge amounts would have to be discarded as useless from time to time, and the stock would have to be replenished periodically.

E. Cost to society

355. The extent to which the acquisition, storage, transport and testing of chemical and bacteriological (biological) munitions would constitute an economic burden, would depend on the level of a country's industrial and military capability, although compared to nuclear weapons and advanced weapons systems in general, it might not seem excessive. But the task of organizing delivery systems and deployment on a large or sophisticated scale could well be economically disastrous for many countries. Moreover the preparation of an armoury of chemical and bacteriological (biological) weapons would constitute a possible danger to people in the vicinity of production, storage and testing facilities.

356. Chemical and bacteriological (biological) attacks could be particularly dangerous in towns and densely populated areas, because of the close contacts between individuals, and because of the centralized provision of services for every day necessities and supply. (services, urban transport networks, trade, etc.). The consequences might also be particularly serious in regions with a warm, moist climate, in low lying areas, and in areas with poorly developed medical facilities.

357. The technical and organizational complexity, as well as the great financial cost, of providing adequate protection for a population against attack by chemical and bacteriological (biological) agents have already been emphasized. The costs would be formidable by any standards. The construction of a system of fall-out shelters to protect only part of the population of one large and highly developed country against nuclear weapons has been estimated at no less than $5,000–$10,000 million. Such shelters could be

modified, at a relatively modest additional cost, to provide protection against chemical and bacteriological (biological) weapons. To construct communal shelters for a corresponding part of the population against chemical and bacteriological (biological) weapons alone would cost much the same as protection against nuclear fall-out. If all other necessary related expenditures are considered—such as detection and warning systems, communications, and medical aid—the total costs of civil defence against chemical and bacteriological (biological) agents would be greater than $15,000–$25,000 million for a developed country of 100–200 million people. But even if such a programme were ever planned and implemented, there could be no assurance that full protection could be achieved.

358. For whatever its cost, no shelter programme could provide absolute protection against attack by chemical or bacteriological (biological) agents. Protective measures would be effective only if there were adequate warning of an attack, and if civil defence plans were brought into operation immediately and efficiently. However, many shelters were available, the likelihood would be that large numbers of people would be affected to varying degrees, and would be in urgent need of medical attention, and once hostilities had ceased, that there would be large numbers of chronic sick and invalids, requiring care, support and treatment, and imposing a heavy burden on a society already disorganized by war.

359. It is almost impossible to conceive of the complexity of the arrangements which would be necessary to control the consequences of a large-scale bacteriological (biological) attack. Even in peacetime, the development of an epidemic of a highly contagious disease started by a few individual cases, introduced from abroad, necessitates enormous material expenditure and the diversion of large numbers of medical personnel. Examples of widespread disruption due to a few smallpox contacts are given in chapter II. No estimates are given of the actual costs involved in dealing with these events, but in some cases they must have run into millions of dollars. Large-scale bacteriological (biological) attacks could thus have a serious impact on the entire economy of the target country and, as is observed in chapter II, depending on the type of agent used, the disease might well spread to neighbouring countries.

360. Whatever might be done to try to save human beings, nothing significant could be done to protect crops, livestock, fodder and food-stuffs from a chemical and bacteriological (biological) weapons attack. Persistent chemical agents could constitute a particular danger to livestock.

361. Water in open reservoirs could be polluted as a result of deliberate attack, or perhaps accidentally, with chemical or bacteriological (biological) weapons. The water supply of large towns could become unusable, and rivers, lakes and streams might be temporarily contaminated.

362. Enormous damage could be done to the economy of a country whose agricultural crops were attacked with herbicides. For example, only ten to 10 grammes per hectare of 2, 4D could render a cotton crop completely unporductive (see annex A). Fruit trees, grape vines and many other plants could also be destroyed. Mixtures of 2, 4D, of 2, 4, 5T and picloram are particularly potent. The chemical known as paraquate can destroy virtually all annual plants, including leguminous plants, rice, wheat and other cereals. Arsenic compounds dessicate the leaves of many crops and make them unusable as food. There are no means known at present of regenerating some of the plants which are affected by herbicides. Experience has shown, however, that in the case of some species, either natural or artificial seeding can easily produce normal growth in the next growing season. But the destruction of fruit trees, vines and other plants, if achieved could not be overcome for many years. For most practical purposes, it would be impossible to prevent the destruction of cultivated plants on which herbicides have been used, and depending on a country's circumstances, widespread famine might follow.

363. If the induced disease were to spread, bacteriological (biological) weapons could affect even more extensive agricultural areas. The effect would however be more delayed and more specific to the corps affected. Annex A gives examples of the extent of the decrease in a wheat harvest and in a rice harvest affected by blast. The uredospores of the rust are easily transported by air currents so that down-wind sections would be affected by rust to a considerable distance, with a corresponding sharp reduction in the crop, while the upwind sections gave a good yield.

364. Over and above all these possible effects of chemical and bacteriological (biological) warfare on farm animals and crops is the possibility discussed in the previous chapter, of widespread ecological changes due to deleterious changes brought about in wild fauna and flora.

F. The relevance of chemical and bacteriological (biological) weapons to military and civil security

365. The comparison of the relative effectiveness of different classes of weapons is a hazardous and often futile exercise. The major difficulty is that from the military point of view, effectiveness cannot be measured just in terms of areas of devastation or of numbers of casualties. The final criterion would always be whether a specific military purpose had been more easily achieved with one rather than another set of weapons.

366. Clearly, from what has been said in the earlier chapters of this report, chemical weapons could be more effective than equivalent weights of high explosive when directed against densely populated targets. Similarly, so far as mass casualties are concerned, bacteriological (biological) weapons could, in some circumstances, have far more devastating effects than chemical weapons, and effects which might extend well beyond the zone of military operations.

367. From the military point of view, one essential difference between anti-personnel chemical and bacteriological (biological) weapons on the one hand, and a conventional high explosive weapon on the other (including small arms and the whole range of projectiles), is that the area of the effects of the latter is more predictable. There are, of course, circumstances where, from the point of view of the individuals attacked, an incapacitating gas would be less damaging than high explosives. On the other hand, whereas military forces can, and do, rely entirely upon conventional weapons, no country, as already observed, could entrust its military security to an armoury of chemical and bacteriological (biological) weapons alone. The latter constitute only one band in the spectrum of weapons.

368. As previous chapters have also shown, neither the effectiveness nor the effects of chemical and bacteriological (biological) weapons can be predicted with assurance. Whatever military reasons might be advanced for the use of these weapons, and whatever their nature, whether incapacitating or lethal, there would be significant risk of escalation, not only in the use of the same type of weapon but also of other categories of weapons systems, once their use had been initiated. Thus, chemical and bacteriological (biological) warfare could open the door to hostilities which could become less controlled, and less controllable, than any war in the past. Uncontrollable hostilities cannot be reconciled with the concept of military security.

369. Since some chemical and bacteriological (biological) weapons constitute a major threat to civilian populations and their food and water supplies, their use cannot be reconciled with general national and international security. Further, because of the scale and intensity of the potential effects of their use, they are considered as weapons of mass destruction. Their very existence thus contributes to international tension without compensating military advantages. They generate a sense of insecurity not only in countries which might be potentially belligerent, but also in those which are not. Neutral countries could be involved through the use of chemical and bacteriological (biological) weapons, especially those whose territories bordered on countries involved in conflict in the course of which chemical and bacteriological (biological) casualties had been suffered by garrisons and civilians close to frontiers. The effects of certain bacteriological (biological) weapons used on a large scale might be particularly difficult to confine to the territory of a small country. Large-scale chemical and bacteriological (biological) agents and chemical agents might be used for acts of sabotage. Such events might occur as isolated acts, even carried out in defiance of the wishes of national leaders and military commanders. The continued existence and manufacture of chemical weapons anywhere may make such occurrences more likely.

370. Obviously any extensive use of chemical weapons would be known to the country attacked. The source of the attack would probably also be known. On the other hand, it would be extremely difficult to detect isolated acts of sabotage in which bacteriological (biological) weapons were used, especially if the causative organism were already present in the attacked country. Because of the suspicions they would generate, acts of sabotage could thus provoke a conflict involving the widespread use of chemical and bacteriological (biological) weapons.

ANNEX A

ECONOMIC LOSS FROM POSSIBLE USE OF CHEMICAL AND BACTERIOLOGICAL (BIOLOGICAL) WEAPONS AGAINST CROPS

TABLE 1.—ECONOMIC LOSS WHICH COULD RESULT FROM THE USE OF CHEMICAL WEAPONS DUE TO THE DESTRUCTION OF CROPS PER HECTARE OF LAND

Type of plant	Average harvest (in tons per hectare)	Price of 1 ton in U.S. dollars	Sum total of losses in U.S. dollars per hectare
Cotton	3	600	1,800
Rice	5	84	420
Wheat	3	69	207
Apple tree	30	[1] 140	[1] 8,400

[1] Will not produce apples for 2 years.

TABLE 2.—ECONOMIC LOSS DUE TO THE USE OF BACTERIOLOGICAL (BIOLOGICAL) WEAPONS AGAINST CROPS

Plant	Type of agent	Losses: Percent	Losses: Tons per hectare	Loss in U.S. dollars per hectare
Wheat	Cereal rust (Puccinia graminis)	80	24	165
Rice	Rice blast (Piricularia drizae).	70	35	294

CONCLUSION

371. All weapons of war are destructive of human life, but chemical and bacteriological (biological) weapons stand in a class of their own as armaments which exercise their effects solely on living matter. The idea that bacteriological (biological) weapons could deliberately be used to spread disease generates a sense of horror. The fact that cer-

tain chemical and bacteriological (biological) agents are potentially unconfined in their effects, both in space and time, and that their large-scale use could conceivably have deleterious and irreversible effects on the balance of nature adds to the sense of insecurity and tension which the existence of this class of weapons engenders. Considerations such as these set them into a category of their own in relation to the continuing arms race.

372. The present inquiry has shown that the potential for developing an armoury of chemical and bacteriological (biological) weapons has grown considerably in recent years, not only in terms of the number of agents, but also in their toxicity and in the diversity of their effects. At one extreme, chemical agents exist and are being developed for use in the control of civil disorders; and others have been developed in order to increase the productivity of agriculture. But even though these substances may be less toxic than most other chemical agents, their ill-considered civil use, or use for military purposes could turn out to be highly dangerous. At the other extreme, some potential chemical agents which could be used in weapons are among the most lethal poisons known. In certain circumstances the area over which some of them might exercise their effects could be strictly confined geographically. In other conditions some chemical and bacteriological (biological) weapons might spread their effects well beyond the target zone. No one could predict how long the effects of certain agents, particularly bacteriological (biological) weapons might endure and spread and what changes they could generate.

373. Moreover, chemical and bacteriological (biological) weapons are not a cheap substitute for other kinds of weapon. They represent an additional drain on the national resources of those countries by which they are developed, produced and stockpiled. The cost cannot of course be estimated with precision; this would depend on the potential of a country's industry. To some the cost might be tolerable; to others it would be crippling, particularly, as has already been shown, when account is taken of the resources which would have to be diverted to the development of testing and delivery systems. And no system of defence, even for the richest countries in the world, and whatever its cost, could be completely secure.

374. Because chemical and bacteriological (biological) weapons are unpredictable, in varying degree, either in the scale or duration of their effects, and because no certain defence can be planned against them, their universal elimination would not detract from any nation's security. Once any chemical or bacteriological (biological) weapon had been used in warfare, there would be a serious risk of escalation, both in the use of more dangerous weapons belonging to the same class, and of other weapons of mass destruction. In short, the development of a chemical or bacteriological (biological) armoury, and a defence, implies an economic burden without necessarily imparting any proportionate compensatory advantage to security. And at the same time it imposes a new and continuing threat to future international security.

375. The general conclusion of the report can thus be summed up in a few lines. Were these weapons ever to be used on a large scale in war, no one could predict how enduring the effects would be, and how they would affect the structure of society and the environment in which we live. This overriding danger would apply as much to the country which initiated the use of these weapons as to the one which had been attacked, regardless of what protective measures it might have taken in parallel with its development of an offensive capability. A particular danger also derives from the fact that any country could develop or acquire, in one way or another, a capability in this type of warfare, despite the fact that this could prove costly. The danger of the proliferation of this class of weapons applies as much to the developing as it does to developed countries.

376. The momentum of the arms race would clearly decrease if the production of these weapons were effectively and unconditionally banned. Their use, which could cause an enormous loss of human life, has already been condemned and prohibited by international agreements, in particular the Geneva Protocol of 1925, and, more recently, in resolutions of the General Assembly of the United Nations. The prospects for general and complete disarmament under effective international control, and hence for peace throughout the world, would brighten significantly if the development, production and stockpiling of chemical and bacteriological (biological) agents intended for purposes of war were to end and if they were eliminated from all military arsenals.

377. If this were to happen, there would be a general lessening of international fear and tension. It is the hope of the authors that this report will contribute to public awareness of the profoundly dangerous results if these weapons were ever used, and that an aroused public will demand and receive assurances that Governments are working for the earliest effective elimination of chemical and bacteriological (biological) weapons.

APPENDIXES

Protocol for the prohibition of the use in war of asphyxiating, poisonous or other gases, and of bacteriological methods of warfare, signed at Geneva, 17 June 1925

The undersigned plenipotentiaries, in the name of their respective Governments:

Whereas the use in war of asphyxiating, poisonous or other gases, and of all analogous liquids, materials or devices, has been justly condemned by the general opinion of the civilized world;

Whereas the prohibition of such use has been declared in Treaties to which the majority of Powers of the world are Parties; and

To the end that this prohibition shall be universally accepted as a part of International Law, binding alike the conscience and the practice of nations;

Declare:

That the High Contracting Parties, so far as they are not already Parties to Treaties prohibiting such use, accept this prohibition, agree to extend this prohibition to the use of bacteriological methods of warfare and agree to be bound as between themselves according to the terms of this declaration.

The High Contracting Parties will exert every effort to induce other States to accede to the present Protocol. Such accession will be notified to the Government of the French Republic, and by the latter to all signatory and acceding Powers, and will take effect on the date of the notification by the Government of the French Republic.

The present Protocol, of which the French and English texts are both authentic, shall be ratified as soon as possible. It shall bear today's date.

The ratifications of the present Protocol shall be addressed to the Government of the French Republic, which will at once notify the deposit of such ratification to each of the signatory and acceding Powers.

The instruments of ratification of and accession to the present Protocol will remain deposited in the archives of the Government of the French Republic.

The present Protocol will come into force for each signatory Power as from the date of deposit of its ratification, and, from that moment, each Power will be bound as regards other Powers which have already deposited their ratifications.

In witness whereof the Plenipotentiaries have signed the present Protocol.

Done at Geneva in a single copy, the seventeenth day of June, One Thousand Nine Hundred and Twenty-Five.

RESOLUTION 2162 B (XXI)

(1484th plenary meeting, December 5, 1966)

The General Assembly,

Guided by the principles of the Charter of the United Nations and of international law,

Considering that weapons of mass destruction constitute a danger to all mankind and are incompatible with the accepted norms of civilization,

Affirming that the strict observance of the rules of international law on the conduct of warfare is in the interest of maintaining these standards of civilization,

Recalling that the Geneva Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, of 17 June 1925, has been signed and and adopted and is recognized by many States,

Noting that the Conference of the Eighteen-Nation Committee on Disarment has the task of seeking an agreement on the cessation of the development and production of chemical and bacteriological weapons and other weapons of mass destruction, and on the elimination of all such weapons from national arsenals, as called for in the draft proposals on general and complete disarmament now before the Conference.

1. *Calls for* strict observance by all States of the principles and objectives of the Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, signed at Geneva on 17 June 1925, and condemns all actions contrary to those objectives;

2. *Invites* all States to accede to the Geneva Protocol of 17 June 1925.

RESOLUTION 2454 A (XXIII)

(1750th plenary meeting, December 20, 1968)

The General Assembly,

Reaffirming the recommendations of its resolution 2162 B (XXI) calling for strict observance by all States of the principles and objectives of the Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or other Gases, and of Bacteriological Methods of Warfare signed at Geneva on 17 June 1925, condemning all actions contrary to those objectives and inviting all States to accede to that Protocol,

Considering that the possibility of the use of chemical and bacteriological weapons constitutes a serious threat to mankind,

Believing that the people of the world should be made aware of the consequences of the use of chemical and bacteriological weapons,

Having considered the report of the Eighteen-Nation Disarmament Committee which recommended that the Secretary-General appoint a group of experts to study the effects of the possible use of such weapons,

Noting the interest in a report on various aspects of the problem of chemical, bacteriological and other biological weapons which has been expressed by many Governments and the welcome given to the recommendation of the Eighteen-Nation Disarmament Committee by the Secretary-General in his Annual Reports for 1967–68,

Believing that such a study would provide a valuable contribution to the consideration in the Eighteen-Nation Disarmament Committee of the problems connected with chemical and bacteriological weapons,

Recalling the value of the report of the Secretary-General on the effects of the possible use of nuclear weapons,

1. *Requests* the Secretary-General to prepare a concise report in accordance with the proposal in Part II of his Introduction to the Annual Report for 1967–68 and in accordance with the recommendation of the Eighteen-Nation Disarmament Committee

contained in paragraph 26 of its report (document A/7189);

2. *Recommends* that the report be based on accessible material and prepared with the assistance of qualified consultant experts by the Secretary-General, taking into account the views expressed and the suggestions made during the discussion of this item at the twenty-third session of the General Assembly;

3. *Calls upon* Governments, national and international scientific institutions and organizations to co-operate with the Secretary-General in the preparation of the report;

4. *Rquests* that the report be transmitted to the Eighteen-Nation Disarmament Committee, the Security Council and the General Assembly at an early date, if possible by 1 July 1969, and to the Governments of Member States in time to permit its consideration at the twenty-fourth session of the General Assembly;

5. *Recommends* that Governments give the report wide distribution in their respective languages, through various media of communication, so as to acquaint public opinion with its contents;

6. *Reiterates* its call for strict observance by all States of the principles and objectives of the Geneva Protocol of 17 June 1925 and invites all States to accede to that Protocol.

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Mr. NELSON. Mr. President, it is the most comprehensive document of this kind that has been called to my attention. I think it is in the interest of the Congress and the public that it be printed in full in the RECORD. The United Nations report was compiled by an internationally distinguished group of scientists, representing many nations, and I think presents, in the most effective fashion I have seen, the implications of engaging in this kind of warfare.

The Secretary General, in his conclusion, states that:

> The general conclusion of the report can thus be summed up in a few lines. Were these weapons ever to be used on a large scale in war, no one could predict how enduring the effects would be, and how they would affect the structure of society and the environment in which we live. This overriding danger would apply as much to the country which initiated the use of these weapons as to the one which had been attacked, regardless of what protective measures it might have taken in parallel with its development of an offensive capability. A particular danger also derives from the fact that any country could develop or acquire, in one way or another, a capability in this type of warfare, despite the fact that this could prove costly. The danger of the proliferation of this class of weapons applies as much to the developing as it does to developed countries.
>
> The momentum of the arms race would clearly decrease if the production of these weapons were effectively and unconditionally banned. Their use, which could cause an enormous loss of human life, has already been condemned and prohibited by international agreements, in particular the Geneva Protocol of 1925, and, more recently, in resolutions of the General Assembly of the United Nations.

The PRESIDING OFFICER. The time of the Senator has expired.

Mr. STENNIS. Mr. President, does the Senator from New Hampshire desire more time?

Mr. McINTYRE. Not at the present moment.

Mr. NELSON. Mr. President, I would like to ask for 2 minutes to complete the reading of that statement.

Mr. STENNIS. Oh, I thought the Senator had concluded.

Mr. NELSON. No.

Mr. STENNIS. Mr. President, I yield 2 minutes to the Senator from Wisconsin.

Mr. NELSON. I thank the Senator.

I just want to read the completion of this summary:

> The prospects for general and complete disarmament under effective international control, and hence for peace throughout the world, would brighten significantly if the development, production and stockpiling of chemical and bacteriological (biological) agents intended for purposes of war were to end and if they were eliminated from all military arsenals.
>
> "If this were to happen, there would be a general lessening of international fear and tension. It is the hope of the authors that this report will contribute to public awareness of the profoundly dangerous results if these weapons were ever used, and that an aroused public will demand and receive assurances that Governments are working for the earliest effective elimination of chemical and bacteriological (biological) weapons."
>
> I have given the study prepared by the consultant experts my earnest consideration and I have decided to accept their unanimous report in its entirety, . . .

I simply say I wish to endorse that statement of the Secretary General. I think the elimination of the production, distribution, and stockpiling of this kind of weapon is our ultimate goal.

I thank the Senator from Mississippi for yielding.

Mr. STENNIS. Mr. President, I yield myself such time as I may take.

The Senator from Indiana has indicated that he may want some time.

Mr. HARTKE. Five minutes.

Mr. STENNIS. I yield the Senator from Indiana 5 minutes.

Mr. HARTKE. Mr. President, first, I should like to thank the committee for the action it has taken in concerning itself with the very important question of chemical and biological warfare, and also to express my special thanks to the distinguished Senator from New Hampshire (Mr. McINTYRE) for the fine work he has done with regard to this rather complicated but at the same time very important legislation dealing with a matter of general concern not alone to the people of this country, but the whole world.

In the statement of the Senator from New Hampshire (Mr. McINTYRE), he also made mention of the fact that we are dealing with the shipment of such materials which are shipped by those other than the Defense Department itself. I think it is very important for us to recognize that the shipment of any type of material of this kind which is dangerous to the public generally should be dealt with; that it is not just the Pentagon itself which is the one unit which is shipping material which can be hazardous to the public health.

It is my intention to support legislation by the Senator from New Hampshire to prohibit the shipment of such materials by other agencies, including private corporations, because we know that a large number of potentially dangerous biological agents which are shipped through the country generally are not under any real control. It has been a matter of great concern to me, and the committee has held hearings on surface transportation.

Also, the whole question of chemical and biological warfare is not a new issue in the Senate. Many of us can recall the intense publicity campaign waged by the Army Chemical Corps nearly 10 years ago—a campaign designed to inform the Congress as to the supposed economy and humanity of gas and germ warfare. At that time we were told that chemicals and biologicals were "Tomorrow's weapons," and that they would some day make it possible for Nations to wage a "war without death."

This publicity campaign succeeded in boosting the status of the chemical corps and our CBW budget increased threefold between 1961 and 1963.

Also, as our involvement in Vietnam deepened, R. & D. gradually gave way to manufacturing, stockpiling, and combat use. Procurement budgets, now shrouded in wartime secrecy, have grown to disturbing proportions. "Tomorrow's Weapons" are now costing us more than $1 million a day. Our CBW program—once an underfunded vision—has grown into an uncontrolled nightmare. "Tomorrow's Weapons" are with us today—but they have brought with them fear, suffering, and disaster. The use of tear gas in Vietnam to flush the enemy from cover, and the use of herbicides to destroy Vietnamese food supplies, is not the humane "war without death" that we were promised. The Utah sheep-kill episode and the nerve gas disposal issue have brought the dangers of CBW closer to home. Accidents in Okinawa and open air testing in Maryland have only served to intensify public fears about lethal gases and germs.

I recall one instance in which I was rather severely criticized for complaining about the utilization of this type of material; and the man in charge of the operation said, "Well, this is just killing without a 'bang.'" I think killing is effective whether with a "bang" or not.

Predictably, as CBW budgets have grown, the Army's craving for publicity has disappeared. Today, the issue of chemical and biological warfare is being raised primarily by civilian opponents rather than by Pentagon advocates.

The PRESIDING OFFICER. The time of the Senator has expired.

Mr. STENNIS. Mr. President, I yield the Senator 2 minutes.

Mr. HARTKE. I thank the Senator. The Senate action today has been prompted by a profound public concern—a concern that becomes harder to control the longer we delay. The American people are demanding the Congress take a hard look at our chemical and biological warfare program—a hard, critical look.

The amendment we are considering today is a modest step in the right direction. It puts mild restrictions on certain kinds of testing, limits the development of certain kinds of delivery systems, prohibits stockpiling of CB weapons overseas, and provides greater safety in transportation of lethal chemicals and biologicals. But most important, in my mind, it strips away some of the unnecessary secrecy which surrounds our CBW program. My own contributions to the amendment are embodied in the report requirement, the prohibition on "backdoor" financing, and the rail shipment notification restrictions. These provisions, providing the Congress with basic information on the scope and the purpose of our CBW program, will make the other restrictions easier to enforce, and will prevent ungrounded public fears from turning CBW into a dangerous and emotional issue.

Mr. President, the CBW issue need not grow into a symbolic attack on military spending, or a ritualistic defense of military preparedness. It can be judged on its own terms, thanks to the collective efforts of those who have brought this widely accepted amendment to the floor. This amendment provides the Senate with an opportunity to answer its own questions, to express its concern, and to respond to public demands, without impairing our military capabilities or compromising our Nation's security.

I thank the Senator from Mississippi for yielding me this time.

Mr. McINTYRE. Mr. President, will the Senator from Mississippi yield me 2 minutes to respond?

Mr. STENNIS. Yes. Mr. President, I yield the Senator from New Hampshire 2 minutes.

Mr. McINTYRE. Mr. President, I commend the Senator from Indiana wholeheartedly for his interest in this field, particularly in this year of 1969, and I commend, too, the fact that his staff, working together with my staff and Pentagon personnel, have done a lot of hard work. There was much give and take in working out these compromises. The Senator and his staff have displayed great merit, and deserve our commendation.

The Senator made mention, in his remarks, about shipments of biological agents throughout the United States, not by the Department of Defense but by others. The Senator may be aware of what I am about to say. I think he has made reference to the fact that his committee has oversight of the matter.

Mr. HARTKE. That is correct.

Mr. McINTYRE. The American Type Culture Collection, which is a private group in Washington, D.C., made shipments of nearly 20,000 different cultures of bacteria and viruses, many of them deadly, in 1967 and again in 1968.

During these same years Fort Detrick made shipments totally about 400—about 200 a year.

Figures are not readily available for the shipments of these bacteria and viruses by the communicable disease lab with headquarters in Atlanta, Ga., but I understand that there is a heavy movement of these agents by the laboratories.

Mr. HARTKE. I thank the Senator from New Hampshire for this information. We will certainly bring it up in committee, and I think we can come forward with some legislation this year which will be effective in making it possible for us to provide greater protection for the people generally in transporting these agents, which are potentially so dangerous and so deadly.

Mr. McINTYRE. I think that will be fine, because I think the whole group of amendments sponsored by the Senator from Indiana, the Senator from Wisconsin, the Senator from New York, the Senator from Texas, the Senator from Rhode Island, and others, have demonstrated that Congress feels the need for more control over shipments of these deadly germs and deadly gases, and not only for more control, but for more knowledge about them.

I thank the Senator.

Mr. STENNIS. Mr. President, I yield myself 2 minutes.

As chairman of the committee, I highly congratulate the Senator from New Hampshire (Mr. McINTYRE) for the splendid work he has done on this subject during our hearings. I also commend him and the authors of the various amendments for the work that they have done in this highly important field, which has developed to the point where it needs such regulation as is reflected by these amendments. I believe the Senators and the staffs have done a splendid job; and in fact I support the amendments. We have not had a chance to have a committee meeting, and I cannot speak for the committee, but I have discussed the matter with the Senator from Maine (Mrs. SMITH), and I am sure she will have a word to say in their support.

I point out that the committee took out the $16 million for research and development of lethal offensive chemical and biological items. This is follow-on to the work of the McIntyre subcommittee, with the other Senators who authored these amendments. I believe they have done a splendid job.

I discussed this matter on the telephone Saturday morning with Secretary Laird, and he thinks some regulation is desirable.

The PRESIDING OFFICER. The Senator's time has expired.

Mr. STENNIS. I yield myself 1 additional minute.

He expressed concern about the situation, and an inclination to support the amendment; and later, at a press conference, he did express support for it.

So I commend it to the Senate. As I say, I think the Senator from Maine will have a few words in its favor also. I thank the Senator from Wisconsin, for the committee, for his very generous words with respect to our efforts on this bill.

Mr. McINTYRE. Mr. President, will the Senator yield?

Mr. STENNIS. I yield to the Senator from New Hampshire.

Mr. McINTYRE. I ask for the yeas and nays.

The yeas and nays were ordered.

Mr. STENNIS. Mr. President, if I have any time left, I yield to the Senator from Arizona.

Mr. GOLDWATER. Mr. President, I merely wish to say that I believe the chairman has made a very wise move in accepting this amendment. While, as he said, I cannot speak for the whole committee, I want him to know that at least he has the backing of the junior Senator from Arizona.

We did a good bit of work on this subject in committee. It is a very touchy, very sensitive field, that all of us believe should have regulation, or more regulation, and I am very happy that the distinguished Senator from New Hampshire was able to work out the compromise that he did, with the large number of amendments with which he had to work. He has done an oustanding job all through the writing of this bill and its defense on the floor. So, Mr. President, I am glad that the chairman has indicated the position which he has with respect to the action which is about to be taken.

Mr. STENNIS. Mr. President, I thank the Senator very much.

The PRESIDING OFFICER. Who yields time?

Mr. DIRKSEN. Mr. President, I yield 1 minute to the Senator from Maine.

Mrs. SMITH. Mr. President, I join the very able chairman of the Committee on Armed Services, and concur with what he has said with respect to this amendment. I also commend the several sponsors of the various amendments for getting together and bringing in what seems to me to be an excellent compromise, and I am glad to support it.

Mr. DIRKSEN. I yield 1 minute to the Senator from California.

Mr. MURPHY. Mr. President, I associate myself with the remarks made by the ranking minority member of the Committee on Armed Services, and by the chairman of the committee, and say that I should like to join in congratulating the Senators who have agreed upon this amendment. I think it is most helpful, most progressive, and certainly would help bring back the control to Congress, where it should be.

Mr. DIRKSEN. Mr. President, I yield myself such time as I may require.

Hideous as the words "chemical and biological warfare" seem to be to the sensitivities of people, yet there are other countries which have had and do have capabilities in the field. I recall very vividly, for example, lying in a ditch with a gas mask over my nose when the first burst of chlorine came over from the enemy in World War I; and I remember when I was a horse officer, how badly those artillery horses were galled and beaten by mustard gas.

That was one time when it was used. The Italians used it in Ethiopia, and the Egyptians used in it Yemen; and we know, from the Penkovsky papers, that there is a capability on the part of the Soviet Union, because he wrote, among other things:

> Many places in the country have experimental centers for testing various chemical and bacteriological devices.

He amplifies that, of course. So there is a capability in this field; and it occurs to me that we have to have some kind of a retaliatory facility for the very purpose of deterring others from ever using it.

So I fully concur in what has been fashioned here by way of a modified amendment.

Mr. President, we have heard many voices recently questioning the need for chemical warfare and biological research programs as a part of this country's defense. I would like to go on record in support of these two programs and at the same time I encourage the increasing interest of the Members of this body in the why and wherefore of these programs.

First, we should recognize that the President recently directed the executive branch to undertake a detailed review of our policies and posture in chemical and biological warfare, including the U.S. position on arms control and the ratification of the 1925 Geneva Protocol.

Second, I remind my colleagues that the Defense Department has consistently followed congressional advice in their chemical and biological defense activities, and I do not believe they have attempted to hide these activities, some of which are necessarily classified, from congressional inquiries made by the committees directly concerned.

A congressional committee in 1959 made several recommendations pertinent to our considerations today. One of the recommendations stated it is recognized that in the present world situation, with other countries pursuing vigorous programs of chemical and biological development, the best immediate guarantee the United States can possess to insure that chemical and biological warfare is not used anywhere against the free world is to have a strong capability in this field, and this will only come with a stronger program of research. Another recommendation was that if chemical and biological weapons are to be considered a deterrent force in the U.S. arsenal of weapons, the program of research advocated here will have to be accompanied by an adequate program of manufacture and deployment of chemical and biological munitions.

The first recommendation alluded to the threat as it existed in 1959. Has there been any reduction in the threat since then? We do not believe so. In 1967, the then Deputy Secretary of Defense testified on chemical and biological warfare before the Senate Subcommittee on Disarmament, saying:

> At long as other nations, such as the Soviet Union, maintain large programs, we believe we must maintain our defensive and retaliatory capability.

I am informed that the Soviets conduct chemical research that is related to offensive and defensive chemical warfare and that they have means which are suitable to deliver them. Col. Oleg Penkovsky, the former Soviet intelligence agent, wrote in his "Penkovsky Papers" about the chemical and biological programs of the U.S.S.R.:

> Many places in the country have experimental centers for testing various chemical and bacteriological devices.

He further wrote:

> Soviet artillery units all are regularly equipped with chemical-warfare shells. They are at the gun sites, and our artillery is routinely trained in their use. And let there be no doubt: if hostilities should erupt, the Soviet Army would use chemical weapons against its opponents. The political decision has been made, and our strategic military planners have developed a doctrine which permits the commander in the field to decide whether to use chemical weapons, and when and where.

The U.S.S.R. has a capability in biological warfare; they have the technological capability to produce, store, and deliver biological warfare agents.

On the defensive side, the Soviets are believed to possess a chemical defensive capability in terms of equipment and training, superior to those of the Western powers. Training in the use of defensive equipment, reconnaissance measures, and means for survival are taught and practiced until individual and unit proficiency are attained.

You may raise the question why we need such a program. I believe I have just covered the major reason—the potential threat posed to the United States and her Allies. We must have a program to deter enemy use of chemical weapons by being able to retailate in kind. To place this statement in proper perspective, let us review some history. There are three major occasions when chemicals were used—World War I, first used by the Germans; in the 1930's when the Italians used chemicals in Ethiopia; and more recently in 1967 when the Egyptians used chemicals in Yemen. We should note that the Italians and Egyptians had been signators to the Geneva Protocol of 1925 and yet subsequently initiated the use of these weapons.

On these occasions, the other side did not have a deterrent capability and did not have a chemical weapon to use. Neither did they have a defensive or protective capability.

However, during World War II with many nations having a capability, chemicals were not used. Many experts believe that the U.S. policy that it would not use chemical weapons unless another nation used them first, and having backed this up with a retaliatory capability, was the major deterrent to the use of chemicals during World War II.

Some might say we do not need these weapons today as deterrents when we have nuclear weapons in our stockpile. Personally, I do not want to have to rely on nuclear weapons as a deterrent in this area because it may engage the United States in a much larger exchange. Further, if a nation were to use chemical weapons or biological weapons against the United States or its Allies, and the United States had no chemical or biological capability, it would force us to respond with nuclear weapons or accept the alternative of possible defeat.

Thus, the United States has maintained a limited chemical and biological offensive and defensive capability primarily as a deterrent and because we cannot permit ourselves to be technologically and militarily surprised by the advances other nations are bound to make. We cannot by legislation or wishful thinking stop the progress of science. Any action which we take to deprive our Nation of this capability without insuring effective and well policed international arms control constitutes unilateral disarmament, and I for one do not believe this to be prudent.

As we all know, the United States is committed to exploring any proposals or ideas that could contribute to effective arms control.

For example we recently participated in a United Nations study of chemical and biological warfare to be used by the 18 Nation Disarmament Committee to explore means of getting an effective disarmament agreement on chemical and biological weapons. However, until we achieve effective agreements with the required controls to eliminate all stockpiles of these weapons, we should maintain a chemical and biological program strong enough to be credible and strong enough to deter any aggressor from using these weapons.

Mr. President, how much time do I have remaining?

The PRESIDING OFFICER. The Senator has 9½ minutes remaining.

Mr. DIRKSEN. I yield 3 minutes to the Senator from Utah.

Mr. MOSS. Mr. President, because of the widely publicized sheep incident last year in Utah and more recently, because of my successful fight to keep the Army from shipping obsolete nerve gas weapons from the Denver Rocky Mountain Arsenal to Utah, I am very familiar with the CBW controversy.

The amendment being proposed today is basically in accord with my own position on CBW. I do, however, have several questions about the specific language of the amendment and then some observations on the CBW problem generally.

I ask the Senator from Wisconsin, first, whether the language in section (b) which forbids the procurement of delivery systems specifically designed to disseminate lethal chemical and biological agents include devices that are being used in the present testing of CBW, such as the artillery shells that are now being used?

Mr. NELSON. Mr. President, I suggest that the Senator direct that question to the subcommittee chairman.

Mr. McINTYRE. Mr. President, it does go to prohibit any dissemination or distribution weapons that are specifically designed for this purpose. Of course, it would not include the 155 mm. howitzer. That is a weapon we could use to dispense the material, if the time ever comes, God forbid, but it is not specifically designed for that purpose. This section refers exclusively to disseminating systems specifically designed to dispense CBW agents.

We had to yield to the Defense Department on this point because the original language was so broad it could have been armor, weaponry, and things we purchase as part of our equipment to deliver normal military high explosives.

Mr. MOSS. Mr. President, I think that the suggestion is still much too restrictive. However, that is something that we would have to deal with later.

Second, I might suggest that the language in section d(1) and (2) which restricts the transportation of lethal chemical and biological agents be tightened to avoid a possible loophole. Instead of applying these restrictions just to shipments to or from military installations, I would broaden the language to include any shipments anywhere within the United States, its territories, or possessions. This could be done by simply dropping the words "to or from any military installations" in sections d(1) and (2).

Mr. McINTYRE. Mr. President, the group working on the proposal felt that if it was too restrictive, we might become involved in the interplay between the military.

What we did do was to try to restrict it to moving and disposal.

Mr. MOSS. Mr. President, this would merely say to or from military installations. If it was not going to or from military installations, it would be included. I think this ought to be tightened up at this time.

Mr. McINTYRE. The Senator might have a point.

Mr. MOSS. A final point, Mr. President. Too much of the public discussion about CBW has become emotional and speculative primarily because of the Army's obsession with secrecy. Rightly or wrongly, and I think rightly, the Government's credibility concerning CBW is highly suspect. Even after the Dugway incident it was some time before the Army would admit that they were testing nerve gas agents let alone responsible for the death of the sheep.

To give the American people good reason to believe what the Government tells them and to provide the public with much-needed information, I suggest that the Surgeon General appoint a committee of three State public health officials and three nonmilitary experts to assist him in making the determination as to whether CBW testing is a hazard to public health. This determination should be made in a public report and should include as much information as possible. In my opinion much of the information now classified need not be and would help in creating a better public understanding of CBW.

Mr. DIRKSEN. Mr. President, I yield 3 minutes to the Senator from South Carolina.

The PRESIDING OFFICER. The Senator from South Carolina is recognized for 3 minutes.

Mr. THURMOND. Mr. President, the management and control of our chemical and biological warfare research programs has become an emotional issue in recent months, due to an unfortunate incident in Utah.

Certainly, this is an area in which the greater care must be taken as these chemical agents and disease producing biological micro-organisms and biological toxins are deadly. Tighter controls may well be in order, judging from the accident in Utah.

While some restrictions would be useful, the McIntyre amendment is broad in its coverage, especially in that it prohibits funds to procure delivery systems or any components of delivery systems for chemical and biological agents.

Such a restriction may be harmless at this point, as the military does not desire any funds in the current bill for offensive delivery systems. However, if this restriction is passed, it becomes law. It would, therefore, tie the hands of those charged with our defense if, in the future, more sophisticated means of delivery for these agents are needed to maintain our defense posture.

Presently, we use standard shells and bombs to deliver these agents but this requirement could change and valuable time could be lost in removing this restriction to allow the Defense Department to meet the needs of an emergency.

Mr. President, the history of the use of these agents shows they have only been used a few times in modern history and in each instance their use was made when the user knew his opponent did not have the means to retaliate.

Mr. President, I ask unanimous consent that Secretary Laird's statement be printed in the RECORD at this point.

There being no objection, the statement was ordered to be printed in the RECORD, as follows:

MEMORANDUM FOR CORRESPONDENTS,
AUGUST 9, 1969

(Secretary of Defense Melvin R. Laird today issued the following statement in response to queries about the DOD position on the pending McIntyre amendment.)

On assuming the office of Secretary of Defense in January, I became concerned with the management and control of our chemical warfare and biological research programs. I felt that improvements were needed in the management and control of these programs. That is why in April I requested and the President ordered a National Security Council study of these matters. This study is in progress.

Pending the completion of the NSC study, I believe it is prudent that we act jointly with Congress and take actions, wherever possible, to improve the management and control of chemical warfare and biological research programs.

Members of my staff, principally Dr. John S. Foster, Jr., Director of Research and Engineering, have been working in recent days with Senator Thomas J. McIntyre of New Hampshire, and with other members of the Senate Armed Services Committee, on a revised amendment to the pending Defense Authorization Bill.

I am in agreement with the goals of the new amendment, which the Senate is scheduled to consider on Monday.

I believe this revised amendment will allow us to maintain our chemical warfare deterrent and our biological research program both of which are essential to national security.

The history of the use of lethal chemical warfare agents has demonstrated on three notable occasions in this century that the only time military forces have used these weapons is when the opposing forces had no immediate capability to deter or to retaliate. This was true early in World War I, later in Ethiopia and more recently in Yemen. Clearly, failure to maintain an effective chemical warfare deterrent would endanger national security.

Because it would not always be possible to determine the origin of attack by biological agents, the deterrent aspects of biological research are not as sharply defined. A continued biological research program, however, is vital on two other major counts.

First, we must strengthen our protective capabilities in such areas as vaccines and therapy.

Second, we must minimize the dangers of technological surprise.

It is important that the American people be informed of why we must continue to maintain our chemical deterrent, conduct biological research, and how we propose to improve the management and control of these programs.

Mr. THURMOND. Mr. President, in view of this, I support this amendment but with some reservation, and mainly in the trust that the military will act promptly and the Congress will respond realistically if they see any indication a change in this policy is required.

Mr. DIRKSEN. Mr. President, I yield 1 minute to the Senator from New York.

The PRESIDING OFFICER (Mr. GOODELL in the chair). The Senator from New York is recognized for 1 minute.

Mr. GOODELL. Mr. President, the high degree of amiability and unanimity on this omnibus amendment at this point belies the difficulty that many have had in pushing this matter forward so that we could have reasonable regulation of chemical and biological weapons.

The amendment does not meet head on the critical issue involved that I hope the McIntyre subcommittee will face in the year ahead. That is whether our country should continue to produce and stockpile chemical and biological weapons and the means of delivering them as a deterrent, and whether we must have a better deterrent in every area of every kind of weapon if we are to preserve our national security.

I trust that the Senator from New Hampshire will explore this question in depth so that we may have a decision on the matter in the year ahead.

Mr. YOUNG of Ohio. Mr. President, approximately $350 million of taxpayers' money has been spent annually for chemical and biological warfare agents. For many years the Department of Defense has purchased and stockpiled enormous amounts of toxic and infectious chemical and biological agents.

In fact, we are in the process of trying to get rid of 27,000 tons of such chemical weapons now obsolete, yet too dangerous to remain stockpiled. During the past 16 years nearly 1,500,000 nerve gas bombs containing a total of 4 million pounds of such gas have been produced. Another 1,350,000 pounds of the same deadly gas is contained in our M55 rockets. Our chemical and biological warfare arsenal now includes numerous and varied agents for the spread of wholesale disease, starvation, choking or suffocating of entire populations, and other such deadly effects.

For the first time in many years, possibly since the days of World War I, Americans are becoming uneasy and concerned about the most grisly weapons in contemporary arsenals—the weapons of chemical and biological warfare. It is a subject that cries out for sober discussion.

The production of these weapons has been shrouded in secrecy. Even we in the Congress know very little about what is occurring in experimentation, development, stockpiling, and disposal of these weapons. Most Senators and Representatives were shocked at the recent disclosure that 28 persons were injured in a nerve gas accident in Okinawa, and of the fact that the Pentagon has stored nerve gases and other chemical-biological warfare weapons in bases throughout the world. That time we were lucky that a more serious catastrophe did not occur that could have taken the lives of millions of men, women and children. The extent to which the Congress has been uninformed on this vital issue was best emphasized by a recent statement of the distinguished senior Senator from Louisiana (Mr. ELLENDER), the ranking majority member of the Committee on Appropriations, who said:

> As far as the Continental U.S. is concerned, evidence has recently been brought out that tremendous stockpiles of various deadly compounds are on hand at centers throughout the country. Most of this work has been done without the knowledge of the Congress. During my twenty years service on the subcommittee of the Appropriations Committee for Defense, I never have come across any line item for the production of nerve gas.

This, despite the fact that almost $1 million a day is being spent by the Pentagon on chemical-biological warfare weapons.

Since 1964 it has not even been possible to determine how much money the Government is spending on these weapons. Estimates vary from $350 million to $500 million per year. In the arsenal of the Pentagon and of those in at least 13 other nations are chemical poisons so toxic that one-fiftieth of a drop can be lethal in minutes. Senators will recall the death in 1968 of 6,400 sheep from nerve gas in the Dugway Proving Ground in Utah.

It is horrible to contemplate, but it is a fact that today the Soviet Union and United States possess enough of these chemicals and biological agents to destroy every man, woman, and child on earth.

It is clear that the time has come for a full-scale congressional investigation of our chemical and biological warfare potential. The fact that we have nerve gases in bases around the world raises grave moral and public policy questions.

At least some of the secrecy ought to be ripped away. No one reasonably would ask that Pentagon officials make full disclosure of every last detail of research, development, production, and storage of its chemical and biological warfare agents. At the same time, a thorough ventilation of the nature of these frightful weapons might well lead to stronger treaties against their production and use.

Congress must act now to fulfill its responsibility in a program that has escaped careful congressional scrutiny for too many years.

Unfortunately, some of these weapons are presently being used in Vietnam. The use of chemical defoliants in Vietnam has been increasingly questioned by those concerned over the longrun environmental dangers. Also, there is evidence that the so-called riot control gases used in Vietnam can be fatal to the weak, sick, and undernourished civilians exposed to them.

On July 2, 1969, U.N. Secretary-General U Thant released an excellent report on chemical and biological warfare in which he strongly urged that all nations ratify the Geneva Protocol of 1925 banning first use of chemical and biological warfare. He also called for all nations to reach agreement to halt the development, production, and stockpiling of all chemical and biological warfare agents and to eliminate them from the arsenal of weapons.

U Thant's report makes it clear that the testing and use of biological warfare agents pose health hazards to everyone—that the deadly diseases that have been stockpiled for use as weapons are just as dangerous to the producer and potential user as they are to the recipient. The report emphasizes the need to promptly reach agreement on a ban on the production, stockpiling, and use of biological weapons. A proposal that would accomplish this is now before the 25-Nation Disarmament Conference which is meeting in Geneva. I am hopeful that the administration will do all it can to see that this resolution is adopted.

Mr. President, today a comparatively few nations possess these lethal weapons. However, any nation, large or small, can develop contagious bacteria and viruses. If and when they do, the danger of an accident or purposeful use becomes greater. The very survival of man is at stake. The development and stockpiling of these horrible chemicals and germs is a pursuit after armaments far in excess of those needed for our national security and national defense.

I am utterly opposed to any further development and stockpiling of such devices. I urge the adoption of the pending amendment to establish effective guidelines and controls over the storage, transportation, disposal, and maintenance of chemical and biological agents. Also, to ban future open-air testing of lethal chemical agents, disease producing biological micro-organisms or poisons except on determination of the Secretary of Defense that such tests are necessary for the national security and only then after the Surgeon General has determined that the proposed tests will not present hazards to public health. The provisions of the pending amendment form an important first step toward stemming and controlling the proliferation of these deadly weapons.

Mr. PELL. Mr. President, I was delighted to read in the newspapers this weekend that the Secretary of Defense, Hon. Melvin Laird, approves of the amendments that we have before us to control the chemical and biological weapons program.

I interpret Secretary Laird's approval of my amendment regarding international law to mean that the Secretary of Defense recognizes a responsibility of the Department of State for interpreting our international obligations, and I assume that the Secretary of Defense will provide for proper consultation with the Department of State regarding the international legal implications of the movement of chemical and biological materials outside of the United States in the future.

Although I am happy that the chairman of the Armed Services Committee and the Department of Defense has approved the amendments which we have before us, I hope this does not mean there will not be further debate on the foreign policy questions involved in the chemical and biological warfare question. I believe that the Senate should discuss the role that the Department of Defense expects CBW to play in the world arms race, and I would hope that we would discuss the implications of Secretary Laird's recent statement implying the chemical and biological weapons are strategic weapons which might be used in a second strike capacity.

Mr. TOWER. Mr. President, I would like to express my understanding of the intent and effect of this amendment. This amendment is not intended to prevent the Department of Defense from undertaking biological and chemical research programs. Those programs have been presented and justified to the Congress as required in the interest of national defense. The amendment recognizes, however, that the public and members of the Congress are concerned that the program be undertaken under conditions of maximum safety and that the Congress be fully aware of the actions that are taken. For this reason, the amendment, while not restricting the types of activities that the Department of Defense may undertake in pursuing the program it has presented and justified to us, imposes certain reporting and coordinating requirements. Some of these requirements may prove burdensome and time-consuming. Perhaps with experience we will later decide to remove some of them. However, despite the burdens the amendment imposes, the Department of Defense has recognized the concern of the public and members of the Congress in matters concerning chemical warfare and biological research programs, and has therefore indicated it will not oppose enactment of the amendment.

As I understand this amendment, it in no way represents a criticism of the CBW program or of the military officials who have administered it. It simply expresses the desire of the Senate to have Congress better informed on the program and indicates the Senate's rightful concern that testing, transportation, disposal and storage of chemical and biological warfare elements be done as safely as possible. With this understanding, I support the amendment.

Mr. MUSKIE. Mr. President, for more than 50 years poison gas has been an instrument of warfare, and for all that time Americans have been repulsed by the thought of poison gas being used to kill and maim people.

As a nation, America traditionally has viewed the case of poisonous gases as inhumane. We have sought to make gas an illegal weapon of war, and in two world wars we declined to use it to kill our enemies.

Despite our public stance, American military contracts have continued to be let and military personnel have been assigned to the task of researching, developing, manufacturing, and storing poison gas and biological agents.

Until a year ago, gas and germ warfare seemed a subject for science fiction. Members of Congress were vaguely aware of the research and development programs, but regarded them as contingency operations, first, to deter other nations from using such weapons first; and second, to aid in research on countermeasures. The first major rumbling of complaint came with the use of tear gas, defoliants, and napalm in Vietnam. More vigorous complaints erupted with news of dangers from testing and disposal of chemical and biological materials and weapons in the United States.

The first major incident came last year when more than 6,000 sheep died in Utah, near the Dugway Proving Ground, where chemical and biological warfare materials were tested. The sheep fall victims to a nerve gas released by a plane. For a long time military secrecy cloaked the cause of the deaths. Now, thanks in large part to the work of Representative RICHARD D. MCCARTHY, Democrat, of New York, the facts about that incident and other threats from our chemical and biological warfare program are being given to the Congress and to the public.

The second major incident—or near incident—was the Army's plan to transport 27,000 tons of poison gas containers by rail from Colorado to the east coast where it would be loaded on barges and dumped in the ocean. That plan has been shelved, temporarily, but additional opposition to the chemical and biological warfare program has been stirred up by the fact that the Army was prepared to ship such dangerous materials across the country through large cities without major precautions against accidental discharge of the gases and without serious attention to the environmental hazards posed by ocean disposal.

In retrospect, the Dugway Proving Ground accident and the ocean dumping proposal may have been blessings in disguise. They have alerted the country to a clear and present danger from chemical and biological warfare operations, in peace and in war.

Materials containing anthrax, tularemia and Q fever germs, nerve gas, and other toxic materials are not minor weapons, and secrecy about their development and use does not guarantee safety.

Americans have a right to expect their Government to use great caution in approaching such an awesome set of weapons. They have a right to expect their Government to use more than ordinary care in handling such weapons. They have a right to expect their Government to develop considerable energy to eliminating the danger of such weapons being used in time of war.

The packet of amendments we are considering now will enable us to meet their responsibility.

The PRESIDING OFFICER. All time having expired, the question is on agreeing to the modified amendment (No. 131) of the Senator from New Hampshire. On this question, the yeas and nays have been ordered, and the clerk will call the roll.

The assistant legislative clerk called the roll.

Mr. KENNEDY. I announce that the Senator from Tennessee (Mr. GORE) is absent on official business.

I also announce that the Senator from Indiana (Mr. BAYH), the Senator from Nevada (Mr. BIBLE), the Senator from Connecticut (Mr. DODD), the Senator from New Mexico (Mr. MONTOYA), the Senator from Georgia (Mr. RUSSELL), and the Senator from Texas (Mr. YARBOROUGH) are necessarily absent.

I further announce that, if present and voting, the Senator from Indiana (Mr. BAYH), the Senator from Tennessee (Mr. GORE), the Senator from New Mexico (Mr. MONTOYA), the Senator from Texas (Mr. YARBOROUGH), and the Senator from Connecticut (Mr. DODD) would each vote "yea."

Mr. SCOTT. I announce that the Senator from Michigan (Mr. GRIFFIN) is detained on official business, and, if present and voting, would vote "yea."

The Senator from Ohio (Mr. SAXBE) is necessarily absent; and if present and voting, would vote "yea."

The result was announced—yeas 91, nays 0, as follows:

[No. 74 Leg.]

YEAS—91

Aiken	Goodell	Mundt
Allen	Gravel	Murphy
Allott	Gurney	Muskie
Anderson	Hansen	Nelson
Baker	Harris	Packwood
Bellmon	Hart	Pastore
Bennett	Hartke	Pearson
Boggs	Hatfield	Pell
Brooke	Holland	Percy
Burdick	Hollings	Prouty
Byrd, Va.	Hruska	Proxmire
Byrd, W. Va.	Hughes	Randolph
Cannon	Inouye	Ribicoff
Case	Jackson	Schweiker
Church	Javits	Scott
Cook	Jordan, N.C.	Smith
Cooper	Jordan, Idaho	Sparkman
Cotton	Kennedy	Spong
Cranston	Long	Stennis
Curtis	Magnuson	Stevens
Dirksen	Mansfield	Symington
Dole	Mathias	Talmadge
Dominick	McCarthy	Thurmond
Eagleton	McClellan	Tower
Eastland	McGee	Tydings
Ellender	McGovern	Williams, N.J.
Ervin	McIntyre	Williams, Del.
Fannin	Metcalf	Young, N. Dak.
Fong	Miller	Young, Ohio
Fulbright	Mondale	
Goldwater	Moss	

NOT VOTING—9

Bayh	Gore	Russell
Bible	Griffin	Saxbe
Dodd	Montoya	Yarborough

So Mr. McINTYRE's amendment (No. 131), as modified, was agreed to.

Mr. McINTYRE. Mr. President, I move to reconsider the vote by which the amendment was agreed to.

Mr. NELSON. I move to lay that motion on the table.

The motion to lay on the table was agreed to.

Mr. STENNIS addressed the Chair.

The PRESIDING OFFICER. The Senator from Mississippi is recognized.

Mr. STENNIS. Mr. President, I wish to make a very brief overall statement about the bill and consideration of additional amendments thereto.

Mr. SYMINGTON. Mr. President, may we have order?

The PRESIDING OFFICER. The Senate will be in order.

Mr. STENNIS. Mr. President, what I will say is nothing new, but I am saying it in an effort to promote our debate in such a way that the issues will be understood by Members of the Senate.

As an illustration, last Friday we had about 3½ hours of debate on an amendment by the device of continuous yielding by the author. This is a practice we have fallen into. I do not blame anyone; no one was out of order; and I do not make these remarks critically. However, the committee had no chance in all that time to present our views and the situations as we saw it with reference to that amendment. That is only an illustration.

I hope we can work out something to avoid such a situation in the future. The committee chairman has no control, except as he may confer and reach understandings with Senators with respect to which amendment is called up and when it shall come up.

The main point I wish to talk about now is that this bill represents a balanced program.

Mr. President, will the Chair enforce the rule so that we may have order?

The PRESIDING OFFICER. The Senate will be in order.

Mr. STENNIS. We have offensive nuclear weapons, and we have provided for a defensive system against the offensive nuclear weapons arrayed against us. We know that we are not going to make a first strike. There is nothing like that in the minds of the people, Congress, or the President. We know that we are not going to start a nuclear war. I do not know, but with the high development of these weapons I doubt that Russia would intentionally start a nuclear war. Perhaps the time when that was probable is behind us. However, no one really knows. So we must be prepared in that field. I do not believe we should say that we will not start one under any circumstances. I said that years ago. I mention these matters to get down to the real issue; namely, the need for conventional forces.

At one time, we were getting away from that. We went into the nuclear field and neglected modernization of the Army. We neglected a great many other things because we put most of our money into nuclear weapons.

Certainly we are not about to reach a millennium, when everyone will be at peace, and the lion and the lamb will lie down together, when there will be no more boundary disputes and no more aggression against one nation by another. We do not believe that that millennium has arrived. We know that we must have sufficient military strength to protect our people, and I am talking about 200 million citizens here at home. We know that we must protect them with sufficient conventional weapons. We know that it must be our policy to protect those 200 million Americans. We have assumed many commitments around the world and may be forced to go beyond our boundaries and protect the perimeter.

We may want to reduce these commitments, but no one is offering a resolution to do so. No Senator has proposed a plan to change the situation. No committee of Congress is hearing any testimony on the subject. There is no report or statement of opinion of a committee that is weighted in favor of any change.

We have not had any requests from a President to that effect—from President Nixon or any prior President.

Thus, our policy still is that we can best protect ourselves by providing some defense of the outer perimeter. That is what a great deal of the hardware in the bill is for.

Some Senators may think the bills should be changed right here on the floor of the Senate, piece by piece, so as to take out the tanks, take out the carriers, take out this, or take out that. I do not believe that is the way to proceed. When the will of the majority is felt, we will find out for sure.

I favored paring some items in the bill, as I said in my opening talk, but we had better know what we are doing and have a committee consider the matter from all angles and submit a report on a bill. This is what the Armed Services Committee did.

At the same time, I should also like to know what the President thinks about it.

This policy should be enunciated clearly; then we can implement it. Let us not place the cart before the horse.

We all remember that following World War II we decided that Japan should have no weapons, except to a very limited degree. We said to Japan, "We will take care of you."

I think we overdid it. We should modify that.

But can we do that? Can we take pieces out of the military bill on the floor of the Senate, until the President, the committees and others have spoken or enunciated some kind of policy?

Look at our obligations around the world. Take Korea. We must not tear down everything we have built up there. We guaranteed Korea's integrity when no other nation joined with us. It was just the United States of America and Korea. We guaranteed Korea's protection. That requires credible military forces and military deterrence. It does not take a wise man to see that.

We all remember Formosa. We all remember Vietnam, where we are now. The Lord only knows how or when we can get out of there. We are members of SEATO and NATO. All these obligations prove conclusively that we need balanced conventional forces, and that we must have them. I want to have them with the smallest number of dollars.

Let me mention something else. One can go to a military service and sometimes get a large listing of the defects in the weapons of a rival military service. That is a part of the picture in the Pentagon. The Navy which believes in its weapons, and the Air Force also believes in its weapons—and I am glad they do. But sometimes, on the side, they are quick to point out defects, real or imaginary, in the weapons of the other service.

Let me give an illustration. I was once inside the matter of the Nike-Hercules ground-to-air defense missile.

I thought we were going too fast and too far, and before it had been perfected enough. The bill provided hundreds of millions of dollars.

I was handling the military construction bill. A general spoke on "Face the Nation" that Sunday afternoon. He was a very fine general. The question was put to him: If a city were properly defended with enough Nike-Hercules, and a hundred enemy bomber planes came in, how many could they knock out? He said, "A hundred out of a hundred."

The next morning I talked with an outstanding admiral of that day, one of the foremost we had. I said, "If a city had the required number of Nike-Hercules and a hundred enemy bombers were coming in to bomb the city, how many Nike-Hercules could they knock down out of that hundred?"

He said, "Not a darned one."

I think both of those gentlemen were wrong. But that general remark of the admiral, coming down the corridor of the building, having no appointment, led us to go further into the matter.

Mr. McNamara told me later that it would save some money. But my point is that we do not know enough about missiles. My point is that there is interservice rivalry, and that is seldom brought up in debate. I am not saying this critically of anyone. I know there is rivalry. Sometimes it is within a service.

All of us remember the old cavalry. The cavalry has gone. But weapons rivalry still exists within the services.

So we had better examine carefully some of the information we are getting—and getting in good faith—about these matters. My point is that the bill provides a balanced program, something that the Joint Chiefs have agreed to.

The Chairman of the Joint Chiefs is no ordinary man. Do not discount General Wheeler, unless you want to condemn all military men. If you do, let General Wheeler go on down the drain with the rest of them. But if you want impartiality, do not discount General Wheeler.

That is not all. We are looking for a balanced program in weaponry. This program is largely one like that approved by former Secretary McNamara. Whatever one may think about him, he had plenty of sense. I think he was one of the most effective Secretaries of Defense we have ever had. I do not think he was right on all things, but he worked, and he knew a lot about defense.

Former Secretary Clifford approved this program, although there were some differences in details.

We squeezed a great deal of water out. But Mr. Clifford is a man of high intelligence and considers things seriously.

Secretary Laird approved this budget just as recently as early March. Senators who do not know Secretary Laird have missed a gem. We who serve on the Committee on Appropriations have been confronting his fine mind and ability for years. I do not know of any Member of Congress who rendered finer service in this field than Representative Melvin Laird. He was usually a jump ahead of most of the rest of us. So the program provided by the bill is his best judgment. He believes the Nation needs this bill as a balanced program. I do not mean that every "i" must be dotted and every "t" crossed, of course, but as an overall proposition.

That is not all. President Nixon approved virtually all of this budget. Mr. Nixon is not a newcomer. He is not one who had been president of General Motors or president of a university or some other institution.

That man learned the hard way. I am not complimenting him. We all know his background and experience. I tell the Senate that when he came back here in 8 years I was amazed, from the word "go," at the fine knowledge he had of the present situation and the present need, here and there and everywhere, of the military program. I know, because I have talked with him over and over. He did not have anything to offer me. I did not have anything that I could give him, except just loyalty to the country. I am not espousing the Nixon program, or anything like that. I am talking about national defense now. But he grasped this problem. He had it in his mind. He was as well versed as anyone outside the military itself. Melvin Laird was there, and so were others. They made hard decisions. They may be planning more.

That is the case here. We are not living in a millennium—oh, not by a long shot. We are not out of Vietnam—not by a long shot. We will have to have the hardware, the weapons, the manpower, the know-how, the skills, and the judgment, if we are to continue as a leader of the free world.

I am no internationalist. I am no big spender, either. I am no big spender—my records shows it—for the military department.

When we talk about such terms as "military-industrial complex," and all that, that does not mean anything to me, and I do not think it means anything to anyone in the show down. I think it is a slander and a libel on a great military profession and the membership of the Senate for those things to be fed out and fed out on the Senate floor, through committee hearings, through television, through radio, everywhere, all the time, to create—and it does create—a prejudice. Whether that is the purpose or not—I will let every man's motives be decided by him or someone else, and not by me—but it is leading this country into what I consider a dangerous state of mind—mistrust, distrust, downgrading the military, and downgrading the Senators who have responsibility for our defense and who are falsely charged with being "dominated by the miliary."

Mr. ERVIN. Mr. President, will the Senator yield?

Mr. STENNIS. Please let me finish with just a few more words.

I give everyone credit for good faith, and I think everyone wants to do what he thinks then is best for the country. But I warn you, we can slip back mighty fast just because we are displeased with a few things. I am displeased with many things. We all wish we could stop the war in Vietnam, for one thing. I am displeased with some contracts for military supplies and material that have been entered into. Incidentally, those contracts came directly out of the brains of the civilian authorities in the Pentagon. We will get into that later.

But I told the military, "You do have some responsibility in the field of spending." When General Ryan, now the Chief of the Air Force, was before us for confirmation, I said, 'General it is not your primary responsibility, but in the nature of things, you do have responsibilities for the expenditures of this money. In part you are responsible in the military area, and I think you ought to train more and more men in the field of management and related fields, so that as you bring them through the categories of promotion, you will have more responsible men. I know you have some who are outstanding, but not enough." He agreed with me heartily. I am going to write the other Chiefs and make the same point. I think it is part of our duty. But if we scuttle this whole thing, if we cut the bone and the muscle here by making too many unwise reductions, acting in the dark, we will rue the day.

I favor reducing military manpower as soon as the shooting stops at least to the level it was before the war started. I am not settling on that as the final figure. But, by a quick calculation, in that category alone there is a minimum of $10 billion a year in savings. There are other savings we can make.

I want the military and the civilian part of the department to do a better job in getting a dollar's worth for every single dollar they spend. But I tell you, we will never do that by settling for second rate weapons. We will never do that by giving the doughboy we send to the front an old tank. We will never do that by sending our aviators, whether they be in the Navy, Air Force, or other service, in a plane not as good as the one he is up against. And so on down the line.

I speak with all deference to everyone, but I tell you, right now we are getting off into the wrong attitude. We are getting off into an attitude of knock down, drag out, regardless of consequences, that can leave this Nation—not immediately, but within a few years—unprepared to defend its own people.

Let us get a balanced program of weapons together. Let us reexamine our foreign policy, and if we want to change it, let competent Senators come in here with a definite resommendation on their resolution, on their report, on their testimony, and on the recommendation of the President of the United States. I will be found somewhere, perhaps not up front but somewhere up near the front, plugging in a proper way for some reasonable modification.

But there are points beside honor involved, in turning our backs upon our commitments. There is involved, for example, the safety and perhaps the survival of the American people.

So, Mr. President, while I welcome debate on any phase of this bill to any reasonable extent, I will approach it in the way that I have outlined; and frankly, I was talking more to the people of the United States than to anyone else in these last few minutes.

Several Senators addressed the Chair.

Mr. STENNIS. I believe the Senator from North Carolina had risen first, if he wishes me to yield.

Mr. ERVIN. Mr. President, I ask the Senator from Mississippi if he does not think that it is a fitting time for us to meditate seriously upon this little verse:

God and the soldier we adore
On the brink of ruin, not before;
When danger's past, and all things righted,
God is forgotten and the soldier slighted.

Mr. STENNIS. I thank the Senator.

Mr. FULBRIGHT. Mr. President, will the Senator yield?

Mr. STENNIS. I am happy to yield to the Senator from Arkansas.

Mr. FULBRIGHT. I certainly have great sympathy with the position of the Senator from Mississippi. He is, I think, one of the most conscientious and dedicated Members of this body, and not just in his position as chairman of the Committee on Armed Services. He has served with equal distinction as chairman of other committees, and has performed some very difficult functions.

I do not quarrel at all, certainly, with his motives or what he is saying. But I should like to comment in this sense: He says he is interested primarily in a balanced program. I take it he meant balanced within the Military Establishment. I think I, and those of my colleagues who share some of my views, are interested in a balanced program also, but we feel that the balance should be between the military program and the other programs of this Government.

Mr. STENNIS. If the Senator will excuse me a moment, I have an urgent matter.

Very well.

Mr. FULBRIGHT. As a result of a series of crises and wars, for which the Senator from Mississippi, of course, is not to blame, there has developed an imbalance, not within the military so much, but between the military and other programs of our Government. This entire debate is about how to correct that imbalance.

To ask the Senate to accept the proposals of the Pentagon without thorough debate and examination, it seems to me, to have the Senate simply to abdicate its real function. On many of these matters there have been hearings, as the Senator mentioned. There have been some extremely interesting hearings in the Committee on Foreign Relations, also, and in the Joint Economic Committee headed by the Senator from Wisconsin (Mr. PROXMIRE).

Some of the witnesses before that committee, such as Mr. Fitzgerald and others, are certainly qualified, and as good as we have in this Government. They are right out of the Pentagon itself. Some have suffered personally because of their daring to do their duty, in my opinion, as citizens.

The difference in view on this problem arises because I think that, as Senators, we should balance the military with other governmental programs. I submit that when you calculate the amount of money devoted to the military establishment since World War II—well over a $1,000 billion—against other activities important to the country, such as education and the development of our natural resources, I think our system of priorities is out of balance. That, as I said, is really what this debate is about.

The Senator has mentioned rivalry among the services. That is not news. We know about that, and I do not complain about it. But it is our duty to correct some of the results of such rivalry.

We have been told, and I think there is a degree of truth in it, that when we give, we will say, a big program, to the Army and the Air Force. About all that can be done to balance things out is give the Navy more aircraft carriers. That way they will receive about as much as the Air Force and the Army; and therefore, to retain a kind of balance. So we continue to build aircraft carriers when they are obsolete. No other country in the world builds them.

That in itself raises a serious question: Why, if aircraft carriers are really useful and not obsolete, is not Russia, or China, or Germany, or somebody, out trying to build aircraft carriers? It is rather odd that we should be the only ones to put so much faith in this kind of machine. Carriers are extraordinarily costly. The Senator from Missouri (Mr. SYMINGTON) is a better spokesman than I on this subject, but I recognize that, as a member of the Committee on Armed Services, he is a little bit embarrassed to take issue with his colleagues. I would be, too. I am always a little bit embarrassed to take issue with my colleagues on a committee, with whom I have shared many hearings; but the Senator from Missouri has said much about this subject on many occasions.

It is, I submit, the balance of all over national programs that should concern us. I do not for a moment suggest that the Senator from Mississippi is a spendthrift. We are not saying that he is extravagant at all.

Mr. STENNIS. Mr. President, if the Senator will yield to me, I do not have to wait until he or anyone else accuses me of something. I simply call attention to my record. I do not have to wait for the Senator or anyone else.

Mr. FULBRIGHT. Of course, I think there are some members of congressional committees who, in the past, have shown a disposition—and it is not the Senator from Mississippi to whom I refer—to urge upon the Pentagon increased appropriations, even over what was requested.

Coming to the question of the military-industrial complex, the Senator says it is a slander that anyone should mention it. I have mentioned it, but I certainly, in most of my formal speeches on the subject, have made it very clear that the people in the Pentagon, by and large, do not deserve that kind of criticism, nor that it should be regarded as a slander. I regard the criticism, if warranted anywhere, as warranted against Congress; and I should share in it, in that, for 25 years, I have never before seriously engaged in an effort to cut or change, in any substantial way, the budget requests of the military establishment; nor has anyone else to speak of.

This is simply the first effort to restore balance to the system. It is not a slander upon the military. Nobody is slandering the military. If there is any criticism at all, I think it is primarily due to Congress failure for too long to expose to debate and serious examination these programs.

I do not believe the Senator from Mississippi could say that we have really seriously examined these programs in the past. Not even the Bureau of the Budget has done so. I ask Mr. Schultze, who was then Director of the Budget, in open hearing, about the research programs in the Pentagon. He said frankly that they did not go into them; they just accepted the Pentagon's views.

We have on record a statement of Mr. McNamara that he made, I think before the Committee on Armed Services, that in not one instance while he was Secretary of Defense, where there was a difference of view between the Bureau of the Budget and the Pentagon, was the Pentagon ever overruled. He always prevailed.

This, again, is most unusual, and at least partly the fault of Congress, because nobody bothered to challenge it.

Therefore, I do not believe the Senator has a legitimate complaint about the way in which he or the Military Establishment has been treated. After all, they have $80 billion available in round figures. An to say that our Military Establishment is obsolete and that our servicemen do not have good rifles and good airplanes, is, it seems to me, a gross reflection upon the efficiency of American industry. The money has certainly been spent in large amounts for that purpose.

The Senator is saying that we have given the money but that we do not know how to produce a good airplane. It has not been for the lack of money that we do not have a good plane. If we do not have one. I have been under the impression that we do have good planes and good rifles. I have been under the impression that we do have good ships and other equipment. Never once have I shared the idea or said that our people are not properly equipped.

We have spent and are spending, as the Senator knows, from the best estimates of our intelligence community, substantially more than the Russians have spent. And they are the ones we seem to be so concerned about.

When the Senator says that we are cutting in the dark and slashing and cutting without knowing what we are doing, he is making a statement that I do not subscribe to.

I think we know a good deal about the normal programs. Many good hearings have been held. We have heard from knowledgeable people.

In addition, on occasions when we have requested information from the Defense Establishment, we have been met with the statement that it was classified or too sensitive. They would not furnish it.

So, to the degree that we are operating in the dark, I submit that it is not the fault of the Senate committees. It is the fault of the establishment itself in refusing to make available what I believe to be appropriate and relevant documents and information.

I do not really believe the Senator has a legitimate quarrel about the debate and about the proposals to try to bring about what I would call a better balance between the Military Establishment and the rest of the Government of the United States.

Mr. PROXMIRE. Mr. President, will the Senator yield briefly?

Mr. STENNIS. I will yield later. I believe the Senator from California had requested that I yield to him. I yield to the Senator from California.

The PRESIDING OFFICER. The Senator from California is recognized.

Mr. MURPHY. Mr. President, relative to the Armed Services Committee, I must say that my experience this year has been a great revelation. I suggest that the matter of balance of expenditures certainly must have been because of the necessity created by world conditions.

If we did not have some of the world problems that exist today, we would not have the problem of making high expenditures in order to achieve the balance that the distinguished chairman of the Armed Services Committee has spoken of.

I think probably that, looking at the past and finding where the fault lies, certainly when we have called on the military, wherever they have been permitted to do so, they have done their job very well insofar as I recall history back beginning with World War I.

However, very often where we have looked at the action of the Political Establishment in international affairs and their record, in my humble opinion, has not been quite as good.

Therefore, I point out that the problems which have been created have caused this difficulty in achieving the balance about which the distinguished chairman talks.

Referring to the remarks of the distinguished Senator from Arkansas concerning the statement that we do not have good planes, my experience is that we do not now have them. We have been very neglectful in certain categories. Our planes are good but old. We have not kept up with our potential aggressors and enemies.

We do have a good rifle. However, strangely enough, for some reason, we have only one manufacturer. We have heard about the deficiencies of the South Vietnamese. However, we find that when they had a good rifle, they are pretty good soldiers. They are brave. They are eager to defend their country.

So, I think that the distinguished chairman of the Armed Services Committee makes an excellent point. While there are many other areas that need our attention in this country, they have not been neglected.

I have had the great privilege of serving on the Labor and Public Welfare Committee and on the Education Subcommittee. There has not been any great neglect. However, we could do more.

I join with the distinguished Senator from Arkansas in hoping for the day when this sort of balance has been achieved and we can proceed on all matters in progress, peace, and prosperity not only in our country but also around the world.

At the present time, I am afraid that we must be realistic.

I am afraid that we cannot achieve all of the theory on these programs. We have to accept the situation as it exists today. We have many plans for research and development. We have very little hardware.

We have to rebuild and reestablish our military in order to carry out our commitments and, hopefully, as the result of the strategic arms limitation meetings that are about to take place, we can look for a day when we can deescalate the expenditures on the military side and increase them on the other side.

My colleagues know that I come from a State where a great deal of these procurement funds will be spent. I have had no pressure, no calls, and no suggestions from the so-called highly publicized military-industrial complex which used to be called the military-industrial-scientific complex. There has been no pressure on me.

My decisions in the committee have been based on the information brought out in the hearings and as a result of the questioning of experts, both military and nonmilitary and the studying and reading I have done over years past in order hopefully to equip myself properly for my present position.

I associate myself with the remarks of the distinguished chairman of the committee, the Senator from Mississippi, and say that he hopes, as we all do, that this balance will be much easier to establish once we get world conditions in balance the way they should be.

Mr. STENNIS. Mr. President, I thank the Senator for his remarks.

I point out to the Senator from Arkansas that my remarks and my plea is for this balance in conventional forces within the military. However, if he will bring in some more balance on our commitments in a bill or a resolution, with a report and other usual documents behind the measure, things that ordinarily go with it, he and I will be found to be closer together. My point is that, until we do that, we cannot simply turn our backs on the commitments we have made.

Mr. FULBRIGHT. Mr. President, we are in the process of trying to do that right now in reexamining our commitments. We have a staff working on it and we think we are making some progress.

I hope the Senator does not think we are not doing our best to do exactly that. In the meantime, other matters come up and require our attention.

I am not being critical of the Senator from Mississippi. He is doing his job as is the military, I think. I think in all honesty that I and the other Members of the Senate have failed to do what we should have been doing for 10 or 15 years in being a little more attentive to this kind of program. We have allowed our priorities to get out of balance.

Does the Senator from Mississippi agree that we have inferior planes and that our planes are not as good as the aircraft of other countries?

Mr. STENNIS. I do not agree. I hope the very opposite is true. However, if we do not build new planes, new types of planes—and we have to make the decision 4 or 5 years in advance—we could find ourselves second rate. We may have already slept too long with reference to other weapons.

Mr. FULBRIGHT. We heard the statement of a Senator from a State in which more planes are built than in any other State, to the effect that we have inferior planes.

I never believed that to be true. I had not heard that at all.

We have some that are inferior in some fields. However, our best planes are as good as the best planes of any other country today.

Mr. STENNIS. I do not know that that is true right now. However, we have provision for some contained in the bill. They are moving along and will be the best.

I have referred to our many commitments to other countries—commitments which require us to defend them.

I mentioned Japan. There is a hard one. Take that one on and get it modified, if the Senator believes it should be modified, and bring us something definite on that problem if the Senator wants to. I believe that we can consider some other matters here in that immediate field.

Mr. FULBRIGHT. I think there is a great deal of merit in what the Senator is saying, and that is what we are trying to do. We recently had the case of the Spanish bases, and we tried to modify it. We did get it modified—not as much as I would like, but we modified it substantially.

Mr. STENNIS. I thank the Senator.

Mr. PROXMIRE. Mr. President, will the Senator yield?

Mr. STENNIS. I yield to the Senator from Wisconsin. I do not mean to try to retain the floor.

Mr. PROXMIRE. I will be brief.

I say to the distinguished Senator from Mississippi that so far as cutting in the dark is concerned, I think that this year, for the first time in many years—certainly, in the years I have been in the Senate—we are acting with far more information and understanding than ever before, for a number of reasons.

First, the Senator from Mississippi has done an excellent job in his committee and in his hearings. I have had a chance to go over the hearings, and I think he and his committee not only have asked the right questions but also have organized unsually well. As I understand it, the Senator has delegated to some of the members of the committee a great deal of authority, and they have investigated thoroughly and have come up with some extremely useful information.

In addition—and I think this is most unusual—this year a number of Senators—I am not one of them—organized a group called Peace Through Law, and they secured outside professional advice on a number of weapons systems.

If the Senator from Mississippi has had a chance to review the report—I think the Senator from Oregon (Mr. HATFIELD) is one of the principal movers in this area—I believe he will be impressed not only by the professionalism involved but also by the moderation of their recommendations. They did not propose to cut deeply, but they did propose to make some moderate, thoughtful cuts that were well documented.

I understand that the Senator from Oregon will speak on this matter a little later. I hope he speaks soon, because the Senate should be aware of the very comprehensive, painstaking, and thorough examination which has been made of this budget.

Also, the Joint Economic Committee held hearings last November, January, and June, in which we examined in considerable detail, on the public record, the military budget. We had some experts on these weapons appear before us. We have developed some substantial information.

So I think this debate will not be cutting in the dark and it will not be irresponsible from the standpoint of those who are offering amendments to reduce the military budget. I agree with the Senator from Mississippi that we must have a strong military force—strong Army, Navy, and Air Force—and we must be secure. I think our amendments are going to be in the area of trying to achieve this. If there is a difference of opinion, it is simply a difference of judgment as to precisely what is needed from a technical standpoint, not a difference in terms of value in judgment. We must have a secure armed force, for our military people certainly are serving this country very well.

Mr. STENNIS. I thank the Senator very much for his remarks. I think he has done some excellent work.

Mr. MILLER. Mr. President, will the Senator yield?

Mr. STENNIS. I yield.

Mr. MILLER. Mr. President, I am pleased that the Senator from Wisconsin is present, because he has a great amount of knowledge about the economic aspects of this matter.

The statement has been made by the Senator from Arkansas that we should have a balance in the broader sense of the term rather than a balance with respect to conventional and strategic forces. I think both points of view are proper. We should have a perspective in both senses.

But I think the danger is that by talking about a balance in the broad sense, much has been said about the military being out of balance. I believe the Senator from Arkansas implied, when he pointed out all the other commitments, that we have in our own domestic responsibilities.

I have been trying to make the point to my colleagues—and this is the third time—that one way of looking at balance is to look at our gross national product.

I believe that economists generally take a look at a nation's gross national product as an indication of its capabilities to meet various commitments. While I recognize that a $78 billion national defense budget sounds like a great amount of money, I think it should be put in the perspective of what our gross national product is.

I have pointed out that for fiscal year 1970, the $78 billion defense budget will comprise approximately 8.1 percent of our gross national product, and that is no larger than it was for fiscal 1969. I thought we should go back in 5-year periods for 15 years to see how it looks. If one goes back to fiscal 1964, fiscal 1959, and fiscal 1954, he will find that the proposed defense budget for fiscal 1970 is less in percentage of our gross national product than 3 of those periods and equal in one.

So I find myself a little unenthusiastic about all this talk about balance when I take a look at our ability, which is reflected in the gross national product.

One other thought on this matter is that if you take from the $78 billion national defense budget $28 billion for the cost of the war in Vietnam, you get down to $50 billion, which we might say represents what could be a normal national defense commitment. The war is an abnormal situation. That would put us down to 5 percent of our gross national product.

I invite the attention of Senators to this fact: Even though the 8.1 percent of our gross national product is what our national defense will come to for fiscal 1970, that includes $28 billion for the war. When you go back to 1964, there is practically nothing for the war; there was nothing for a war in 1959; and there was nothing for a war in 1954. Yet, the percentage of the gross national product devoted to military was greater than the percentage we are going to have for fiscal 1970.

My point is simply this: Before we start talking too much and too enthusiastically about a balance, let us put things in perspective. If we put things in perspective, then I think we might be able to do a better job.

I thank the Senator for yielding.

Mr. STENNIS. I thank the Senator.

Mr. ELLENDER. Mr. President, will the Senator yield?

Mr. STENNIS. I yield.

Mr. ELLENDER. Mr. President, there is no one in the Senate for whom I have higher respect than the distinguished Senator from Mississippi. I know that he is doing a good job as chairman of the Committee on Armed Services. He is very conscientious.

Mr. STENNIS. I wish I could be as good a Senator and as effective a Senator as the Senator from Louisiana.

Mr. ELLENDER. I have been trying for the past 12 years to get most of our troops removed from Western Europe. We have had between four and one-half and six divisions there for 20 years. The main reason why they were sent there, as I understand it, was to help contain the Soviet Union, and to reassure our NATO allies that they would be protected by U.S. forces.

We built huge airfields in Japan, Okinawa, the Philippines, and all over Africa to isolate Russia, and in the process we actually have been sustaining all of Western Europe militarily. We have also constructed many harbors and other military installations. But, somehow, we seem to be unable to get the countries of Western Europe to assist us in our efforts. They do not seem to sense the danger as our military advisers see it, and that should give us something to think about.

The Senator stated that we are in South Korea. We have been there virtually alone for many, many years. And this is supposedly a United Nations undertaking.

It is not totally a U.S. action, as the Senator knows but we have been carrying most of the burden. It seems that the executive department is unable to obtain help or any kind of assistance from the other members of the United Nations. We have been carrying that load alone, as I have stated, at a very substantial cost to our taxpayers.

Now as to Western Europe, it seems to me that it is up to the Chief Executive and perhaps Congress to try to get assistance from our erstwhile allies or withdraw most of our manpower from that area. We have been in Western Europe now for 20 years, as I said. It has been costing the taxpayers of this Nation over $2 billion a year to sustain the five and one-half divisions stationed there. Together with their families that are and have been in that area for the past 15 years, the total of roughly 600,000 Americans.

I cannot understand why we should not obtain assistance. The Senator is on the Subcommittee on Appropriations for the Armed Services. He knows that I have tried every time a new Secretary of Defense was named—beginning with Mr. McElroy and then Mr. Wilson, and their successors—to get help from Western Europe. All I could obtain was, "We will try." Try—that is all they have done and with no results.

From the start the countries of Western Europe were not carrying their just load as they promised to do. On a visit there in 1960, between the Republican and Democratic National Conventions, I found that our so-called allies had no divisions that were ready for action. In Germany, Belgium, and other countries, there were more or less paper divisions. If the Russians had struck in 1960, there would have been only five and a half divisions from our country ready to go, and one brigade from Canada. As I have stated, the rest of them were paper divisions and it would have required months to bring them to our stanards.

Why that situation was permitted to continue I cannot say, but somebody was not on the job. When I visited SHAEF in 1960, even our military people there stated to me that our allies were well prepared and ready to go, but after an investigation I found that they were mere paper divisions, particularly in Germany.

Now, to come to our local situation, I have voted every dollar requested by the Defense Department to maintain our defenses. Five or six years ago it was my feeling that since we were living in a missile age, we should spent much of our time and money in developing more and better missiles. It was obvious to me that if a war were to occur between us and Russia, it would be a war in which nuclear missiles would be used, and not conventional weapons.

I stated at the time that it was my feeling and my belief that our country could not afford to carry on both a missile-age program and a conventional war program. It would be simply impossible; it would be too costly. But my advice was not heeded, and we are making efforts now to carry on preparation for both a missile-age war and a conventional warfare program. I see no reason why we should do that if the people from Western Europe, who are now able to assist us, do not joint in helping us. It is my belief that as long as the U.S. Government permits the French, Germans, Belgians, Danes ,and the British to lay their heads on Uncle Sam's shoulder and to carry them along, they will not do anything to help us out.

Mr. President, it strikes me that every effort should be made by the present administration to obtain assistance, real assistance, from the governments of Western Europe; and, if they do not agree, we should get out of Western Europe. That is what I advocate and that is what I have been proposing for at least 10 years, with little or no success. They seem not to see any danger and our military people take the position that Europe should be protected. I cannot agree.

I am not going to try to debate now the many mistakes made by our policy planners or by the managers of the Pentagon's research and development program. However, as the Senator from Mississippi knows, it has been my belief for a long time that we have been providing too large a reservoir of research money for the Pentagon, and the planners have fallen over themselves to find ways to spend the available funds. I think this year the Defense was allowed over $8 billion by the Bureau of the Budget. Is that correct?

Mr. STENNIS. The exact figure was $8.2 billion.

Mr. ELLENDER. And it was cut back by how much?

Mr. STENNIS. About $1 billion in all.

Mr. ELLENDER. As I figure it, there is over $7 billion in the bill before us.

Mr. STENNIS. It is $7.179 billion.

Mr. ELLENDER. As long as we have that much money for the Pentagon to do research, ways will be found to spend it. I am very hopeful that during this session we will be able to cut back on some of these research funds. Today we are budgeting almost $17 billion for research funds in all departments of Government. I cannot help but feel there is much waste. Such a huge sum cannot be frugally administered.

My good friend from Arkansas (Mr. McCLELLAN) is familiar with all the billions of dollars that we have spent for the F-111, but we still have funds in the pending bill for further research and building more prototypes and some planes for our Air Force.

Mr. McCLELLAN. Will the Senator yield at that point?

Mr. ELLENDER. I shall yield in a moment. Also, we were presented with a large sum to continue the MOL—the Manned Orbital Laboratory. It was only after a good deal of coaxing that research for the MOL was discontinued. The Air Force is not spending any more money in that direction. Over $1 billion was spent through the Air Force before the project was halted.

In a related area, I am chairman of the subcommittee which goes over the funds requested by the Atomic Energy Commission. For years, we have been working on a small atomic engine for the space program. We have already spent $1,200,000,000 on this engine and up to now we have not satisfactorily constructed a prototype. I asked how long it would take to complete the engine, and I was told 7 more years would be needed and that the cost would be about $1,100-000,000 more. So we will be spending well over $2 billion in order to perfect this machine. Yet at the same time, I am proposing a small amount in that very same bill to continue our public works programs, to fight air pollution and water pollution and, somehow, I have been unable to get amounts budgeted for those worthy projects.

I am for a balanced military program, for our own immediate protection, but not for one to protect the whole world. Most of the millions of dollars we have spent on the military assistance advisory groups and other missions throughout the world have not been well spent. They have brought us more grief and trouble than anything else, in my opinion. They have served to keep the pot boiling, and have helped create fear and suspicion among nations which should be good friends and neighbors. They have helped get us into arguments where we had no good reason to be, and no real American interest to protect.

So far as I am concerned, I should like to see every American soldier now in Europe come back, and let the Europeans do more to protect themselves. They are well able to take care of themselves by this time.

Mr. McCLELLAN. The Senator from Louisiana mentioned a while ago as one illustration the F-111 airplane. In all fairness, I am not absolving the military from all the blame in connection with that airplane, but I think the record should be kept straight that the military, from the very beginning, disapproved of that airplane, and from the beginning, the military people warned that the commonality of the concept would not work, that the two planes would not be able to perform the missions for which they were designed. Thus, I simply want to keep the record straight that the primary mistake and responsibility, and then the compounding of that mistake, lies primarily with the civilian head of the Department of Defense and not with the military who repeatedly tried to get that concept modified and the plane redesigned so as to make it work.

I am not absolving the military from all the blame but this is one instance where there was a great overrun of the costs, where the Secretary of Defense said he was taking the figures out of his head and overruled everyone else. Thus, we cannot blame the military and the experts in the military field when they try to counsel, and their counsel is overruled in that fashion. I want to keep the record straight. I am sure the military have made many blunders, but the Senator mentioned that one plane, and I have some knowledge about that.

Mr. ELLENDER. I have named no one.

Mr. McCLELLAN. I did. I named someone.

Mr. ELLENDER. I did not. I was talking about the Defense Department generally. I know that there was quite a difference of opinion between the Navy and the Air Force regarding the F-111 and that the Navy took the position that they should have their own plane.

Mr. McCLELLAN. The result was they did not get any plane. If they had gotten what was given to them, they would not have had a weapon.

Mr. ELLENDER. The point is that the Department of Defense, in that area, spent about $2.5 billion. Is that not correct?

Mr. McCLELLAN. They spent nearly $5 billion.

Mr. ELLENDER. Very well. That makes it wose; $5 billion and they have no planes at present.

Mr. McCLELLAN. They will be getting 400 planes, instead of the 1700 originally ordered.

Mr. ELLENDER. As I said, I named no one. I was speaking of the Department of Defense generally. I am certain Mr. McNamara did not move alone.

Mr. McCLELLAN. He overruled all the military.

Mr. ELLENDER. Perhaps.

Mr. McCLELLAN. That is an undisputed fact.

Mr. ELLENDER. The point I was trying to emphasize most is that we have made many promises to assist everyone in the world. That has been the effect of the MAAG's I referred to earlier. That is some of the programs I have been trying to emphasize. That is why we have spent so many billions of dollars to help people who did not do enough to try and help themselves.

Mr. McCLELLAN. Let me say to the distinguished Senator from Louisiana that I wanted to keep the record straight with respect to the TFX airplane.

Now I want to say to the Senator that I am in complete agreement with him about Western Europe. We have supported them all these years, providing defense for them, and I think it is high time they began to provide their own. I agree completely with the Senator from Louisiana about that. When we talk about bringing our troops home, the Western European countries should take up some of the burden of defending the free world.

Mr. COOPER. Mr. President, will the Senator from Mississippi yield?

Mr. STENNIS. I yield.

Mr. COOPER. Mr. President, I have listened with a good deal of interest to the statement of the Senator from Mississippi and the remarks which have been made in response. We appreciate his sincerity and the great amount of work he has performed on the bill before us. For myself, I do not find any fault in his concept of balance.

While the amendment which was offered by the Senator from Michigan (Mr. HART) and myself took a good deal of time, I do not think it has been wasted. It has directed the attention of the Senate, the Congress, and the people to the defense budget, and naturally the debate led into the larger questions of security and the means of attaining security.

I have not been one who has criticized the military. I have always recognized that our military leaders have a particular responsibility, a responsibility to plan and recommend those programs which they believe are necessary for the security of the country. The security of this country is not limited only by its physical protection but, in my view, it comprehends protecting its institutions and our free system of Government.

Anyone who has been in the military service, whether in a squad, platoon, company, or regiment, knows that every commander of a unit seeks all the materiel and arms he can to meet any contingency. I have no doubt that this responsibility enters into the thinking and concern of military leaders. But to secure balance, there are several things to be considered.

One consideration is the resources of our country and this demands the amount be allocated for effective and reasonable purposes. As the Senator from Louisiana pointed out a second consideration involves the use of our resources in assistance and defense of other countries, any inquiry as to the efforts they are willing to make. I remember when the Senator from Mississippi and I attended the NATO assembly meeting, after the invasion of Czechoslovakia.

Then, the representatives of other countries, were concerned, and the meeting reflected great interest in the defense of Europe. It was my duty to file a report, and on examination, and as a result of comments from military leaders, I at least, came to the conclusion that if there had been any balance between the NATO forces and the Soviet forces, the balance had been upset by the invasion of Czechoslovakia. Yet since that time, our NATO allies, no matter how much they are appealed to, have not increased their contributions necessary for the adequate defense of their own countries.

I had attempted to secure from the Department of Defense the cost of our total contribution to the security of Western Europe. I secured information from the Department of Defense, which I placed in my report. The total cost, not merely the cost of the troops in Europe, but the cost of the 6th fleet weapons, and backup costs, was $12 billion annually. This fact demands help from the other countries.

As Senators have said, we must relate our defense needs to our foreign policy commitments. What a good many of us have tried to do is to insist that the Executive branch be very careful about commitments. We do not want it to be taken for granted that a commitment exists to send troops to another country, to engage in war, or to put our troops on foreign soil in a position where we could back into a war—which we have done in Vietnam—unless a joint authority is given by the Executive and by the Congress of the United States.

We ought to establish what our commitments are, and their relationship to the security of this country. Otherwise, we may be engaged in military spending, and wars in areas throughout the world.

We should try to find agreement with the Soviet Union upon the control of nuclear arms. We hope that progress can be made. Agreements could reduce materially the demand for spending, and even more important, reduce the chance of nuclear war.

Now I would like to make a suggestion.

Mr. STENNIS. I will consider a suggestion from the Senator from Kentucky at any time.

Mr. COOPER. We have a bill before us involving about $20 billion. It involves expenditures for all of the branches of the armed services, and it includes many items with which those of us who do not serve on the Armed Services Committee are not familiar.

For a year I have found how difficult it is to learn about one issue—anti-ballistic-missile systems. I believe it would be very helpful if the Senator from Mississippi would go through the bill, explain the provisions of the bill, the need and relationship of the weapons systems, which are very difficult for all of us, and explain the reasons supporting the various provisions and their funding. Give us your views of the balance of the bill of which the Senator spoke so well.

Mr. STENNIS. I thank the Senator very much. I know there is a need in that field or the Senator would not have brought it up. I will do my best to fulfill that need, to some degree. I will have to arrange a time.

Mr. President, I do not want to hold the floor any longer. I yield the floor.

Mr. McCLELLAN obtained the floor.

Mr. GOLDWATER. Mr. President, will the Senator yield?

Mr. McCLELLAN. I yield to the Senator from Arizona, without losing my right to the floor.

Mr. GOLDWATER. I thank the Senator from Arkansas for yielding.

Mr. President, this morning, under controlled conditions, the senior Senator from Kansas (Mr. PEARSON) addressed himself to the military-industrial complex. Having forgotten that it was under controlled conditions, I tried to question the Senator at the finish of his speech, but the Chair, properly, silenced me. However, before I was seated, I stated I thought the Senator had made a good speech, but I did not agree with it. I should like to correct what I think may be a wrong impression.

I think the Senator made a fine speech, in which he recommended to the American people that they realize that we have a military-industrial complex, and we should be proud and glad we have it, and he made some very interesting suggestions.

When I said I disagreed with it, it was only as to a point or two in his thinking.

His use of the famous quotation by General Eisenhower in his farewell speech on the military-industrial complex was put in the RECORD without what I think is an equally important part, in which President Eisenhower said:

> We now stand 10 years past the midpoint of a century that has witnessed four major wars among great nations. Three of these involved our own country. Despite these holocausts America is today the strongest, the most influential and most productive nation in the world. Understandably proud of this preeminence, we yet realize that America's leadership and prestige depend, not merely upon our unmatched material progress, riches, and military strength, but on how we use our power in the interests of world peace and human betterment.

I merely wanted to get that point in the RECORD, together with one other that the Senator made. I have discussed this matter with him, and I recognize why he made it. If I did not serve on the Armed Services Committee, I would feel myself somewhat in agreement with him. He comments in one sentence:

> But nowhere is this weakness more glaring than in defense matters.

I take personal offense at that, because I have served on committees of the Senate for many, many years, and I have never served on a committee that is so thorough and so constant in its investigations as is the Armed Services Committee, under the chairmanship of the Senator from Mississippi (Mr. STENNIS).

The Senator went further, and this is one other point I disagreed with, but it does not mean I disagree with the entire speech at all. He said:

> I submit that under the present conditions it is a simple physical impossibility for the two armed services committees and the two military subcommittees of the appropriations committees to effectively review and evaluate the policy and budgetary requested of the Department of Defense.

I wanted to make a statement on my own behalf that this is not so; that I think the two committees and the two subcommittees involved do an excellent job.

I also wanted my verification on the record that the suggestion which he made to return to a Truman type of committee that we knew back in World War II is a good one, whether it means expansion of the present committees or setting up a new one.

I wanted merely to correct the record. I thank the Senator from Arkansas for yielding to me.

Mr. McCLELLAN. Mr. President, I yield to the Senator from Connecticut (Mr. RIBICOFF) without losing my right to the floor.

Mr. RIBICOFF. Mr. President, during the past several days, the Senate has been deeply concerned about waste in the defense budget. This concern has been demonstrated by the number of amendments introduced relating to the role of the General Accounting Office in auditing defense contracts.

Every Member of this body is dedicated to efficient and effective government. And so is the Committee on Government Operations.

The Committee on Government Operations is concerned about any waste, excess spending, or inefficient practices in the Federal Government, wherever they exist. In particular, it is especially concerned that the agency established and charged with monitoring Federal spending—GAO—be properly constituted and staffed for this critical task.

As was repeatedly noted during last week's debate, the Committee on Government Operations has legislative oversight over the operations and activities of the General Accounting Office. The following excerpts from Senate rule XXV makes this very clear:

> (j)(1) Committee on Government Operations . . . to which shall be referred all proposed legislation, messages, petitions, memorials and other matters relating to the following subjects:
>
> (A) Budget and accounting measures, other than appropriations.
>
> (B) Reorganizations in the executive branch of the Government.
>
> (2) Such committee shall have the duty of—
>
> (A) receiving and examining reports of the Comptroller General of the United States and of submitting such recommendations to the Senate as it deems necessary or desirable in connection with the subject matter of such reports;
>
> (B) studying the operation of Government activities at all levels with a view to determining its economy and efficiency.

Commenting on proposals to expand the concept and functions of the General Accounting Office, the able and distinguished chairman of the Senate Armed Services Committee, Senator JOHN STENNIS, placed in the RECORD of August 7, 1969, a letter he had received from Elmer B. Staats, the Comptroller General, which stated in part:

> Before legislation of this type is enacted, it would be our recommendation that the most careful consideration be given to it by the Congress. The type of reviews made by this office and the needs of the interested committees of the Congress need further development and exploration.

This assessment should begin with the committee that has statutory responsibility for the activities of the General Accounting Office.

I have been authorized by the chairman of the Committee on Government Operations, Senator JOHN McCLELLAN, to say that the committee plans to hold hearings on the General Accounting Office to determine its capacity to meet its current—and proposed—obligations and responsibilities.

The hearings would be a general assessment of the GAO, its statutory authority, budget and staff. We would also seek to determine in what additional ways the GAO could better fulfill its obligations to the legislative branch. I would also like to note that these proposed hearings have the full endorsement and support of Senator KARL MUNDT, ranking minority member of the committee. The committee hopes to hear testimony from the Comptroller General, from interested Senators, from the Department of Defense, and others. We

incomplete